Metaphor and Content: An Embodied Paradigm for Learning

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(Abstract)

Through a direct application of two cognitive science theories, conceptual metaphor (Lakoff & Johnson, 1980, 1999) and structure mapping (Gentner, 1983, 1989; Gentner & Markman, 1995), this project defined an instructional design model for the design, development, and assessment of metaphor-enhanced, computer-mediated learning environments. It used the model to produce an instructional product with a metaphor-based interface. The project also built a parallel learning environment that employed a concept map interface. To test the metaphor-based product's effectiveness at enabling learners to build rich mental models of a complex, abstract concept, the project ran fifty-seven preservice teachers (55 female, 2 male; mean age of 21) through the instruction, randomly assigning half to the concept map interface environment and half to the metaphor-based interface environment. Participants completed four essay-type assessment questions. Trained raters, blind to participant assignment, isolated any of the 13 targeted concepts present within participants' protocols and, through consensus, constructed a concept map for each participant, representing that participant's mental model of the targeted domain. Map attributes were translated into four weighted subscores (nodes, branches, levels, and cross-links) and summed. Comparison across the two groups indicated no significant difference for richness of mental model, $t(55)=-.72$, $p> .05$, although the discussion suggests methods for increasing the power in subsequent experimental sessions. A significant interaction between Subscore and Achievement, $F(3,51)=33.42$, $p< .01$, suggests that concept map cross-links are much more sensitive to differences in domain integration and the general richness of a participant's mental model than the level and branch subscores. This result has implications for

classroom application. Concept maps have taken a place as a learner's, a teacher's, and a researcher's tool. With cross-domain validation and domain-specific extensions, specification of the relative sensitivity of various subscales, that is, the structure of the concept map, will enable educators to justify weighting scales and identify learner achievement. Credible concept map weighting scales also enhance learners' self-reliant and impartial assessment of personal growth in domain-specific knowledge. Results suggest that learners who have difficulty integrating domain concepts require direct, explicit instruction to help them to make connections between disparate conceptual strands.

To

EJC, EE, JSR, and LJR

And to

Frederick Francis Ellwanger
(1954-1975)

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And Dr. Carroll – ah – Dr. Carroll. Dr. Albert Bandura wrote

. . . human acquisition of specialized cognitive competencies relies increasingly on modeled expertise. In this process, the knowledge and reasoning strategies for sound judgment are gleaned from those who are highly knowledgeable and skilled in the relevant domain of activity. (1989)

I thank you, Dr. Carroll, for my tenure as a graduate research assistant at your Center for Human-Computer Interaction. It was delicious as whipped cream and chocolate dessert—topped by a red cherry.

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Chapter 1: Introduction

Learners often find it difficult to construct sound mental models of abstract and unfamiliar concepts (Lawson, Alkhoury, Benford, Clark, & Falconer, 2000). It is easier to learn the concrete: what we can see, hear, feel, smell, and touch. Fortunately, the human cognitive apparatus can surmount this difficulty through a natural, ubiquitous mechanism: analogical reasoning (Lakoff, 1993; Lakoff & Johnson, 1980, 1999). Analogical reasoning is a cognitive process that allows people to use their knowledge of and interactions with concrete and familiar experiences to help them understand the complex and subjective. Theorists (e.g., Bono, 1990; Kuhn, 1993) and researchers from both Human-Computer Interaction (e.g., Carroll & Mack, 1999; Carroll, Mack, & Kellogg, 1988; Meyer, 2001; Morgan, 1993; Neale & Carroll, 1997) and the Learning Sciences (e.g., Baker & Lawson, 2001; Berkley & Cates, 2000; Brown & Kane, 1988; Land, 1995; Mayer, 1993; Moreno & Mayer, 1999; Papert, 1980; Rieber & Noah, 1997; Rieber, Noah, & Nolan, 1998) suggest that human analogical reasoning engaged through metaphor-based environments helps learners to incorporate new concepts into their existing mental schema.

According to the theory of conceptual metaphor, people use their interactions within the concrete environment to structure their intuitions of subjective and abstract domains (Lakoff, 1993; Lakoff & Johnson, 1980, 1999). Today's computer interfaces present us with extensions of the natural environment. They afford user interactions and transactions (as defined by Ames, see Cantril, 1960) with virtual objects that can be seen and manipulated. Because a computer interface can present a virtual environment to the learner, and because computer mediation is so prevalent in contemporary instructional environments, it seems a natural extension to design,

develop, and assess computer-mediated instructional environments that incorporate instructional metaphors.

Metaphors are especially appropriate when learners are introduced to new, abstract concepts. The metaphor acts as a scaffolding (Jonassen, 1981); that is, a learner structures the to-be-learned domain, the target, according to the relational structure of the concrete and more familiar domain, the source domain (see structure mapping theory in Gentner, 1983, 1989; Gentner & Markman, 1997). This projection of relational structure from one domain to another is called mapping. Within pedagogical applications, an instructional metaphor source domain can be carefully structured so that it replicates the relational structure of the target domain (Carroll & Mack, 1999, p. 395). Thereby, the source domain can be a resource for appropriate learner scaffolding.

Need for the Study

Developers, educators, and researchers tend to take a pragmatic approach to the design and development of metaphor-based instruction (Madsen, 1994): They may consider a learner's goals, prior knowledge, learning context and experience, but may employ an intuitive approach (Carroll et al., 1988) to the specification of source and target domains and analogical mapping (for a sample of researchers' design rationale for instructional metaphors, see Baker & Lawson, 2001; Meyer, 2001; Moreno & Mayer, 1999). A growing body of literature documents learner gains derived from metaphor-based instruction, but inconsistent results continue to plague scientists and educators (Baker & Lawson, 2001). While pragmatically designed metaphor-based instruction can be effective, a more formalistically structured connection between source and target may increase the ability to couple metaphor-based learning environments with consistent learner gains. Codification requires an underlying system based upon sound theory and research,

such as might be found within cognitive science. To this end, direct application of cognitive theory (Gentner, 1983; Gentner & Markman, 1997; Lakoff & Johnson, 1980, 1999) toward design of metaphor-based instruction suggests (a) that computer interfaces might provide concrete environments that serve as source domains mapping to abstract target domains and (b) the principles of structure mapping might provide a formalism to guide the selection and specification of apt instructional metaphors. The fact that cognitive scientists "have overwhelmingly agreed that mapping is the core component of analogy" (Salvucci & Anderson, 1998, p. 334), that the mapping process is "pivotal" (Spellman & Holyoak, 1996, p. 2), lends support to the hypothesis that formal specification of domains and source-target relationships should be a central consideration in the development of metaphor-based instruction. Since the source domain can serve as a scaffolding, providing structure for a learner's organization of a targeted conceptual domain (Carroll & Mack, 1999), it is possible that a formal approach to domain specification and analogical mapping might increase control over the design, development, and assessment of metaphor-based, computer-mediated instructional environments. If so, metaphor-based, computer-mediated instruction could translate into learner gains when instructional content concerns abstract domains.

Purpose of the Study

This study, Analogical Designs, investigates a formal approach to the design, development, and assessment of metaphor-based, computer-mediated learning environments. That formalism is based upon two cognitive theories: conceptual metaphor and structure mapping.

According to the theory of conceptual metaphor, human metaphor-making is embodied – a natural outgrowth of the characteristics of the human body (both the cognitive apparatus and

the rest of the body) and the manner in which humans negotiate the physical and cultural environments (Lakoff & Johnson, 1999). By extension, Analogical Designs assumes that the designer of a computer interface has the potential to create a virtual concrete world for a learner to negotiate, a world structured such that it serves as a concrete source domain for a targeted abstract concept.

Structure mapping specifies the principles of human analogical reasoning that guide and constrain the mapping process from a targeted to-be-learned concept to a selected source domain (Gentner, 1983; Gentner & Gentner, 1983; Gentner & Markman, 1995, 1997). In a formal approach based upon the principles of structure mapping, Analogical Designs investigates the effect of metaphor-based, computer-mediated instructional environments designed, developed, and assessed according to the principles of structure mapping on the learner's mental model of a targeted conceptual domain.

Chapter 2: Review of the Literature

The analogical process is ubiquitous within human reasoning (Hummel & Holyoak, 1997). It is a parsimonious process, allowing people to make inferential judgments "on the basis of a single case (i.e., the source) rather than relying on a large number of examples" (Spellman & Holyoak, 1996). Pedagogically, analogical reasoning allows the designer of instruction to "codify and communicate new knowledge in a comprehensible way for the learner" (Carroll & Mack, 1999). Hence, designers can shape metaphors to serve as scaffolding when learners are introduced to challenging concepts (Jonassen, 1981).

When masons and carpenters construct buildings, they assume that the scaffolding that supports them, stories above the ground, is well designed and constructed. The consequence of inadequate scaffold design, specification, construction, or set-up may be irreparable, life-long injury. While inadequate specification, design, or development within metaphor-based learning environments may not result in physical injury, resultant learner misconceptions may be as debilitating to individual's academic success, self-esteem and life-long potential.

Terminology

There is some inconsistency, across disciplines that study and employ analogical reasoning and metaphor, in the use of terminology. This section serves as a brief introduction to that terminology as it defines the conventions adopted for this discussion and the study derived from it.

1. Concept – a neural structure that allows humans to mentally characterize categories and reason about them (Lakoff & Johnson, 1999)

2. Domain – a system "of objects, object attributes, and relations between objects" (Gentner, 1983, p. 156)

3. Source domain – a concrete, relatively familiar, or relatively well-known domain

4. Target domain – an abstract, relatively unfamiliar, or relatively unknown domain

5. Analogy – the cognitive process through which humans transfer their knowledge and inferences from one known or relatively familiar domain to another less well-known or unfamiliar domain according to their shared relational structure

6. Mapping – the process of making relational connections between objects in a source domain and objects in a target domain

7. Cross-domain mapping – the mapping of relations from a source to a target domain (Lakoff, 1993)

8. Metaphor – a specific example of a mapping between a source and target domain

9. Isomorphism – a one-to-one mapping between two domains that preserves the relations existing between domain objects. Morphism refers to structural consistency (Holyoak & Thagard, 1989). Iso- means one-to-one. Isomorphism contrasts with homomorphism, which refers to many-to-one mappings between source and target domains

10. Subsumption – the idea that humans organize their conceptual system so that sub-concepts are collected together as subsets of more inclusive concepts (Ausubel, 1962; Novak, 1992)

11. Metaphorist – one who studies metaphor or analogy

12. To-be-learned – This terminology is borrowed from the cognitive science literature. It literally refers to the content that is to be learned by the learner or participant (Mayer, 1993, p. 568, 571). For example, participants in word recognition experiments encoded words from a to-be-learned list (Kintsch, 1988, p. 179). In the same vein, Tulving (1973, p. 361) used the term to-be-remembered to refer to the content that a participant was to remember.

As I suggested above, there is some inconsistency, among theorists and practitioners, about the terminology to use for the human cognitive process that maps relational structure from one domain to another. Lakoff and Johnson (1980, 1999) use the term "metaphor", Gentner and her colleagues (Gentner, 1983, 1989, 1993; Gentner & Markman, 1997; Gentner & Schumaker, 1986; Gentner & Stevens, 1983b) use the term "analogy". That their use of the two terms refers to the same cognitive process is supported by Gentner and Jeziorski (1993), who wrote, "the conceptual metaphors analyzed by Lakoff and Johnson are examples of systematic relational metaphors, that is, metaphors that could also be called analogies" (p. 452, see also Clement & Gentner, 1991). Within this discussion, I will be consistent with Lakoff or Gentner, respectively, in choice of labels when discussing the individual's theory. In general, though, I'll use the term "metaphor" when I refer to the statements that label and define a mapping between source and target domains. I will use the term "analogy" to refer to the cognitive process of mapping relational structure. Thus, I will introduce an instructional design model that uses metaphors to help learners make analogical connections from a source domain to a targeted conceptual domain.

Structural Specification Is Central to Analogy

Carroll and Mack (1999) suggested that the pedagogical application of metaphor should "serve to codify and communicate new knowledge in a comprehensible way for new learners" and that instructional metaphors "may be carefully crafted and presented in a way that helps the learner make just the connections the instructor wants the learner to make" (p. 395). Although instruction designed to provide scaffolding for concept acquisition may require syntactic specification of domain and mapping relational structure, metaphor-based design often follows a pragmatic approach (see Baker & Lawson, 2001, for example of pragmatic approach toward

designing instructional metaphors in science education; for description of pragmatic approach to metaphor-based design, see Madsen, 1994; see Meyer, 2001, for example of pragmatic orientation toward computer-mediated, metaphor-based instruction). The pragmatic approach derives from pioneering cognitive science research in the early 1980s (Gentner & Holyoak, 1997). At that time, two research agendas led to the development of analogy theories that seemed in contradiction. Holyoak and his colleagues, working from a problem-solving orientation (i.e., specification of initial state and goal state in order to work toward solutions in ill-defined problems), developed a pragmatic explanation of analogical reasoning that led to multiconstraint theory (Gentner & Holyoak, 1997; Gick & Holyoak, 1980; Holland, Holyoak, Nisbett, & Thagard, 1986). At the same time, Gentner and her colleagues, investigating mental models and analogy in science, discovered the principles of mapping theory that became structure mapping (Gentner, 1980, 1983; Gentner & Holyoak, 1997; Gentner & Stevens, 1983b; Gick & Holyoak, 1980; Holland et al., 1986). Initially, the two theories disagreed about the roles of both syntactic structure and goal orientation in analogical reasoning.

By 1989, Holyoak and Thagard (Clement & Gentner, 1991) had modified Holyoak's original analogy theory to include structural constraints. Today, cognitive theorists agree that the mapping procedure, in which "a familiar analog must be mapped to the target analog to identify systematic correspondences between the two thereby aligning the corresponding parts of each analog" (Gentner & Holyoak, 1997, p. 33), is present to some degree in all cognitive theories of analogy. While structure mapping follows a strict isomorphic mapping, multiconstraint theorists consider isomorphic mapping "an ideal that can be satisfied to some imperfect degree, rather than as an absolute requirement for a successful mapping" (Holyoak & Thagard, 1989, p. 301). Too, both multiconstraint and structure mapping approaches acknowledge a mediating role for

the analogist's goals within the overall process of analogical reasoning. However, the Gentner model disallows pragmatic considerations during the actual process of mapping between source and target domains while Holyoak and his associates maintain that some mapping principles can be flexible and modified, when necessary, by analogist's goals (Holyoak & Thagard, 1989). In summary, multiconstraint theorist Holyoak and his colleagues (1989) agree that "the basic assumption that mapping involves finding structural correspondences is common to both [structural and pragmatic] approaches, as well as to virtually all other theoretical treatments" (pp. 304-305). The consensus across metaphorists suggests that, to provide learners with sound scaffolding for unfamiliar concepts (Jonassen, 1981), practitioners and researchers who design metaphor-based instruction should specify (a) the relational structure of the targeted conceptual domain and (b) its mapping to a source domain.

The present investigation is limited to the case in which instruction, serving as an advance organizer (Jonassen, 1981; Novak, 1992), prompts a learner to make relational mappings between a concrete source domain and an abstract, targeted concept. As such, it concentrates on the portion of structure mapping that aligns most closely with multiconstraint theory and "virtually all other theoretical treatments" (Holyoak & Thagard, 1989, pp. 304-305). Therefore, I will present the underlying principles of structure mapping theory and discuss how structural specification could be used to guide the design, development, and evaluation of computer-mediated, metaphor-based instruction intended to enhance learner understanding of a targeted conceptual domain. First, though, I'll discuss the theory of conceptual metaphor, how it may support the use of interface metaphors in computer-mediated instruction designed for concept learning, and the aspects of the theory that align with structure mapping.

Computer Interfaces as Metaphors: Mapping from Concrete to Abstract

Humans construct their understanding of the world and their place in it through constant transactions with the physical world (Cantril, 1960). Once computer scientists and engineers had conceived and developed the graphical computer interface (see, for example, the history of HyperCard, Goodman, 1988), human-computer interaction expanded to afford virtual push-pull and other sensory transactions that could be designed to model the familiar actions and procedures humans normally conduct with the concrete world (Berkley & Cates, 1996; Berkley & Cates, 2000; Bishop & Cates, 1996; Carroll et al., 1988; Cates, 1996; Neale & Carroll, 1997). The computer interface, then, became a virtual world that could be designed according to specifications to highlight (in the sense that metaphors and analogies highlight salient aspects of a domain, see Gentner & Markman, 1997; Lakoff & Johnson, 1980, pp. 10-13; 1999) specific virtual objects, project and highlight specific relations between virtual objects, and enable the user to conduct transactions with virtual objects. Thus, the computer interface could be designed as a virtual concrete world, and thus, it could help people to construct their understanding of the world in which they live and their place in it. That is, the computer interface could be designed to help people to learn (Carroll & Mack, 1999; Carroll et al., 1988).

In the real world, people use their interactions with concrete objects and events and their understanding of the relations between them to understand abstract and subjective concepts (Lakoff & Johnson, 1980, 1999). When people make connections between the concrete and the subjective, people are engaging in cross-domain relational mappings (Gentner, 1983; Gentner & Markman, 1997; Lakoff & Johnson, 1980, 1999). Hence, they are creating metaphors and engaging in analogical reasoning.

For example, consider the first time you or a friend or family member achieved a victory. Did you or they, perhaps, JUMP FOR JOY? According to Lakoff and Johnson (1999), the primary physical experience of being happy is feeling energetic and having an upright posture. Thus, the sensorimotor domain is bodily orientation, and through association, people map that orientation on to the accompanying subjective domain of happiness. Over time, the relational mapping from the concrete sensorimotor domain to the subjective domain results in a primary metaphor: HAPPY IS UP (p. 50); hence the English sentence, "I'm feeling *up* today" (p. 50). Another example of a primary metaphor mapping from concrete experience to subjective experience is a mapping from (a) the physical experience of being physically close to (b) the subjective experience of intimacy. The primary metaphor is INTIMACY IS CLOSENESS (p. 50). Lakoff and Johnson's example of an English sentence that functions according to this metaphor is "We've been *close* for years, but we're beginning to *drift apart*."

According to Lakoff and Johnson's theory of conceptual metaphor (1999), the human conceptual system contains hundreds of primary metaphors. Individuals develop primary metaphors when their sensorimotor experiences correlate with subjective experiences and judgments (p. 128). Subsequent sections of this review describe Lakoff and Johnson's (Lakoff, 1987; Lakoff, 1993; Lakoff & Johnson, 1980, 1999) position on

1. The embodied nature of conceptual metaphor

2. Basic-level experience and how it determines categorization

3. Body syntonicity and three components of embodied thought

4. Highlighting

5. The transition from direct to indirect reasoning

6. The transition to complex metaphors

7. The image-schema as a relational characteristic of a concrete domain.

The discussion will summarize Lakoff and Johnson's case that metaphorical thinking is a ubiquitous human cognitive process, that metaphors are constructed through cross-domain mappings from the concrete to abstract or subjective domains, and that metaphors develop naturally and effortlessly from human's concrete, embodied interaction with the environment. Further, parallels will be drawn between basic tenants of conceptual metaphor and the three central principles of structure mapping.

Lakoff and Johnson (1980; 1999) suggested that people naturally and regularly form metaphors to map the relational structure from their experiences within the concrete world to subjective and abstract domains in order to enable understanding of what cannot be experienced by the senses or, as Skinner (1974) put it, cannot be shared directly by the verbal community. Assuming Lakoff and Johnson are correct, perhaps computer interfaces specifically designed as virtual models of controlled episodic experiences that map isomorphically to targeted content, sub-concept by subconcept (that is, according to the principles of structure mapping), can act as a scaffolding to assist learners in constructing integrated and sound mental models of targeted abstract concepts.

Conceptual Metaphor: A Natural and Ubiquitous Human Cognitive Process

When Lakoff and Johnson first conceived an embodied view of metaphor, they agreed that metaphoric thinking is both physically and culturally constrained (embodied) and basic to human cognition. In 1979, theirs was a radical challenge (Lakoff & Johnson, 1980) to traditional, objectivist scientific and philosophical paradigms (Lakoff, 1987) that marginalized metaphor. Today, researchers and theorists across disciplines acknowledge the fundamental role of metaphor in human communication, interaction, learning, teaching and thinking (Cameron &

Low, 1999; Carroll & Mack, 1999; Duranti, 1997; Egan, 1997; Gentner & Markman, 1997; Hummel & Holyoak, 1997; Lakoff & Johnson, 1999; Ortony, 1993; Salvucci & Anderson, 1998; Winner & Gardner, 1993). Although they fundamentally agree that metaphor is a mechanism for understanding something in terms of something else, the metaphorists divide into camps by a multitude of theoretical perspectives and analytic frameworks (Cameron, 1999; Gibbs, 1999). Gibbs(1999), alone, lists nine different metaphor theories. From within that tumultuous surf, diverse agendas (e.g., linguistics, problem-solving, philosophy, mental modeling) working at different levels of analysis can converge. When they do, they may afford profound direction for applied research. Over the course of last twenty-one years, linguist George Lakoff and philosopher Mark Johnson extended, elaborated, and supported a view of embodied cognition through conceptual metaphor (Lakoff 1987, 1993; Lakoff and Johnson 1980, 1999) . During that same period, working specifically within cognitive psychology, Dedre Gentner proposed and refined a structural alignment view of analogy (Gentner 1980, 1983, 1989, 1993; Gentner & Gentner, 1983; Gentner & Markman, 1997; Gentner & Schumaker, 1986; Gentner & Stevens, 1983). A superposition[1] of the two theories (i.e., embodied conceptual metaphor and structural alignment) provides a convergent source of insight into human learning from both global and structural levels. These theories assert that (a) metaphor is pervasive in the conceptual system (Lakoff & Johnson, 1980), (b) metaphor is one of the most basic mechanisms people have for "understanding their experience" (Lakoff, 1980, pp. 210-211), (c)"metaphor is a major and indispensable part of our ordinary, conventional way of conceptualizing the world" (Lakoff, 1993, p. 204), and (d) analogical reasoning is "fluent, apparently effortless" (Gentner &

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[1] Comparison to the characteristics of physical water or sound waves suggests that theory overlap will amplify areas of agreement and cancel areas of disagreement.

Markman, 1997, p. 53). Indeed, Hummel and Holyoak (1997) describe analogical reasoning as "ubiquitous in human reasoning" (p. 427). It is possible, then, that computer-mediated learning environments designed from the vantage of metaphor and analogy could enhance human learning through mechanisms indigenous to human cognition (see Carroll, 1997; Carroll & Mack, 1999, but note the reservations Carroll and his colleagues held toward Gentner's theory).

Domains are "familiar categories of daily experience" (Winner & Gardner, 1993). More specifically, a domain is defined as "a system of objects, object attributes, and relations between objects" (Gentner, 1983). According to both Lakoff's conceptual theory and Gentner's structural theory (Gentner & Markman, 1997), individuals' ability to transfer inferences from a relatively familiar domain to a less familiar domain is enhanced when the domains possess highly developed relational structure. Additionally, Lakoff's view of embodied cognition (Lakoff, 1987; Lakoff, 1993; Lakoff & Johnson, 1980, 1999) proposes that human reasoning is based upon transactional analysis (for synopsis of Transactional Analysis, see Ames' chart entitled Transaction of Living: Analysis if Sub-Phenomena Involved and Involving Perception, Cantril, 1960, pp. 68-69). That is, learning proceeds from a base of transactional relationships with the environment, perceived through the senses. When learning involves concepts and subjective content, that learning process is naturally metaphoric (Lakoff & Johnson, 1999). Two affordances, then, provided by the confluence of embodied cognition and structural alignment are (a) human metaphoric learning is pervasive in everyday thought and based upon sensory perception and interaction with the environment, and (b) relational mapping between a source domain and a target domain is natural, fluent, effortless, omnipresent, and greatest when the source domain is constrained by highly developed relational structures. It appears that interface designs engineered upon these two theoretical principles should engender gains in learners'

ability to associate and assimilate new conceptual knowledge and skills. As the discussion of conceptual metaphor and structure mapping will illustrate, this engineering can be constrained such that (a) the to-be-learned is appropriate for development as a cross-domain metaphor and (b) the interface is designed and developed according to structural principles. Therefore, within this model of metaphorical interface design, it will be essential that both the source and target domains contain sufficiently differentiated and relationally complex concepts. Specification of domain structure and cross-domain mappings will also be essential.

Primary Metaphor

According to Lakoff, metaphoric activity begins with primary metaphors. Primary metaphors are formed by individuals when their sensorimotor experiences correlate with subjective experiences and subjective judgments (Lakoff & Johnson, 1999, p. 128). Initially, young persons perceive the two experiences as one in an over-generalization process called conflation (Lakoff & Johnson, 1999). Although individuals learn to recognize the two as separate experiences, strong neural associations between the two remain (Lakoff & Johnson, 1999), as they are "instantiated neurally in the synaptic weights associated with neural connections" (p. 73). Primary metaphor allows individuals to apply the mental imagery from sensorimotor experiences to those in other domains (Lakoff, 1987; Lakoff, 1993). When humans apply mental imagery, they apply the topology (the relative location and space characteristics and relations) of a sensorimotor domain to the abstract or subjective. A common primary metaphor, which will be developed in a subsequent section, is the container metaphor (Lakoff, 1993). People often use a container metaphor when they categorize. The topology of the container (e.g., in or out, inside and outside) allows us to *put* birds *into* the vertebrate subphylum. Other animals may be either *inside* or *outside* that classification container. The topology forms a domain's image-schema.

Humans form hundreds of primary, conceptual metaphors simply through interacting

with their surrounds (Lakoff & Johnson, 1999). Because people possess similar sensory

apparatus and similar neurological structures (Lakoff & Johnson, 1999), and as much as humans

function within similar physical surrounds, primary metaphors are widespread and may be

universal across cultures (Lakoff, 1993). Primary metaphors are acquired

> automatically and unconsciously via the normal process of neural learning and [we] may
>
> be unaware that we have them. We have no choice in this process. When the embodied
>
> experiences of the world are universal, then the corresponding primary metaphors are
>
> universally acquired. This explains the widespread occurrence around the world of a
>
> great many primary metaphors.
>
> Universal conceptual metaphors are learned; they are universals that are not
>
> innate. These conceptual universals contribute to linguistic universals, for example, how
>
> time is expressed in languages around the world (see Chapter 10). There appear to be at
>
> least several hundred such widespread, and perhaps universal, metaphors. (Lakoff &
>
> Johnson, 1999, p. 57)

Lakoff and Johnson's (1999) Chapter 10 analyzed motion and events as metaphors for time,

across cultures and languages. They provided examples from Hindu (p. 140), Aymara (a Chilean

language, p. 141), American Sign Language (p. 144), Hopi, ancient Greek (p. 157), Northern

Africa (p. 157), and Pueblo (p. 164) cultures, as well as two examples from contemporary

physics (a) Einstein's theory of general relativity (p. 160) and (b) the metaphysics engendered by

Stephen Hawking's description of time beginning with the Big Bang (p. 159).

Although their theory speaks to the physical grounding of human thought, it is important

to remember that Lakoff and Johnson (1980) agree with the transactional theorists (e.g., Ames,

and Dewey, see Cantril, 1960) that "every experience takes place within a vast background of cultural presuppositions" (Lakoff & Johnson, 1980, p. 57). They allow that culture (i.e., assumptions, values, and attitudes) mediates all experiences. However, they distinguish between experiences that are more physical (e.g., standing up) and more cultural (e.g., weddings). Primary metaphors are based upon experiences defined as physical.

Within primary metaphors, the sensorimotor experience becomes the source domain and the subjective experience or judgment becomes the target. Metaphors map from objects in the source domain to objects within the target domain. The mappings are cognitive associations between the source and target domains.

In the case of primary metaphors, mapping occurs from the sensorimotor domain to the subjective domains. The sensorimotor domain allows for direct understanding of events, objects, relations and properties because of individuals' physical involvement with them. The manner in which people interact with environment, then, determines how people structure their perceptions of those transactions.

Categorization Proceeds from Basic-level Experience

In fact, Rosch's investigations determined that humans tend to naturally categorize their experiences and objects at the level at which they interact with the environment. This is called the basic-level (Rosch, 1978, 1983; Varela, Thompson, & Rosch, 1991). Superordinate categories contain nested, subordinate categories. Please refer to Figure 1. This diagram is hierarchically organized, illustrating a classical view of categorization. However, category membership is not always determined by necessary and sufficient conditions. Due to prototype effects, category structures can also be radially organized or demarcated by graded boundaries. Radial categories are structured by a center-periphery schema. An external container holds

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(subsumes) the subcategories, as in hierarchy structure. The sub-categories are linked like a series of hubs, with the most salient category in the center. Central radial category members can be predicted. Non-central category members cannot be predicted by central category members. However, non-central members are motivated by central members. For example, within the category of motherhood, surrogate mothers and foster parents are non-central sub-categories (Lakoff, 1987). While classical categories may form taxonomies that have well-defined boundaries, graded categories have fuzzy boarders. Red (e.g., red ball) and tall (e.g., tall man) are examples of categories with fuzzy boundaries. These categories form along a negative to positive scale on which zero represents a prototypical member.

Figure 1. Sample domain taxonomy.
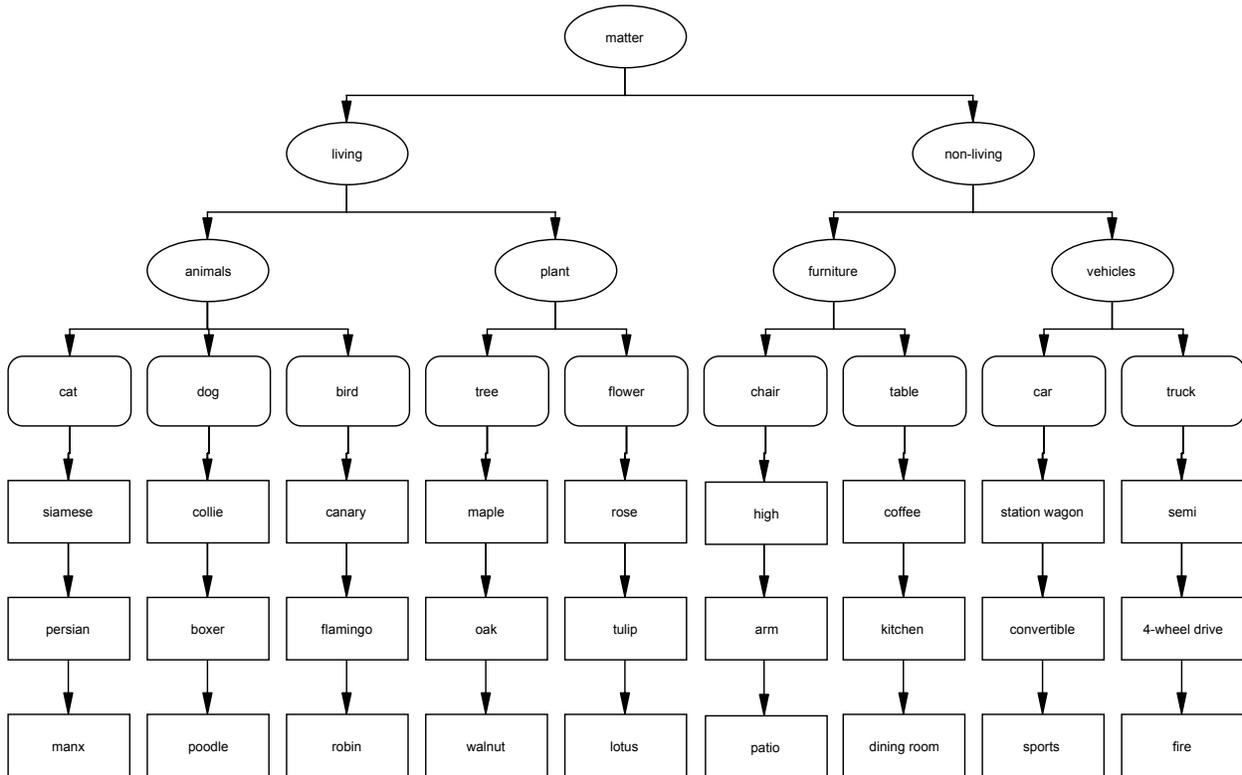
Figure 1. Eleanor Rosch explained human categorization in terms of vertical and horizontal structures. Within the taxonomy, basic-level categories are enclosed within rounded rectangle. The superordinate categories are in ovals. To save space in this illustration, the subordinate categories (enclosed within squares) are joined vertically although they are really all at one level of the hierarchy (the lowest level).

Chair is an example of a basic-level category. It is subsumed by higher-order categories such as furniture, then non-living things, and then matter. Higher-order categories are successively more complex and abstract. Lower-order categories (in this case, specific types of chairs) are more concrete. Basic-level categories are the highest taxonomic level at which humans can visualize objects: "Basic objects might be the most inclusive categories for which it was possible to form a mental image isomorphic [that is, characterized by one-to-one matching] to the appearance of members of the class as a whole" (Rosch, 1978, p. 34). Furniture is simply too general, too abstract a term for visualization. What does a piece of furniture look like? Contrast with this your ability to image chair, table, bed, or desk. The categories represented by these labels are sufficiently concrete to afford images. Children first recognize, sort, and label objects at the basic-level. Objects are most often named by basic-level labels. It is speculated that cultures generate language at the basic-level (Berlin, 1978; Rosch, 1978).

Humans form basic-level categories "when objects of the world are perceived to have high correlational structure" (Rosch, 1978). Again, knowledge of the world is a transactional analysis between an individual's physical sensations, culturally distributed knowledge and beliefs, and prior experience (Cantril, 1960). These categories are formed based upon high correlations among attributes, motor movements humans use to interact with objects, and shapes. In all of these areas, basic-level objects are the most inclusive level at which high correlations are maintained. And the basic-level is the level at which the unenhanced (via technology such as a microscope) and untrained (via specialized training such microbiology) human body and mind recognizes and interacts with the environment.

Body Syntonicity: Three Components of Embodied Thought.

According to Lakoff and Johnson (1980), "understanding emerges from interaction, from constant negotiation with the environment and other people" (p. 230). Seymour Papert (1980) might consider this human propensity to embody thought an example of body syntonicity, which he defines as human learning when it is related to "individuals' sense and knowledge about their bodies" (p. 63). Humans recognize, analyze, and understand categories through physical interaction with the environment by imposing entity structure, orientational structure, experiential gestalts, background, highlighting, interactional properties (Lakoff & Johnson, 1980). These can be discussed in terms of three concepts: entity structure—people understand themselves and objects as bounded structures, orientational structure—people project human physical attributes to their surrounds, and experiential gestalts—backgrounds for experience. The concept of the experiential gestalt is central to the theory of conceptual metaphor and requires a bit more explanation.

Humans categorize to reduce cognitive load according to the principle of cognitive economy (Rosch, 1978). The categories, themselves, are organized about prototypical members. Lakoff suggests that humans categorize their "direct interactions with others and with [their] immediate physical and cultural environments" (Lakoff & Johnson, 1980, p. 176) into experiential gestalts (see Table 1). They organize perceptions of objects and substances into gestalt categories defined by parameters: perceptual, motor activity, part/whole, functional, and purposive. Lakoff labels these parameters the dimensions of experience. Gestalt categories of direct actions, activities, events, and experiences employ the dimensions (parameters) of participants, parts, motor activities, perceptions, stages, linear sequences (of parts), causal relations, and purpose (goals/plans for actions and end states for events). Again, the gestalts

serve as the background for experiences that are aspects of the gestalt. Individuals are usually

unaware of the gestalt functioning in the background.

Table 1. Experiential Gestalts

Dimension of Experience	Gestalt category		Experiential Gestalts Interactions with the Environment: People and Physical and Cultural Environment			
			Direct Actions	Activities	Events	Experiences
	Instance					
	Participants					
	Parts					
	Motor activities					
	Perceptions					
	Stages					
	Linear sequences (of parts)					
	Causal relations					
	Purpose	Goals/plans		■	■	■
		End states	■	■		■

Table 1. According to Lakoff and Johnson (1980), people maximize cognitive efficiency by organizing their interactions with people and physical and cultural experiences into prototypical categories. These experiential gestalts are characterized by dimensions of experience. A person comprehends an interaction by drawing on prior knowledge and, in effect, cognitively completing the blank dimensions of experience beneath the relative gestalt category.

Highlighting as the Keyhole of Transfer

As individuals move toward direct understanding, they highlight relevant aspects of the

gestalt. Highlighting is a pragmatic cognitive mechanism relevant to both direct and indirect

understanding, and it occurs in metaphoric reasoning (Lakoff & Johnson, 1980). It must be

recognized that one consequence of highlighting is that aspects of the gestalt perceived as less

pragmatically viable are downplayed or hidden altogether. Lakoff and Johnson wrote that "any

consistent set of metaphors will most likely hide indefinitely many aspects of reality—aspects

that can be highlighted only by other metaphors that are inconsistent with it" (p. 221).[2] As

highlighting also filters domain structures such as schemas and metaphor mappings, it can be an

important factor in heuristic reasoning that can lead to prejudicial beliefs (Gilovich, 1991).

Reddy (1993) argued that people can "momentarily think" (p. 176) in terms of another metaphor,

but that "thinking will remain brief, isolated, and fragmentary in the face of an entrenched

system of opposing attitudes and assumptions" (pp. 176-177). The consequences of such

mechanisms of cognitive economy can be far-reaching and insidiously embedded within

distributed thought (see Salomon, 1997, for an introduction to distributed cognition), where

metaphors can propagate and proliferate covertly. Many issues have been analyzed with respect

to distributed metaphors; for example, (a) the conduit metaphor through which English-speakers

structure their "common sense" about communication (Reddy, 1993, p. 176), (b) the effects of

gender metaphors on science (Keller, 1995; Martin, 19991) and (b) the use of metaphor to shape

United States public opinion toward war (for metaphors of the Cold War, see Edwards, 1996; for

metaphors of the Gulf War, see Lakoff, 1991, November). I'll briefly elaborate some of the

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[2] At this point in their argument, Lakoff and Johnson (1980, chap. 27) were actually arguing against an objectivist model which would insist that mapping is completely algorithmic. They posit that people would prefer to maintain consistent sets of metaphor to provide cognitive coherence and a consistent view of the world. However, they argue, while people maintain sets of consistent metaphors, they also may maintain one or more alternative sets that may be inconsistent, but basically compatible with the first. The alternative sets, though inconsistent with the first, are coherent. The sets overlap, and choice of set is constrained by the pragmatics of a situation (pp. 93-96). In turn, choice of metaphor set determines which aspects of a situation will be highlighted. Thus, Lakoff and Johnson appear to agree with the multiconstraint theorists' position on pragmatic centrality (Holyoak & Thagard, 1989, 1997; Hummel & Holyoak, 1997). This position also aligns with Carroll and Mack's active learning theory of metaphor (Carroll & Mack, 1999).

empirical research with respect to the Gulf War because it touches on a crossover between the

conceptual metaphor work and the structural metaphor research.

Lakoff first circulated his discussion of the Persian Gulf War metaphors employed by the

Bush administration via electronic mail on December 31, 1990. Interestingly, "during the first

two days of the counterattack in January, 1991" (Holyoak & Thagard, 1997, p. 36), Spellman

and Holyoak used the core metaphor, THE PERSIAN GULF WAR IS LIKE WORLD WAR II, to

independently conduct an experiment that investigated (a) the pressure to maintain structural

consistency as predicted by both structure mapping and multiconstraint theory and (b) the

possibility that mappings might violate isomorphism if pragmatic considerations favored

multiple mappings (p. 37). According to the researchers, the metaphor was particularly "messy

and ambiguous" (p. 36), and therefore well suited for their purposes: a study of pragmatic effects

on the structural principle of isomorphism. The researchers asked students to compare Saddam

Hussein to Hitler and then map specified players and countries from source to target domains

(e.g., cross-domain people mappings: Bush to FDR or to Churchill; cross-domain countries

mappings: the United States in 1991 to the United States in World War II or Great Britain).

Results indicated that participants maintained relational coherence in their mappings.

Individuals' interpretation of the analogy led them to highlight pairings in one of two coherent

models of cross-domain mappings; that is, results indicated that the analogy caused students to

highlight specific aspects of the source domain knowledge (World War II) and map it on to the

target domain (Persian Gulf) according to one of two coherent sets of correspondences (see also,

Spellman & Holyoak, 1996). As indicated above, highlighting is a pragmatic mechanism. In

addition to determining the mapping model, highlighting motivated some participants to

"violate" the isomorphic constraint as they mapped Kuwait to both Poland and Austria.

However, some participants maintained isomorphism by mapping Kuwait to "the group of countries Hitler took over" (Holyoak & Thagard, 1997, p. 37). Overall, participants' mappings "maximized structural consistency" (p. 37). Lakoff's theory of conceptual metaphor also considers the mapping process to be constraint-driven, but flexible (Lakoff, 1993).

A culture's major metaphor sets are coherent with its value system (Lakoff & Johnson, 1980). Metaphor sets determine which components of experience are recognized and responded to. This is highlighting at the highest level. Highlighting will be mentioned again within this review, both within the discussion of indirect understanding through metaphor and within the discussion of cross-domain mapping (Lakoff, 1993).

From Direct to Indirect Reasoning

People interact with objects and events and events in the physical environment. According to Lakoff and Johnson (1980), people have a direct understanding of an event or object when those interactions allow people to clearly delineate entity structure, orientational structure, and experiential gestalt (Lakoff & Johnson, 1980, pp. 176-177). In contrast, thinking in such domains as "human emotions, abstract concepts, mental activity, time, work, human institutions" requires indirect understanding (p. 177). Therefore, people project resources and understandings from embodied domains on to the more abstract, less physically–based domains. So, the entailments and sub-components of entity structure, orientational structure, and experiential gestalts are applied from concrete domains and to situations requiring indirect understanding. As was the case with experiential gestalts, individuals are usually unaware of the role of conceptual metaphor in both individual and distributed thought (Salomon, 1997). Lakoff and Johnson (1980), themselves, remarked,

And after having worked out all of the consequences we could think of, for philosophy and for linguistics, what stands out most in our minds are the metaphors themselves and the insights they have given us into our own daily experiences. We still react with awe when we notice ourselves and those around us living by metaphors like TIME IS MONEY, LOVE IS A JOURNEY and PROBLEMS ARE PUZZLES. We continually find it important to realize that the way we have been brought up to perceive our world is not the only way and that it is possible to see beyond the "truths" of our culture. (p. 239)

Whether aware of the process or not, once an individual creates a primary metaphor such as AFFECTION IS WARMTH, objects from the sensorimotor domain are mapped on to objects within subjective judgment. They are mapped according to, and constrained by, the relations that exist within the sensorimotor domain. Within the source domain, objects and their relations form an inferential structure (Lakoff & Johnson, 1999). The inferential structure forms a domain's entailments: A person who is warm is safe, healthy, sheltered. When an individual is warm, there is no need for protective outerwear. The skin can be exposed. Once domains are mapped in this manner, the inferential structure of the source can be applied to the target domain. Therefore, if Pete is a warm person, he makes others feel safe, healthy, sheltered from harm. Because Pete is warm, there is no need to put up outer defenses, and others often feel free to expose their true natures.

In general, the target domain inherits inferential structure from the source domain (Gentner & Markman, 1997; Holyoak & Thagard, 1989; Hummel & Holyoak, 1997; Lakoff & Johnson, 1980, 1999). And this transference of relational structure, this projection of entailments from the source domain to the target, this is truly the power afforded by metaphor. For it is the foundation of human inferential reasoning (Cameron & Low, 1999; Gardner & Winner, 1979;

Gentner, 1980, 1983, 1993; Gentner & Gentner, 1983; Holyoak & Thagard, 1989; Hummel & Holyoak, 1997; Lakoff & Johnson, 1999; Neale & Carroll, 1997; Ortony, 1993; Winner & Gardner, 1993). More prosaically, "analogy is a powerful cognitive mechanism that people use to make inferences and learn new abstractions" (Gentner & Holyoak, 1997, p. 32) and has been viewed as a "central part of human induction" (p. 33). More poetically, "Analogies are like comets, flashing through our awareness and riveting our attention" (Gentner & Markman, 1997, p. 55).

Metaphoric Complexity Builds Upon Primary Metaphors

Primary metaphors combine together to form complex metaphors (Lakoff & Johnson, 1980, 1999). Lakoff and Johnson metaphorically map them to atoms and molecules. Complex metaphors "form a huge part of our conceptual system and affect how we think and what we care about almost every waking moment" (Lakoff & Johnson, 1999). Complex metaphors structure dreams and they, themselves, serve as the "base for larger metaphorical combinations" (p. 60). Most complex conceptual metaphors are mutually developed and accepted by entire cultures. When metaphors are broadly adopted, they provide the basis for the cultural norms that shape daily living and human potentials. Lakoff and Johnson provide extensive analysis and discussion of examples of complex metaphors.

One example, LIFE IS A JOURNEY (Lakoff, 1987; Lakoff & Johnson, 1999), is grounded in the primary metaphors PURPOSES ARE DESTINATIONS and ACTIONS ARE MOTIONS. These combine with cultural beliefs (lives are supposed to have and achieve purposes), entailing "A PURPOSEFUL LIFE IS A JOURNEY, A PERSON LIVING A LIFE IS A TRAVELER, LIFE GOALS ARE DESTINATIONS, and A LIFE PLAN IS AN ITINERARY" (p. 61). These engender the complex metaphor, LOVE IS A JOURNEY, allowing all the inferential patterns of journeys (e.g., roads,

travelers, and vehicles) to extend to love (e.g., "We're just spinning our wheels", "We're going in different directions", or "Our relationship has hit a dead-end. . .", p. 123).

Their analyses of complex metaphors, such as their treatment of the primary metaphors for time, are often extensive. Lakoff and Johnson (1999, pp. 137-169) analyzed three coherent sets of complex metaphors, hierarchical metaphor systems that start with a primary metaphor, for time. The three primary metaphors are TIME IS ORIENTATION, TIME IS MOTION and TIME IS A RESOURCE. All three use a spatial source domain to explain the subjective experience of time.

1. TIME IS MOTION maps the sensorimotor domain (motion in space) to the subjective domain (passage of time). People experience the passage of time as they see motion. The authors (Lakoff & Johnson, 1999) provided the English phrase "Time flies" as a common example of the metaphor as used in English (p. 52). Within this set, people also conceive of TIME IS A MOVING OBSERVER (e.g., "We're *getting close* to Christmas", p. 146) or TIME IS A FLOWING SUBSTANCE (e.g.,"The summer is passing by"). The authors used this set of metaphors to discus pragmatic considerations that arise when sub-metaphors are inconsistent with each other, yet coherent. They suggest the metaphor is common across the world's languages, providing the example that Ekkehart Malotki's 1983 study of the Hopi (American Pueblo Indians) recorded "more than four hundred pages of Hopi time expressions, more than two hundred pages of which are time metaphors" (p. 150)

2. TIME IS ORIENTATION is "a common way of orienting time" (Lakoff & Johnson, 1999, p. 140) across cultures, and the authors provided examples from Puri, Hindi, and Aymara languages. In this sense, time is oriented to the location of an observer, with the past behind the observer, the present at the location of the observer, and the future in front of the observer (e.g., "That's all *behind* us now," p. 140). Cultures may hold the same orientation metaphor, yet orient

their time differently: While the Puri point backward for yesterday and forward for tomorrow (p. 140), the Aymara view the past as what they have just done before their eyes (p. 141).

3.   TIME IS A RESOURCE derives from a Western cultural orientation (Lakoff & Johnson, 1999), perhaps resultant from the capitalist ideologies (e.g., control and management of people) and the Industrial Revolution (Berman, 1989), along with the invention of the clock (Gentry & Csete, 1995, p. 24). TIME IS A RESOURCE leads to the TIME IS MONEY. As a result of the metaphorical entailments, time can be both wasted and saved. One example English phrase is, "You've used up all of your time" (Lakoff & Johnson, 1999, p. 161). Lakoff and Johnson discussed a Western institutional reification of the metaphor, such as paying people by the hour (p. 164), which leads to the possibility that employees can steal time (p. 165). This goes hand-in-hand with LABOR IS A RESOURCE, which—returning to the concept of highlighting—hides the distinction between "between meaningful labor and dehumanizing labor" (Lakoff & Johnson, 1980, p. 236) All cultures have not held a TIME IS MONEY metaphor. Pueblo Indians don't. When pressed, the closest they can come to expressing the concept are the beautiful and poetic, "My path didn't take me there" or "I couldn't find a path to that" (p. 164). However, the phrases do exhibit the characteristics of other complex metaphors.

As illustrated above, sets of complex metaphors are hierarchically subsumed within the major category of one or more primary metaphors. People find coherence when they can categorize an experience in terms of various experiential gestalts (Lakoff & Johnson, 1980, p. 82). Member metaphors inherit gestalt dimensions from those that subsume them. They also share common entailments (p. 44). Therefore, both within a set and between sets, complex metaphors that share dimensions and entailments are coherent. When a metaphor or metaphor set has coherence, it fits together with an internal systematicity (p. 91). In the real world, metaphor

systems may contain specific entailments that make them inconsistent with each other. Real world metaphor sets tend to present coherent, rather than completely consistent systems. As discussed previously, people prefer consistency (Lakoff & Johnson, 1980). Therefore, pragmatic concerns cause people to highlight aspects of a specific metaphor or metaphor set (e.g. Lakoff & Johnson, 1980, pp. 91-92), such that it presents itself as consistent for the purpose at hand (pp. 180-181). This is an automatic process, what Lakoff and Johnson have come to define as the cognitive unconscious (Lakoff & Johnson, 1999, pp. 9-15): "any mental operations and structures that are involved in language, perception, conceptual systems, and reason" (p. 12). Most metaphor-making is unconscious and automatic thought (p. 13). Indeed, unconscious thought, which is more than more than 95% of thought, "shapes and structures all conscious thought" (p. 13).

Image-schemas Afford Rich, Concrete Mappings Between Domains

A metaphor is a cross-domain mapping (Lakoff, 1993), with each domain composed of a system of objects, object attributes, and relations between objects. Within a domain, objects and relations are organized into conceptual schemas. A schema is a "set of elements and a scenario that indicates the relationships among the elements" (Lakoff & Johnson, 1999, p. 161). That metaphoric reasoning is a natural process (Lakoff, 1993; Lakoff & Johnson, 1980, 1999); that metaphors are physically connected and embodied (Lakoff, 1993; Lakoff & Johnson, 1980, 1999) is important to a discussion that argues for the development of content-based metaphorical interfaces to enhance students' ability to learn abstract subject-matter. If the process is natural and physically grounded, then computer interfaces that employ well-developed content-based interface metaphors capitalize on a natural, human cognitive process. And this is why schemas are important to this discussion: They are physically grounded. Humans conceptualize across

many domains. Lakoff's Conceptual Metaphor WWW Server (http://cogsci.berkeley.edu/) lists 172 conceptual metaphor source domains. The spatial domain is an overaching (superordinate) domain that serves as an especially salient basis for many of those conceptual metaphors, because it is so grounded in sensorimotor experiences. The spatial domain contains a plentitude of subordinate domains, along with their schemas, that are used in metaphoric mappings to such abstract concepts as time and causation. Some common image-schemas that " structure systems of spatial relations in the world's languages" (Lakoff & Johnson, 1999, p. 35) are: adjacency, balance, center-periphery, contact, containers, cycle, end of path, force, forced motion (pushing, pulling, propelling, pulling), front-back, iteration, link, near-far, part-whole, path, reflexive, source-path-goal, support, straight-curve, up-down (Lakoff, 1987, pp. 270-271; Lakoff & Johnson, 1980, 1999, p. 35). Some (e.g., containers) derive from structures in everyday experiences, and some (e.g., front-back, horizontal, vertical) result from common orientations and relations.

According to Lakoff's invariance principle, "metaphorical mappings preserve the cognitive topology (that is, image-schema structure) of the source domain, in a way consistent with the inherent structure of the target domain" (Lakoff, 1993, p. 215). Therefore, schemas from the source are mapped on to the target, and many have their root in image-schemas. Lakoff suggests that schemas exist for other modalities of experience such as sound and force. Because the schema research is centered in image-schemas, this discussion will center there.

Image-schemas are abstractions. Like primary metaphors, they are grounded by associations between visual, kinesthetic, and cultural experiences, along with general knowledge and language. Image-schemas refer to concrete, general systems of entities and their relations that correspond to our everyday sensorimotor experiences. Derived from our experience, they, in

turn, characterize and organize what we perceive and how we image—a reflexive, recursive process. We possess a kinesthetic awareness of an image-schema, as well as a catalog of its inherent topological possibilities upon instantiation. Finally, because they are composed of probable topological instantiations, image-schemas, themselves, cannot be directly imaged. Instead, the instantiations of image-schemas are imaged as occasioned. Two examples may provide clarification: The container image-schema will serve to introduce the concept of the image-schema. The examination of "over" as a path image-schema will provide an indication of the distinction between the abstract nature of the image-schema and the concrete nature of its instantiations.

The Container Schema

Humans perceive themselves as entities. As such, they have boundaries, insides, and outsides. Humans interact with external objects, and perceive the objects as possessing boundaries. For example, imagine a cooler that contains one quart of milk. The plastic sides of the quart form the boundary of the container (A). The milk (B) resides inside the container. A similar analysis could be carried out for the cooler (X). This scene represents an instantiation of the container schema. According to the invariance principle, the relationships that can be inferred from this schema transfer when the container domain serves as a source within a metaphorical mapping. One obvious relationship is that if B is inside A, and A is inside X, then B is inside X. Before Rosch's research expanded awareness of prototypes and basic-level categories, allowing for category membership based upon probabilities (for example, see discussion of cue validity, Lakoff, 1987, pp. 52-54; Rosch, 1978, pp. 30-31), the classical concept of categories conceived of them as well defined, bounded sets. In other words, the concept of categories was constrained by an embodied view that CATEGORIES ARE CONTAINERS. Therefore, the logic of the concrete

topological relationships existent for containers extended to the logic for category membership: If B is a member of category A, and A is a member of category X, then B is a member of category X. Although the recently uncovered nature of prototypes and radial category membership no longer supports such a limited view of category membership within human cognition, this clear-cut entailment of the container metaphor is widely accepted (Lakoff, 1987, 1993; Lakoff & Johnson, 1980, 1999; Rosch, 1978, 1983). In fact, "the container schema is the basis for Boolean logic of classes" (Lakoff, 1987, p. 272).

The Case of Over: An Examination of One of the Path Image-Schemas

Emily Dickenson captured the elusive nature of the image-schema when she penned the opening lines, "I dwell in possibilities, a fairer house than prose . . ." (1988, p. 51). The actual concepts and relations of an image-schema are representative of multiple instantiations. While each part, each instantiation, can be imaged individually, the whole, the collected total, cannot be imaged because the properties of the parts conflict and negate each other. The image-schema can be likened unto the Wallace Steven's speaker, " I was of three minds,// Like a tree// In which there are three blackbirds. . ."; likened also unto the figures in Picasso's *Guernica* whose twisted bodies and features incorporate multiple locations in time and space concurrently. Only instantiations of the schema are imageable. Lakoff's presentation of the case of "over" illustrates this concept.

Lakoff published a chapter based upon Claudia Brugman's research of the image-schema for the preposition "over" (1987), discussing the aspects of her analysis. Over is a particular type of image-schema, a path schema. Path schemas contain 3 parts: the trajector, the path, and the landmark. The trajector is the figure, and it can move over the ground (the landmark) via a path.

The over schema has several properties, and each property can be illustrated by English sentences:

1. Contact – In some senses of over, the trajector makes contact with the landmark. Examples: The cat climbed over the wall. The deer crossed over the mountain. The man lives over the hill. The flowers are blooming all over the hill. The deer walked all over the hill.

2. Path – In most senses of over, the trajector follows a path. Examples: The bird flew over the yard. The bird flew over the hill. The bird flew over the wall. The cat climbed over the wall. The deer crossed over the mountain. The man lives over the hill. The deer walked all over the hill. The fence fell over.

3. Extended – In some senses, the landmark is extended horizontally. Examples: The bird flew over the yard. The bird flew over the hill. The deer crossed over the mountain. The flowers are blooming all over the hill. The deer walked all over the hill.

4. Verticality – In some senses, the landmark is extended vertically. Examples: The bird flew over the hill. The bird flew over the wall. The cat climbed over the wall. The deer crossed over the mountain. Hang the painting over the door. The flowers are blooming all over the hill. The deer walked all over the hill. The fence fell over.

5. End-point – In some senses, the path leads to an endpoint. Example: The man lives over the hill.

6. Cover – In some senses, the trajector marks a path that covers the landmark. Example: The flowers are blooming all over the hill. The deer walked all over the hill.

7. Reflexive – In some senses, the trajector is self-reflexive, acting as both the trajector and landmark. Example: The fence fell over.

The Brugman/Lakoff presentation is much more extensive than this summary discussion. However, the examples do illustrate that the senses of the over schema can be mutually exclusive. A landmark cannot be both extended and non-extended. It cannot simultaneously require both contact and no contact. An image-schema is a collection of possible senses from which a combination of the properties leads to a concrete image, a collection of possibilities. The sentences provided above as examples demonstrate the physical and kinesthetic nature of image-schemas.

Image-schemas are based upon structural correlations that "constantly recur in our everyday bodily experience" (Lakoff, 1987, p. 267). They are pervasive in experience, well understood, well structured, and simply structured. Therefore, they are conceptually well demarcated. People understand image schemas directly, just as they understand basic-level concepts directly. This is because both schemas and basic-level concepts occur as repeated transactions between the human body and the environment. Lakoff and Johnson (1980) define these structures, structures that can be directly understood from human transactions within the environment, as emergent. They emerge directly from human transactions within the environment. Abstract concepts are not emergent. In order to understand abstract concepts, people must use image schemas and/or basic-level concepts, combining them through projections of either (a) basic-level concepts to superordinate or subordinate concepts or (b) concrete source domains to abstract domains through metaphorical mappings (Lakoff, 1987, pp. 267-268). Metaphorical mappings between source and target follow the invariance principle. Thus, when relationships are mapped, apt (pragmatically motivated) image-schemas from the source domain afford inferences in the target domain (Lakoff, 1993).

The findings of Lakoff and his colleagues indicate that image-schemas are embodied, basic-level categories are embodied, and metaphors are embodied. "In general the major orientations up-down, in-out, central-peripheral, active-passive, etc., seem to cut across all cultures," although "which concepts are oriented which way and which orientations are most important vary from culture to culture" (Lakoff & Johnson, 1980, p. 24). However, during his investigations of metaphor through factor-analysis, Osgood has found evidence of considerable "cross-cultural generality" (Paivio & Walsh, 1993, p. 317). When people interact with their environment, they form metaphors. It appears expedient for designers and developers of instruction to capitalize on this natural human propensity: that cross-domain mappings from human experiences of concrete episodes shape the relational structure of more subjective and abstractive domains. The process of human metaphor-making, as described by cognitive theorists, is natural, omnipresent, and effortless. It is possible that content-based metaphorical interfaces engineered according to the principles that underlie human analogical reasoning might assist learners in grounding unfamiliar, complex content. It is possible that metaphor-based instruction might also provide learners with relatively natural and effortless scaffolding for building mental models of complex concepts.

The theory of conceptual metaphor suggests an idea, a possibility: that designers could build a computer-mediated environment that would enable learners to map *from* transactions with concrete episodes (a source domain embodied within a computer interface) *to* a targeted domain of abstract concepts. But possibility is a long way from realization. In order to use cognitive theory to design instructional environments that map from source to target, designers must know what cognitive theory has discovered about the mapping process. Additionally, that mapping theory must align with conceptual metaphor.

The next section will present a set of mapping principles formed through the superposition of two major metaphor theories: conceptual metaphor and structure mapping. This will serve as an introduction to structure mapping. The balance of the section describes the major principles of structure mapping as it applies to the design, development, and evaluation of metaphor-based, computer-mediated instruction.

Structure Mapping: The Process of Cross-Domain Mapping

Transfer of Relational Structure

From early on, Gentner (1980) defined metaphor as a mapping of relational structure (structure mapping) from a known domain (the familiar, source, or base) to the "domain of inquiry" (p. 8); that is, to the less familiar or target domain. Her research interests lay in analogical reasoning and model generation, and she coined the term *analogy* as a neutral term (as opposed to metaphor which was so strongly linked to figurative language) to include both analogy and metaphor. Gentner (Gentner, 1983; Gentner & Markman, 1997) has since structured a continuum in which the term metaphor stretches between analogy (relational metaphor, such as MY JOB IS A JAIL) and mere appearance (attribute metaphor, such as A ZEBRA IS A JAIL). As stated earlier, in general, I use the term analogy to refer to the cognitive process of relational mappings between domains and metaphor to refer to specific instances of mappings. However, in keeping with the terminology employed by the individual theorists (i.e., Gentner and Lakoff and Johnson), I try to use the term metaphor when discussing conceptual metaphor and analogy when discussing structure mapping. Structure mapping operates on the premises that (a) relationships between objects, rather than attributes, are mapped from the source to the target, (b) mappings are more probable when predicates are connected and constrained by superordinate (higher-

order) predicates, and (c) mappings are composed of systems of relations (Clement & Gentner, 1991; Fauconnier, 2001; Gentner, 1983, 1989, 1993; Gentner & Gentner, 1983; Gentner & Holyoak, 1997; Gentner & Markman, 1997). Analogy is transfer of relational structure from one domain to another (Clement & Gentner, 1991; Fauconnier, 2001; Gentner, 1989; Holyoak & Koh, 1987).

Similarities Between Conceptual Metaphor and Structure Mapping

These premises are consistent with Lakoff's assertions that

1. Categories are formed based upon relationships to prototypical category members (Lakoff, 1987; Lakoff & Johnson, 1999; Rosch, 1978).

2. Primary metaphors are created based upon associations between familiar psychomotor experiences and less understood abstract experiences.

3. Image-schemas are composed of relationships, and those relationships are grounded in embodied experiences.

4. Primary metaphors are combined according to relationships to form complex metaphors.

5. Although categories can be defined hierarchically, radially, or by graded boundaries, the complexity of the source to target domain mapping determines the probabilities of the mapping. Higher-order relations are preserved. Lakoff calls this the invariance principle. Gentner labels this principle systematicity.

6. Mappings are asymmetrical (Gentner & Markman, 1997, p. 52; Lakoff & Johnson, 1999, pp. 57-58). The source domain is usually the more familiar and more concrete. Targets are usually less familiar and more abstract. People conceptualize that LOVE IS A JOURNEY, but they do not conceptualize the converse, that a ~~JOURNEY IS LOVE~~.

Mapping and Inference Depend on Deep Relational Structure

Within her early investigations, Gentner reported that protocols produced by novice (naive) and expert scientists provide evidence that the two groups differ in the type of analogical thinking employed to think about scientific domains. Experts tend to explain a scientific principle through one or a few integrated examples. The expert has "an abstract model with broad scope" (Gentner, 1980, p. 59) while the novice grabs at local models with "close surface resemblance to the case at hand" (p. 58). They "remember surface details, not important relationships" (Gentner, 2000). It seems that experts' domain knowledge is integrated and subsumed within higher-order principles (corresponding to the higher-order predicates of the theory). Novices, on the other hand, tend to look for superficial similarities, for common attributes, when explaining physical phenomena. So do young children (Gentner, 1989). Unfortunately, superficial mappings are limited in predictive and inferential power. Frequently, they lead to misconceptions (Dunbar, 2001). This is because both analogical mapping and extraction and storage of underlying principles highlighted by cross-domain mapping, are "governed by structural similarity and systematicity" (Gentner, 1989, p. 230). This problem can be particularly troublesome in abstract domains such as philosophy, science and math, in which "the correlation between surface features and structural features is low" (p. 231). Indeed, researchers report that many students approach abstract instructional content with non-normative pre-conceptions (many based upon superficial metaphors) that are difficult to dislodge:

> Within the past decade and a half there has been an increasing awareness of the detrimental effects (to school learning) of some students' prior knowledge. Students come to class with preconceptions which inhibit the acquisition of content knowledge and are often quite resistant to remediation. (Brown & Clement, 1989, p. 238)

These students often resort to rote learning strategies that leave the underlying misconceptions intact and domain relational structure unspecified or absent (Baker & Lawson, 2001; Banet & Ayuso, 2000; Clement, 1993; Martins & Ogborn, 1997; Petrie & Oshlag, 1993).

Fortunately, as people mature they experience a relational shift away from reliance on superficial similarity to relational structure (p. 226). Researchers suggest that increase in knowledge (general life experiences and/or domain-specific knowledge) accounts for the relational shift in analogical thinking accomplished by both children and experts (Dunbar, 2001; Gardner & Winner, 1979; Gentner, 1989; Goswami, 2001; Winner, 1988; Winner & Gardner, 1993). Dunbar (2001) suggested that learners do not have to be experts to engage in deep relational analogy. They must simply be in a context that highlights structural relations (p. 330). The implication for the instructional designer is to create that context, to uncover, isolate, define, and develop apt instructional metaphors within environments that encourage novices to form normative *relational* connections from a concrete source domain to a targeted abstract domain (Brown & Clement, 1989; Clement, 1993; Ogborn & Martins, 1996). Drawing on conceptual metaphor, those metaphors should serve as the experiential basis for students. Within computer-based learning environments, the learning environment itself, the interface, could be designed to model the relational structure of the base domain. Thus, it could serve as a scaffold, an advance organizer, to help learners build a sound mental model of a targeted domain (Jonassen, 1981). This is a big step toward meaningful learning (Ausubel, 1962; Jonassen, 1981; Novak, 1992; Novak & Gowin, 1984).

Refinement of Theory Addresses Early Criticisms

Carroll and Mack (1999) questioned the validity of both operational approaches to metaphor (study of the effectiveness of suggesting metaphoric comparisons to learners) and

structural approaches (approaches like Gentner's structure mapping that analyze how metaphoric mapping occurs). Stating that structural theories lacked a focus on learning dynamics and operational theories did not go far enough, Carroll and Mack proposed their own theory of metaphor: "Metaphors are kernel comparison statements whose primary function in learning is to stimulate active learner-initiated thought processes" (p. 386). They defined metaphor as open-ended, as opposed to models ("explicit and comprehensive comparisons"). And, they suggested that utilization of open-ended metaphors capable of producing partial isomorphisms (mappings between source and target domains) within the learning environment empowered students to become "active learners."

The Carroll and Mack article was first published in the early 1980s. This probably accounts for the fact that most of their discussion of Gentner's theory involved a critique of the items within her 1980 publication. Over the course of the past 21 years, Gentner has tested and refined the theory of structure mapping, as well as participated in the development of a computer simulation of the structural alignment called the structure-mapping engine (SME). That theorists validate their models with computer simulations in addition to experiments with human subjects could be motivated by criticisms like the following:

> . . . We must face the processing problem of how the node-node and relation-relation
> mappings are computed: structural theories like Gentner's (1980) merely *assume . . .* that
> these mappings obtain, but finesse the inevitable question of how. When these
> computational problems are faced, however, they might undermine the initial
> attractiveness of the structural theories. (Carroll & Mack, 1999, pp. 390-391).

In any case, in refining the theory Gentner has removed some of the original characteristics and renamed or incorporated others into a terser statement of structural alignment

between source and target. The theory assumes that knowledge is represented as propositional

networks of nodes and predicates. The nodes are concepts and the predicates are propositions

about the concepts (see Figure 2). Predicates are divided into attributes (predicates that take one

argument) and relations (predicates that take two or more arguments). Attributes describe

characteristics of an object. An example would be the word "red" in the phrase "red ball."

Relations describe relationships, such as causality, that connect objects or concepts. A simple

example would be "The truck hit the powerline." This is a first-order predicate, because the

relation takes objects as its arguments: HIT(truck, powerline). A second example might be

ERASE(outage, dissertation) or, "The outage erased the dissertation." Higher-order predicates

take lower-order predicates (as opposed to objects) as arguments. The sentence, "The truck hit

the powerline and caused the outage that erased my dissertation." is composed of two first-order

relations and one second-order relation: CAUSED [HIT(truck, powerline), ERASE(outage,

dissertation)]. It describes relationships between relationships. Relations that take objects as

arguments are first-order predicates. Higher-order predicates at level Nth contain at least one

higher-order predicate from the (N-1)th level as argument (Gentner, 1983).

Figure 2. Structure mapping: Concept nodes, attributes, and predicates.
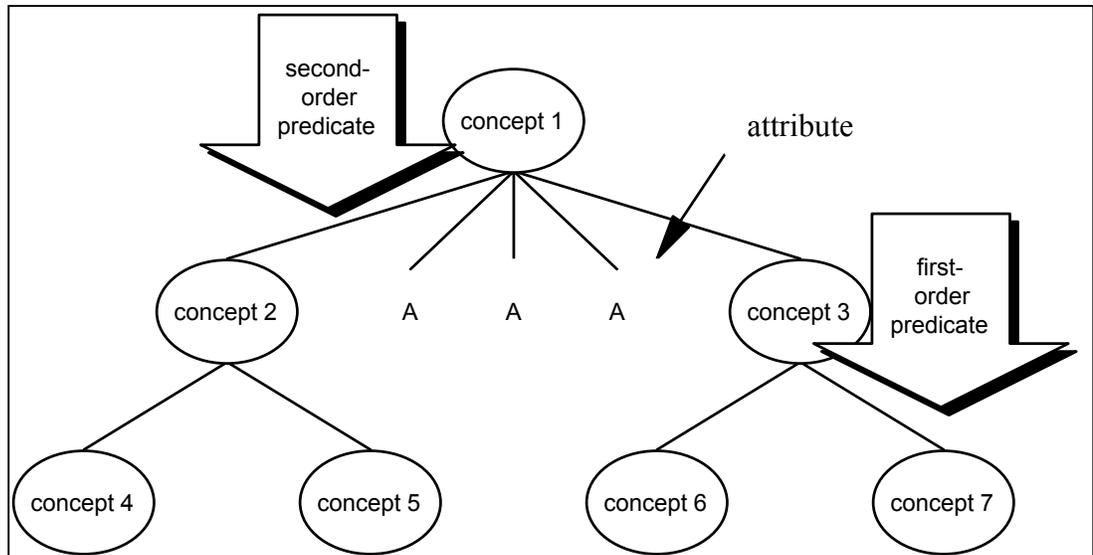
Figure 2. Structure mapping represents knowledge as propositional networks composed of concept nodes, relations, and attributes.

Structure mapping, today, is defined by three principles (Gentner & Markman, 1997):

1. Alignment of relational structure – Alignments must be structurally consistent. Consistency requires that two conditions be met. First, matching relations must have matching arguments. This is illustrated in Figure 3. The figure contains a source domain at the left and a target domain at the right. Although concepts from the left-hand branch of the source are mapped to arguments on the left-hand side of the target, the right-hand branch is not mapped due to missing arguments. So, "object mappings are determined not only on the basis of their intrinsic similarities, but also on the basis of their playing similar roles in relational structures" (1993). The oval (cloud-like shape) beneath the right-hand side of the target is labeled "candidate inferences." This means that the structure within the source causes an individual to look for matching inferences within the target domain. Again, this is the power of metaphorical reasoning. Second, items that are

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mapped from the source must map in one-to-one correspondence with items in the target. Structure mapping does not allow two items from the source to map on to one item in the target, or one item from the source to map on to two items within the target. That is, studies indicate that people prefer to make isomorphic mappings. In real-life, isomorphic mapping may be over-ridden by pragmatic considerations.

Figure 3. Cross-domain mapping illustrating candidate inferences.
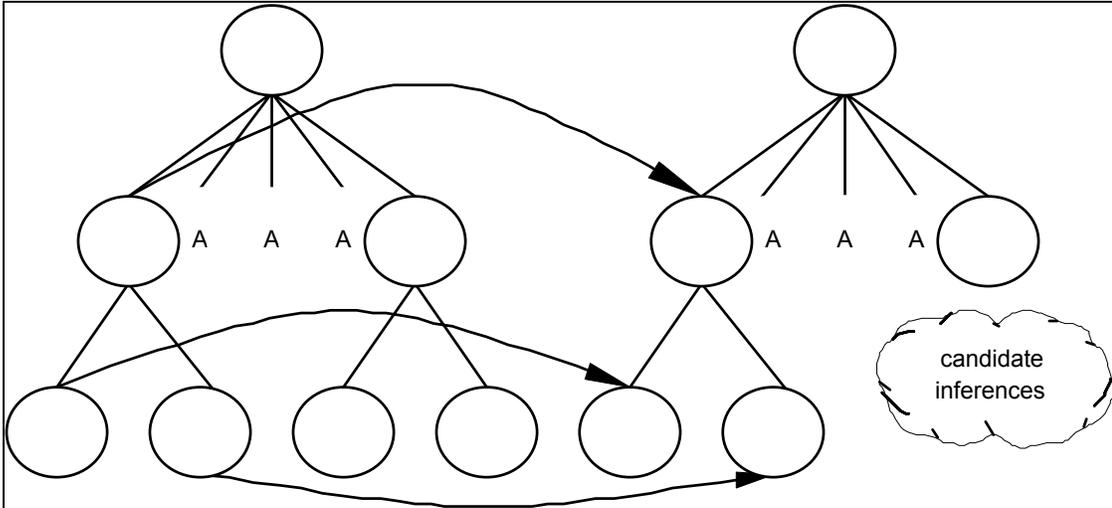
Figure 3. According to structure mapping, domains are mapped between concepts according to systematicity and parallel relational structure. People generate candidate inferences when parallel relations are missing from the target domain.

2.   Relational focus – Structure mapping is based upon a mapping of relations. This does not require that attributes map from the source to the target. Indeed, if the relationships and the attributes both map, the target and source form an identity rather than a metaphor or analogical relationship. Abstract domains tend to have a concentration of relations rather than a large number of attributes (Gentner, 1980, 1983; Gentner & Markman, 1997).

3.   Systematicity – Cognitively, people prefer to map systems of relations rather than isolated relations. When a given source is mapped to a target, those components that are systematically connected together have a greater probability of being mapped than isolated correspondences. This is because people seek "coherence and inferential power in interpreting analogy" (Gentner, 1993, p. 449). Therefore, it is the systems that contain hierarchies of higher-order predicates that will be mapped, rather than isolated predicates. Structure mapping has suggested two additional characteristics of human analogical processing: inferential reasoning and alignable differences.

Theory Constitutive Metaphors Can Serve As Pedagogical Tools

As mentioned above, analogical mappings have "predictive power" (Gentner & Markman, 1997). That is, they encourage inferential reasoning (Egan, 1997; Gentner, 1989, 1993; Gentner & Gentner, 1983; Gentner & Holyoak, 1997; Gentner & Markman, 1995, 1997; Gentner & Schumaker, 1986; Holland et al., 1986; Holyoak, Gentner, & Kokinov, 2001; Holyoak & Thagard, 1989; Jonassen, 1981; Lakoff & Johnson, 1999; Mayer, 1993; Schön, 1993; Spellman & Holyoak, 1996). An individual with an analogy in her head is like an astrophysicist with a theory. Consider, for example, one astrophysicist's view of black holes (Hawking, 1992). According to John Wheeler, black holes are like men in black tuxedos dancing with girls in white dresses, whirling, with the lights turned low. All you can see is the girl. "Well, the girl is the ordinary star and the boy is the black hole. You can't see the black hole any more than you

can see the boy. But the girl going around gives you convincing evidence that there must be something there, holding her in orbit" (p. 86). The theory, like the analogy, predicts the inference—in this case, the location of the black hole. Astrophysicist Stephen Hawking's application of analogy led him to the discovery of black body radiation. That process is significant to this review for two reasons. The first is to make an analogy between an individual's use of analogical reasoning and a scientist's use of a mathematical theory's prediction of a physical property to discover the property (and black hole radiation has been confirmed). The second is to share a recent episode in the saga of scientific discovery (Gentner, 1993) in which the inferential power of analogical reasoning opened the path to great discovery. The literature contains many examples of scientific reasoning and discovery which were based upon analogy and metaphor; one is the theory of sound propagation as waves 2000 years ago which was followed by the wave theory of light, 1600 years later (Holyoak et al., 2001) . In a review of scientific inventions and discoveries, Koestler reported that most of the inventions and scientific discoveries he studied "resulted because scientists noticed novel connections between distant content domains" (Spencer & Weisberg, 1986, p. 442).

It is also noteworthy that Sciama (Hawking, 1992) categorized the analogy between thermodynamics and block holes as superficial when it was based upon superficial category attributes. The analogy became profound when it was based upon a mapping of genuine relations between concepts in the source and concepts in the target domains. According to Gentner and Jeziorski, "the strength of analogy in licensing scientific prediction rests in the degree of systematic structural match between the two domains" (1993, p. 453). The type of metaphor described in these scientific discoveries is categorized as a theory-constitutive metaphor (Boyd, 1993; Petrie & Oshlag, 1993). Theory constitutive metaphors are integral to the structure of a

theory. They serve to inspire and guide theories and their development in both the hard and soft sciences. According to Petrie and Oshlag (1993),

> the very possibility of learning something new can only be understood by presupposing the operation of something very much like metaphor. . . . This is not just the heuristic claim that metaphors are often useful in learning, but the epistemic claim that metaphor, or something very much like it, is what renders possible and intelligible the acquisition of new knowledge. (p. 582)

Theory-constitutive metaphors

> are integral parts of the very structure of a theory at any given time in its development. All theories contain such metaphors, and their usefulness consists of both their ability to help us learn the theory and their inductive fruitfulness in guiding further research in the theory (Petrie & Oshlag, 1993, p. 581).

Often, theory-constitutive metaphors progress from highly specific, single-case metaphors to more abstract concepts or schemas, as in the wave analogies developed for sound and light (Holyoak et al., 2001, p. 6). Metaphors, then, serve as one of those self-replicating components of thought that Dawkins defined as the meme (1989). Considering them in this vein, metaphors can be likened to a thought-gene, if not the DNA of thought. Changes in metaphor can accompany and lead paradigm-shifts, which lead revolutions in scientific thought and inquiry (Kuhn, 1996). Because theory-constitutive metaphors are so intrinsically embedded within a theory's birth and development, they serve as exquisite pedagogical tools. According to Kuhn (1993)

> Something with the properties of metaphor is often called upon when a new term is introduced to the vocabulary of science. But it is also called upon when such terms – by

now established in the common parlance of the profession – are introduced to a new

scientific generation by a generation that has already learned their use. Just as reference

must be established for each new element in the vocabulary of science, so accepted

patterns of reference must be reestablished for each new cohort of recruits to the sciences.

The techniques involved in both modes of introduction are much the same. . . ." (p. 534)

Alignable Differences Contribute to Understanding

Domains that have high structural alignment have salient alignable differences as well as

similarities (Gentner & Markman, 1997; Markman & Gentner, 1993). In a series of experiments,

Gentner and Markman (1993) demonstrated that (1) pairs with many commonalities have many

alignable differences, (2) commonalities and alignable differences are conceptually related, and

(3) alignable differences outnumber nonalignable differences (p. 517). For example, the

researchers reported

Participants were given a page containing 40 word pairs, half similar and half dissimilar,

and were given five minutes to list one difference for as many different pairs as they

could. They were told that they would not have time to do all 40 pairs, and so they should

do the easiest pairs first. The results provided strong evidence for the alignability

predictions: Participants listed many more differences for similar pairs ($M = 11.4$) than

for dissimilar pairs ($M = 5.9$). Furthermore, this difference was concentrated in the

alignable differences. Over twice as many alignable differences were given for similar

pairs ($M = 9.0$) than for dissimilar pairs ($M = 3.9$).

In fact, Gentner and Markman (1995) coined the phrase, "No differences without similarity."

Specialists in linguistics (Cameron & Low, 1999), psychology (Ortony, 1993), human-computer

interaction (Carroll et al., 1988; Mark & Mambrey, 1997), and instructional design (Cates, 1994;

Jonassen, 1981) observe that metaphors can foster misconceptions as well as enhance positive transfer. This point was discussed earlier, as learners often bring inappropriate preconceptions, (erroneous mental models) with them when they approach science and math and other domains in which students are required to learn abstract concepts (Baker & Lawson, 2001; Banet & Ayuso, 2000; Brown & Clement, 1989; Clement, 1993; Gentner & Markman, 1997). Some of the misconceptions are engendered by superficial metaphors (Gentner & Markman, 1997). Use of structure mapping principles to evaluate metaphor aptness and guide design and development may help alleviate misconceptions due to a hastily chosen and inadequately developed metaphor. However, there is always the possibility that some difference between source and target domain might foster a misconception as well. This suggests that consideration of similarities as well as alignable differences (Gentner & Markman, 1997, p. 50) during interface design and development might help designers to obviate these possible sources of misconception. Carroll, Mack, and Kellogg (1988) advised that "good interface metaphors can also do more than merely exploit similarities, they can pose questions and open new possibilities. The keys to playing this role are the inevitable mismatches of metaphor mappings and the use of composite metaphors" (p. 74).

Domain and Mapping Specification

In order to specify intra- and inter-domain relations, a researcher or designer needs a specification methodology. Gentner (1980, pp. 8-9) chose to use propositional networks to represent a given domain's set of concepts and predicates. However, she noted four key points:

1. Propositional networks are *not* the only way to represent a domain.

2. Representations must allow for a distinction between relations and attributes, because only relationships map.

3. Representations must be hierarchical (higher concepts subsuming lower ones).

4. Nodes must treat concepts taken as a whole.

Within mapping theory, only relations form the links between concept nodes. Attributes are dropped (Gentner & Schumaker, 1986). Consequently, only relations (not attributes) are necessary within a domain representation. While some type of methodology is required for domain specification, it need not be propositional networks as long as it can (a) represent concepts, (b) represent relations between concepts, and (c) depict hierarchical structure. For example, the concept mapping technique developed by Novak (Novak & Gowin, 1984) could be used to represent knowledge domains and constrain cross-domain mappings, as concept maps meet structure mapping requirements:

1. Concept maps are one way to represent a domain.

2. Concept maps could allow for a distinction between attributes and relations, especially if only the relations were mapped. Novak and Gowin define relations between concepts as "propositions", "the meaning relationship between the two concepts" and label them "linking words" (p. 36).

3. Concept maps are hierarchical representations (concept mapping is based upon Ausubel's theory about subsumption).

4. Concept maps treat nodes as whole concepts.

A methodology like concept maps could adequately represent the relational structure of a domain.

Theories Converge on Centrality of Deep Relational Structure

The important parallels between Gentner's and Lakoff's theories lie in the mapping of relationships between the two domains: (a) Mappings between domains are based upon

relationships, and (b) People prefer mappings of systematic, higher-order relations, (c) Domains are structured as relational hierarchies, (d) Metaphorical mappings highlight pragmatically salient components (similarities as well as alignable differences) of both domains, and (e) Metaphorical mappings promote inferential reasoning.

Metaphor: The Implicit Framework

Metaphor functions as a lens to focus individual and group perspectives of a situation (Schön, 1993). Concerned with the application of metaphor to social policy and "policy analytic literary criticism" (p. 149), Schön found that people use metaphors to shape their understanding and frameworks of situations. Thus, the metaphor structures the cognitive framework. Schön proposed that the underlying tacit metaphor could be discovered through an analysis of discourse, a process akin to the deconstruction employed for literary readings. The elements of his theory of generative metaphor are familiar because they cohere with conceptual metaphor and structure mapping:

1. Immersion within an experience triggers a metaphor. Domains are restructured to allow alignment between the concrete source and the target, according to relations between objects (also concepts).

2. Mappings are pre-analytic, controlled by relations between nodes.

3. Choice of metaphor determines highlighting, salient similarities and salient differences.

4. Images carried by metaphors are normative; they prescribe problem solutions. And these images and problem solutions become the text of a discourse.

Discovering, uncovering, underlying metaphors requires the researcher to work through the process of generative metaphor in reverse. Schön labels this the "hermeneutic problem," (p. 138), entailing the interpretation of text:

1. Note what people say and do: These actions and behaviors reveal what they think. These are the stories people tell, and the stories are the text. The text is individual and/or social interpretation of the problem setting.

2. Uncover the inferences implicit within the text: Connect the evidence pertinent to each inference. These inferences are perspectives, explanations, and inventions applied to the target. Inferences can often be detected through analysis of prescriptions offered as problem set solutions, as metaphors often set the direction of problem solving. They determine problem identification, what is considered "wrong and what needs to be fixed" (p. 138).

3. Identify the metaphor: The critical component is to separate the deep underlying metaphor from any superficial ones. Remember, superficial metaphors are mapped according to attributes while deep metaphors are mapped according to relationships. The deep metaphor "accounts for centrally important features of the story" (p. 149).

4. Specify the metaphor's assumptions (entailments), salient similarities and dissimilarities.

5. Test metaphoric interpretation against the original story, as "an interpretation is testable against the givens of the story" (p. 149).

Schön's (Schön, 1993; Schön & Rein, 1994) entire hypothesis of frame restructuring is based upon stakeholders' realization of their underlying metaphors. For, the normative power of the metaphor is engendered by its tacit state. Once each stakeholder is critically aware of the metaphors, frame restructuring — based upon the set of uncovered metaphors — can begin.

Gentner and her colleagues (Loewenstein, Thompson, & Gentner, 1999; Thompson, Gentner, & Lowenstein, 2000) found a significant improvement in learning through analogical transfer when participants identified the analogical connections. Similarities between the process of frame restructuring (restructure knowledge of a problem set) and the process of analogical

learning (restructure knowledge of a domain) suggest involvement of similar or identical cognitive mechanisms. The implication for designers of content-based metaphorical interfaces: Structure the learning environment so that, when learners are introduced to an instructional metaphor, instructional strategies prompt the learners to describe the connection between the metaphor and the to-be-learned content.

While many conceptual domains might require application of generative metaphorical analysis to uncover underlying metaphors (e.g., philosophical stances toward the relationship between school and society), both Kuhn and Boyd have indicated that many scientific advances and domains have been derived from and propagate by metaphors. Kuhn (1993) proposed that a redistribution of category membership, with an accompanying re-identification of salient features, is the essence of scientific evolution (or revolution, as he had previously labeled it, Kuhn, 1996). Defining metaphor as "all those processes in which the juxtaposition either of terms or of concrete examples calls forth a network of similarities which help to determine the way in which language attaches to the world" (Kuhn, 1993, p. 539), Kuhn believes that theory change is accompanied by changes in metaphors and the domains to which they attach. Metaphors, then, are used to communicate new scientific theory and employed, pedagogically, to pass that knowledge on to successive generations. In his theory of constitutive metaphor, Boyd (1993) considers that metaphor occupies two roles (a) "as constitutive of the assumptions of the domain from which it is derived" and (b) "as a portal opening up new domains" (D. Hoyt, personal communication, June 14, 2001). In both cases, the theorists believe that the conceptual domain co-evolves along with its metaphors. When pedagogically sound metaphors (i.e., they map from source to target in accord with (a) the knowledge domain, (b) conceptual metaphor,

and (c) structure mapping) have already been overtly and explicitly identified and developed along with the domain itself, the instructional designer's task is simplified.

In some cases, designers may have to conduct research studies to uncover natural metaphors held by domain practioners and experts. Specific procedures for uncovering the less obvious metaphors, are described by Madsen (1994) and within many of the chapters of *Researching and Applying Metaphor*, edited by Cameron and Low (1999). Within that collection, Cortazzi and Jin (1999), discussed two techniques they use for collection of metaphors from naturally occurring data. Using a spontaneous metaphors technique, the researchers obtained narrative accounts on a selected topic from 85 participants. The research team analyzed protocols for presence of metaphors. The researchers categorized the list into dominant, reoccurring metaphors (termed generic). Using the metaphor elicitation technique, 140 participants were asked to complete sentence stems, such as (a) "Teaching is . . ., because" or (b) "Learning to teach is . . ." (p. 161). These were also categorized into dominant, reoccurring metaphors.

Metaphor, Learning, and Human Development: Propensities and Capabilities

David Ausubel, the father of subsumption (meaningful association) theory advised that if he "were to reduce all of educational psychology to just one principle, [he] would say this: The most important single factor influencing learning is what the learner already knows. Ascertain this and teach him accordingly" (Ausubel, 1968, epigraph). As each of the researchers discussed within this review have reminded, analogical reasoning maps from a relatively familiar domain to an unfamiliar one, affording inferential candidates that may result in substantial, substantiated insights. Therefore, metaphors can be a powerful pedagogical tool (Baker & Lawson, 2001; Bean

& et al., 1990a; Carroll & Mack, 1999; Gentner & Gentner, 1983; Jonassen, 1981; Kuhn, 1993; Mayer, 1993; Petrie & Oshlag, 1993).

Teachers often employ metaphors within their teaching (Baker & Lawson, 2001; Bean & et al., 1990a, 1990b). Gentner and Gentner (1983) found that choice of pedagogical metaphor (i.e., a source domain of teaming crowds or a source domain of rushing water) significantly and idiosyncratically determined learner's misconceptions about the flow of electrical current. Kintsch and Greeno (Kintsch, 1989) found that a text's presentation of mathematics word problems determined a student's mental model of the problem. Additionally, a student's memory of the problem depends more on the mental model than upon the problem, itself. Because metaphors are so powerful at forging connections, at instantiating and constraining insights, and at actually leading a learner to a pre-determinable target domain relational structure, careful selection of appropriate metaphor is important.

Metaphor theorists have also ventured into the developmental arena, exploring the capacity and breadth of children's metaphorical reasoning. Investigations have probed the ability of young children to recognize, generate, and understand metaphors (Gardner & Winner, 1979; Gentner, 1977; Winner, 1988; Winner & Gardner, 1993). Studies also investigated the possibility of learner gains when learning environments are structured about a content-based metaphor or analogical reasoning (Brown & Kane, 1988; Gentner, 2000).

Gentner's (1980) research into the differences between expert and naïve models in science indicated that naïve subjects tend to explain natural phenomena with localized and narrow analogies based upon attribute relationships rather than an integrated system of higher-order relations. Developmental research into children's acquisition of metaphor appears to parallel that result (Brown & Kane, 1988; Egan, 1997; Gardner & Winner, 1979; Winner, 1988;

Winner & Gardner, 1993) for pre-school children above the age of 3. This is an important finding because these researchers independently conclude that, after three years of age, children's level of comprehension of analogy is based upon what they know (prior experience and domain knowledge) rather than a development stage (Gentner & Holyoak, 1997). As the discussion of conceptual metaphor continually stressed, cognition is an embodied process. It is natural that individuals should fall back to what they know best, physical experiences of surface similarities (salient features), when more profound domain knowledge is not available. That children's analogical behavior models the characteristics of the expert/novice is quite logical to expect (Brown & Kane, 1988). Brown and Gentner have both conducted studies that explored young children's analogical abilities (Brown & Kane, 1988; Gentner, 2000).

Gentner: Young Children and Analogical Learning

Gentner had proposed, in early 1977, that studies of children's metaphorical development, conducted at that time, were based on faulty paradigms that biased results. For example, older children might perform better at selecting or producing appropriate metaphors within a given experimental environment due to increased vocabulary, or increased exposure to metaphors such as the application of the term sweet to describe a personality. Young children might have insufficient target domain knowledge. Finally, young children, inexperienced in language, might misinterpret experimenter's prompts and provide literal responses when metaphorical are desired. Therefore, Gentner devised an experimental methodology that utilized children's spatial awareness through spatial analogies. Given Lakoff's position that spatial reasoning is physically embodied from first cognitions, it follows that this might be a very appropriate domain for paradigms investigating the metaphorical ability of young children. During the study, preschool children, first grade students and adults mapped body parts to

pictures of physical objects (e.g., Prompt: If a tree had a knee, where would it be? Task: Identify the location of the knee on the picture of the tree.). Results suggested that analogical ability is present in both the preschool children and the first graders.

Gentner (2000) reported results that indicated that young children have the ability to learn through analogous situations. In a series of experiments, preschool children worked with two analogous rooms—a small-scaled model or a room and a life-sized room. The two rooms were furnished with appropriately scaled, identical furnishings. The child observed while a small Snoopy hid a toy in the small room. The child was told that Big Snoopy did just what Small Snoopy did, and the child was asked to find the toy, hidden in the corresponding location, in the large room. Children of 42 months were successful at the task. Gentner pointed out that "mundane (close) analogies can be valuable for novices in their attempt to derive a schema because close similarity paves the way for analogical reasoning through bootstrapping."

Gentner's recent research has indicated that learners internalize lessons learned through analogical mapping three times better if they simply discover and state the comparison in their own words (Loewenstein et al., 1999; Thompson et al., 2000). The direction to the learner was simply, "Think about the similarities between the two cases. What are the key parallels? Identify the overall principle that captures these two strategies." These results suggest that, within content-based metaphorically designed learning environments, learners should be engaged in tasks that allow them to explicitly state the relationship between the base (the interface) and the target (the domain of inquiry). Carroll and Mack concur that students are much more likely to employ analogical connections to solve a problem if they are reminded or informed that it exists (1999).

Brown and Kane (1988), on the other hand, found that even very young children can use analogical reasoning to spontaneously transfer rules and solve problems: "With minimal prompts, 3-year-olds can proceed merrily through a series of problems after experiencing the first solution" (p. 519). While 3-year-olds, on the average, were not able to transfer solutions from an example to a novel situation unless prompted to look for problem similarity, 4 and 5-year-olds could solve problems without outside prompts. Across all three age groups, young children were successful at analogical transfer, and this transfer was accomplished on the basis of structural similarity (p. 518). That is, Brown and Kane suggested that the young participants in their experiments completed analogical transfer through a process predicted and described by Gentner's structure mapping, according to "deeper relational commonalities" (p. 516). Results from this set of seven studies also suggest that transfer through analogical reasoning is more efficient and effective when learners engage in learning strategies in which they generate their own elaborations and explanations of example problem (source domain) solutions and their underlying rules. This effect was present whether explanations and elaborations were self-generated by the pre-schoolers or prompted by the experimenters. Brown and Kane suggested that production of explanation and elaborations assists individuals (even very young individuals) in constructing a mental model (Gentner & Stevens, 1983b) or situation model (Kintsch, 1977, 1989; Kintsch & van Dijk, 1978; McNamara, Kintsch, Songer, & Kintsch, 1996) of the problem set/solution. Brown and Kane's results add convergent evidence to Gentner's findings and Carroll and Mack's prediction that learners benefit when they overtly formulate statements that explain and elaborate key relationships mapped through the analogy.

Pragmatic Centrality: A Pragmatic Consideration

Holyoak and Thagard (1989) also suggested that the activities of elaboration and explanation facilitate analogical reasoning. The core component of their constraint-satisfaction theory is pragmatic centrality, defined as focus on goal structure. They suggested that promptings to the analogist for explanation and elaboration serve to focus the analogist's attention on the "goal structure of the problems" (p. 303). Holyoak and Thagard suggested that pragmatic centrality operates during the mapping process to motivate and direct selective attention. Empirically, the researchers supported their conclusion by citing three experiments with 3- to 5-year-olds conducted by Ann Brown and her colleagues: From their findings, Brown, Kane, and Echols (1986) had concluded that (a) children's analogical transfer ability is determined by the level at which they represented a situation rather than their developmental level and (b) level of representation is determined by the level of analysis the child conducts of the base domain. Their findings align with Craig and Lockhart's levels of processing assumption: semantic encoding facilitates attention, comprehension, and memory (Ellis & Hunt, 1993).

Assuming the Holyoak and Thagard (1989) interpretation is correct, implication for instructional designers who employ content-based metaphorical interfaces follows logically: Once again, designers should include activities within instructional strategies that provide opportunities for learners to explain and elaborate the relationships and relationship hierarchy that map between the interface (source domain) to the domain of inquiry (target domain). Theory suggests that elaboration and explanation increase the probability that learners will actively map relations from the target to the domain of inquiry because they motivate and direct selective attention. Thereby, elaboration and explanation help the learner to define a goal state. Holyoak and Thagard consider goal states to be pragmatic knowledge. Increased transfer might be the

result of the learner's attempt to achieve a goal state. Technically, pragmatic knowledge might affect the process either before mapping (Gentner's model), or during mapping (Holyoak and Thagard's model). If pragmatic knowledge acts during mapping, then pragmatic centrality shapes the probability and type of inferences that result.

Kuhn (1993) distinguished between metaphor use within pedagogical situations and those situations in which metaphor is used to introduce scientific concepts to the academy. When a new metaphor is birthed along with a new concept, it might be profitable for individual thinkers to forgo the constraints of pragmatic centrality. "This form of transfer is very flexible, and allows analogies to be used in an exploratory fashion to derive unanticipated candidate inferences about the target" (Gentner, 1989, as cited in Holyoak & Thagard, 1989, p. 303). However, when it is important that learners and professionals create pre-specified candidate inferences (which is often the case in the classroom, within guided-discovery contexts) evidence suggests pragmatic centrality might provide a theoretical basis for the transfer effects researchers have documented when learners are prompted to explain and elaborate mappings between analogical domains.

Contrasting Metaphor with Irony: Developmental Constraints

Winner and Gardner have also conducted a series of experiments that suggested young children are capable of analogical thinking (Gardner & Winner, 1979; Winner, 1988; Winner & Gardner, 1993). One interesting finding was the indication that younger children (three-and four-year-olds) were more willing to engage in metaphorical play with words than their more literal elders of seven or eight-years-old (Gardner & Winner, 1979). Egan (1997) suggests that parents, educators, and communities should actively attempt to nurture, maintain, and integrate the young child's sense of the Mythic, a delight in binary dualities and stories, and images while encouraging growth into "literate rationality" (p. 100). Egan offers that

A further constituent of Mythic understanding, then, is metaphor, and the richer and more

flexible the metaphoric capacity, the greater its potential to contribute to early

understanding. Metaphor is one of our cognitive grappling tools; it enables us to see the

world in multiple perspectives and to engage with the world flexibly. (p. 58)

Children may have limited domain knowledge, but they have a tremendous capacity to imagine

and image, as evidenced by their continued delight over the ages in fairy stories. What is the

nightmare, if not evidence that children have the capacity to imagine—bigger than life?

Lest it be assumed that these researchers unequivocally reject the notion that some

activities and cognitive processes might be developmentally constrained, it is interesting to note

that Winner and Gardner have concluded that irony is developmentally constrained (Winner,

1988; Winner & Gardner, 1993). According to the team, although children as young as three can

reason metaphorically if they have sufficient domain knowledge, they do not begin to understand

irony until six or seven-years-old. In order to have a metalinguistic awareness of irony, a child

must be able to infer what someone else is thinking. This is defined as a first-order belief.

Additionally, the child must reason a belief about the first person's belief (a second-order belief).

This little story of mine might illustrate their definition:

Once upon a time, I was sitting in a fast-food restaurant with my family. We were

chatting and munching, and I had a vague awareness that the couple at the table in front

of us were doing the same. Her back was to me, but he sat facing me. Suddenly, his voice

rose and grabbed my attention. He seemed a caricature of the overinflated. He was a

HUGE man. I don't know how he fit at the table. He wore dark pants, a crisp white shirt,

and bright red suspenders. And he said to the woman, "I think you think I'm staring, but

I'm not." As my husband later related, the huge man in the red suspenders had been

staring at all the women as they stood in line to order and pay for their food. He'd been staring at various women when we walked into the establishment. He'd stared women while we ordered. And he'd been staring, apparently, when his companion had finally complained. He had retorted with a defense composed of the best example of second-order beliefs I've heard. "I think you think I'm staring, but I'm not." Before we could shift our attention, the huge man in the red suspenders and his companion left the restaurant.

Children younger than six- or seven-years-old might not understand that story because they cannot conceptualize second-order beliefs. But you can.

Metaphorical Interfaces

While human-computer interaction specialists continue to base system and software interfaces and user training upon metaphor theory (e.g., for discussion of groupware see Mark & Mambrey, 1997; for discussion of interface design see Neale & Carroll, 1997), instructional designers have continued to face a challenge in validating that metaphorical interfaces positively affect learning (Berkley & Cates, 1996, 2000; Rieber & Noah, 1997, 1998). However, Reese (1998) conducted a pilot study in which 98% of the posttest protocols produced by participating middle school students evidenced higher-order thinking after learners had completed a metaphorically conceived, computer-based learning environment. Although a full specification of the target domain and cross-domain had not been conducted, Reese's interface, M1, was heuristically based upon the conjunction of Lakoff's and Gentner's metaphor theories (2000). A comparison between (a) the M1 interface and the methodology used within its posttest evaluation phase and (b) the posttest instruments and interface characteristics of both Rieber's simulation (Rieber & Noah, 1997; Rieber et al., 1998) and Berkley's THE HUMAN BODY IS A CONSTRUCTION

SITE environments (Berkley & Cates, 1996; Berkley & Cates, 2000) seems to reveal fundamental differences in conceptualization, realization, and evaluation of the metaphorical interfaces. Differences concern (a) hierarchical interpretation of target and source, (b) probability of mappings between target and source upon the complexity of domain hierarchy, (c) restriction of interface design and development to complex conceptual learning outcomes and (d) alignment between learning goal afforded by an interface metaphor and assessment instruments employed to tests its effectiveness. Individuals can employ prior knowledge. Individuals can understand something new in terms of something familiar, but this is not an application of metaphor. To qualify as metaphoric understanding, something of one kind must be understood in terms of something else of a *different* kind (Lakoff & Johnson, 1980). We can gain understanding of the laws of motion in general through manipulation of specific examples: the laws of motion for a roller coaster, for a ball on a table, or for a refrigerator. This is understanding something in terms of something else, but it is not an instantiation of distal relational metaphor. Metaphoric mapping requires that the first and second somethings are members of different domains.

Toward an Instructional Design Model of Content-Based Metaphorical Interfaces

Assessment

The challenge, then, is specification and validation of a model that will allow designers to design and assess content-based metaphorical interfaces to deliver instruction that enhances learners' mental models of a targeted conceptual domain. That model must allow for alignment between assessment and the instructional goals. Those goals are composed of two items--(a) mental models and (b) far and abstract transfer (mapping of relations from the source to the target domains).

Viewing Mental Models Derived From Analogy As Similar to Situation Models

Kintsch (Kintsch, 1977, 1989; Kintsch & van Dijk, 1978; McNamara et al., 1996) made a distinction between the two types of mental models derived from reading or listening to text (that is, organized discourse as opposed to lists of such things as names or labels, see Smith & Ragan, 1993). In the case of the text base model, learners have constructed a model of the specific details of the text as a component of the reading comprehension process. The situation model goes beyond reconstruction of the microstructure of the text. It is comprised of a hierarchical macrostructure, derived from the text, and applied to the content domain. It is an integration of new knowledge into the learner's knowledge system. While use of the text base allows learners to recall and list domain content specific to the text, use of a situation model allows learners to make relational connections between domain nodes (e.g., objects, concepts). The situation model corresponds to domain, rather than text base knowledge. It also "includes inferences that are made using knowledge about the domain of text information" (Kintsch & Greeno, 1985, p. 110). The situation model applies to problem solving tasks as well, in which it is labeled the problem model. Kintsch used the general term *model* to refer to either the problem or situation model. (1989). According to Kintsch, text base knowledge means someone has comprehended and remembered the wording of the text. A situation model means someone has learned something. It is in this second sense that the word model is employed within this review. Kintsch (1988) observed that "both text bases and situation models are mental models of one kind or another in the sense of Gentner and Stevens" (p. 181); that is, they are both types of "human understanding of a domain" (Gentner & Stevens, 1983a, p. 1). It is something with the characteristics of the situation model (i.e., learner understanding of domain knowledge characterized by the relational structure of the domain that affords inferences and elaborations) at work during both

metaphorical mapping from one domain to another and during generation of candidate inferences.

Metaphors as Advance Organizers

Basing many of his observations upon both Gagné's learning outcomes and events of instruction (Gagné, 1972; Gagné, Briggs, & Wager, 1992) and Ausubel's subsumption theory (1962), Jonassen (1981) suggested that content should be a major consideration that drives instructional design and development. Furthermore, he suggested that instruction should be designed in isomorphic (one-to-one correspondence, as in metaphoric mapping) relationship to content. When derived from content in this manner, a metaphor serves as an advance organizer. The metaphorical mapping provides scaffolding and an active context that learners can use as they interact with new content. The metaphor provides a means by which designers can "shape the processing of individuals" (Jonassen, 1981, p. 205).

Although research findings on the effectiveness of advance organizers is inconsistent, Jonassen (1981, p. 207) cited a meta-analysis of 132 studies by Luiten that indicated that organizers facilitate learning and transfer. The key factor might be the alignment of content, instructional objectives, assessment instrumentation, and their interaction with the organizer. Content/treatment interaction was, in fact, the thrust of Jonassen's presentation: advance organizers such as metaphors can be shown to effect learner gains when the experimental paradigm tests appropriate dependent variables. Citing R. E. Mayer's review of existing studies coupled with Mayer's own research studies, Jonassen summarized that organizers like analogy (metaphor) are most effective when content is conceptual in nature, unorganized, and unfamiliar to the learner.

David P. Ausubel developed the concept of the advance organizer as a component of his subsumptive theory of meaningful verbal learning (1962). Joseph Novak, Ausubel's co-author in the revision of Ausubels' educational psychology textbook (Ausubel, Novak, & Hanesian, 1978) and a close colleague, based his development of concept maps upon Ausubel's theory. Indeed, Ausubel considers concept maps to be an "unprecedented attempt by Novak to ascertain an individual's organization of cognitive structure by using his (Novak's) original technique of 'cognitive mapping'" (Ausubel, 2000). Novak (1992) also advocated that advance organizers should be composed of abstract, general ideas. He wrote that Ausubel's proposal of advance organizers was the use of "general, more abstract introduction of ideas [to serve] to anchor into cognitive structure more specific information to be learned subsequently" (Novak, 1992, p. 8). Novak emphasized that advance organizers increased meaningful learning, and that any assessment of their effectiveness must align appropriately with this instructional goal. Ausubel defined meaningful learning as

> the problems of cognitive organization and interaction, i.e., with (a) systematic changes in the availability and identifiability of presented ideational materials as they interact with and are incorporated into existing cognitive structure, and (b) variables increasing or decreasing the incorporability of these materials well as their subsequent availability. (Ausubel, 1962, pp. 213-214)

Thus, Ausubel (2000) distinguished meaningful learning from rote learning, according to the to-be-learned content's "relatability to cognitive structure" (p. 4): Rote learning is arbitrary and verbatim; meaningful learning is nonarbitary and non-verbatium. Ausubel proposed that advance organizers could "introduce the appropriate subsumers and make them part of cognitive structure

prior to the actual presentation of the learning task" (Ausubel, 1962, p. 219). Thus, the organizers would facilitate subsumption of the to-be-learned.

While Ausubel's 1963 description of the advance organizer clearly defined their role as a cognitive scaffold for new knowledge, it could be interpreted as advancing two conflicting accounts of appropriate application. Ironically, Ausubel cited the same research, Northrop's (1952) study of the effects of auditory and visual outlines (use of still footage projecting subject headings) on naval recruits' ability to learn from instructional films, to support both positions.

Northrop (1952) had studied the effect of headings over three conditions (three types of films): discrete items (relatively unorganized episodes), systematically, logically organized films, and dramatic (story) films. However, from reading the report alone, it is difficult to define exactly what type of content treatment was presented within the dramatic (story) films. The topic of the dramatic film was "castaway", with main headings: how to set up a life raft, how to use equipment, how to avoid overexposure, how to get food and water, and how to survive a storm. Learners achieved gains in both the discrete and the dramatic conditions, but only the discrete condition was significant. Any increase in learning was confined to the half of the group that had scored below the mean on the Naval General Classification Test (an IQ test).

From these results, Aususbel initially concluded, advance organizers should be used with factual rather than abstract content, as "it would therefore seem advisable to restrict the use of organizers to the learning of material that is relatively factual in nature, and hence offer[s] adequate scope for the ideational scaffolding provided by abstract organizers" (1963, p. 82) . He advised that "organizers also undoubtedly facilitate the learning of factual material more than they do the learning of abstract material, since abstractions in a sense contain their own build-in organizers--both for themselves and for related detail items" (p. 82).

And, herein lies the source of some confusion about the interaction between organizers and content. Factual material may be defined to form a binary opposition with either abstract or with fictional material (stories). Northrop's study did not contrast fact with abstract. Rather, he contrasted a film composed of discrete episodes with two coherent treatments. Furthermore, Northrop's study employed headings – what Ausubel (1963) defined, some 132 pages later, as a perceptual or mechanical organizer.

Ausubel (1963) defined two types of organizers. Perceptual or mechanical organizers (e.g., underlining, rhythm, or fractionation--breaking into parts such as headings) make material more perceptually salient. Integrative organizers (such as models and analogies) explicate domain structure through the introduction of appropriate subsuming concepts. Ausubel wrote that, while perceptual organizers generally facilitate the learning of factual materials, integrative organizers (such as models and analogies) generally facilitate "information that is more abstract than informational in character" (p. 215). During this second discussion of the abstract/factual dyad, Ausubel again cited Northrop's 1952 study. This time, Ausubel used it to support the interaction between content and type of advance organizer. This second discussion suggests that Ausubel's original intent may have been to define perceptual organizers as specifically applicable to factual content. Jonassen (1981) might categorize the effect as a content/treatment interaction.

In any case, Analogical Designs, the design model presented within this paper, derives from the position that metaphor-based computer interfaces designed according to structure mapping theory may serve as integrative advance organizers that provide scaffolding for learners' introduction to abstract conceptual domains. This review continues from this perspective.

Jonassen's (1981) proposals follow from Ausubel's general concept. Jonassen proposed that analogical organizers should provide a high level context for the learner. Additionally, they should be used with learning that requires "far transfer, discovery learning application of higher-order rules, integration of premises, and the use of linear reasoning" (p. 208). This makes sense: Analogies are a cognitive tool for building relational structure (Gentner, 1983; Gentner & Markman, 1997; Lakoff & Johnson, 1980, 1999). Meaningful learning requires that the to-be-learned incorporate within an existing relational structure. Therefore, analogies are most apt in cases in which instructional goals ask learners to build mental models of relational structure. Speaking of experimental paradigms in particular, Ausubel observed, "one cannot have one's cake and eat it too. If one chooses the particular kind of methodological rigor associated with the use of rote learning materials, one must be satisfied with only applying findings from such experiments to rote learning situations" (Ausubel, 1962, p. 215).

A review of transfer categories might be beneficial at this point. The categories of transfer fall along a continuum from learning tasks that are rather minimal (such as the mundane analogy task employed in an ACT-R experiment and simulation in which both computer and human participants substituted values for equation variables based upon an example equation, see Anderson & Lebiere, 1998) to those that require a great deal of cognitive restructuring (such as Hawking's black holes are thermodynamic systems analogy, see Hawking, 1992). The ACT-R task was an example of near transfer (a great deal of overlap between the original and new situations; the transfer contexts are similar). Near transfer can be very literal, as this task was. Near transfer requires declarative knowledge or mastery of basic skills. Low road transfer also applies to the ACT-R task as well. Low road transfer calls for a transfer of well-learned skills in a fashion that approaches automaticity. On the other end of the spectrum are far, figurative, and

high road transfers. These terms apply to the Hawking context. In far transfer, there is little

overlap between the original and transfer situations. The contexts are dissimilar. Figurative

transfer requires that the declarative knowledge be combined with procedural knowledge.

Finally, high road transfer requires that the individual abstract a rule, principle, prototype, or

schema from one learning context and apply it toward another. This type of thinking requires

concerted and conscious effort (Schunk, 2000). Methodologically, assessment dependent

variables in such cases should be "breadth of transfer and not recall" (Schunk, 2000, p. 208).

Discriminating Between Advance Organizers and Metaphorical Interfaces

When Ausubel published his theory of meaningful verbal learning and retention in the

early 1960s, he explained that analogy was an example of an integrative organizer (1963). Since

that time, educational pedagogy has come to rely on analogy as a type of advance organizer

because, "by using analogy to compare new material to familiar material, we can help students

store the new information more meaningful and retrieve it more effectively" (Ormrod, 2000, p.

537). And Ormrod provided an example from Mayer's research: "Radar is like an echo" (p. 537).

Mayer (1983) had originally developed the radar metaphor for his study of advance organizers,

but he later analyzed the radar metaphor within his chapter on instructive metaphor (1993, pp.

573-577). Given the prominence awarded analogy as a type advance organizer, it is a bit of a

challenge to integrate Ausubel's recent descriptions of advance organizers. Within his recent

book (a restatement of Assimilation Theory in a revision of the 1963 monograph), Ausubel

specifically operationalized advance organizers as "introductory material at a higher level of

abstraction, generality, and inclusiveness than the learning task itself" (Ausubel, 2000). Ausubel

anticipated that, given the operationalized definition, researchers could refine their research

investigating the effect of the advance organizer upon transfer in the acquisition of new

knowledge. As a pedagogical strategy, advance organizers "deliberately" manipulate "cognitive structure so as to enhance proactive facilitation or minimize proactive inhibition. . . . The function of the organizer is to provide ideational scaffolding (anchorage)" (p. 62). Interface metaphors, too, are developed to provide ideational scaffolding, to allow learners to access prior knowledge and build a cognitive scaffold to correctly organize new conceptual material. However, based, as it is, upon conceptual metaphor, Analogical Designs requires a concrete source domain. Instructional metaphors, then, are a specific type of advance organizer that requires a mapping from a concrete, specific domain to a more abstract one (Mayer, 1993). As such, they can be neither constructed nor evaluated as Ausubel recently operationalized the advance organizer unless one considers the relational structure, itself, as more abstract, general, and inclusive than the learning task. Ausubel advised that advance organizers could be discriminated from instructional content because learners could never use an advance organizer to directly answer a posttest question. Given this criterion, the metaphorically mapped relational structure from the source domain may well serve as the entity operationalized by Ausubel.

Assessing the Structure of Learners' Mental Models

In addition to addressing both (a) breadth of transfer and (b) identification of changes within a learner's mental model, a methodology for assessing learner gains derived from the metaphor-based, computer-mediated instruction supported by mapping theory must also meet the structure mapping requirements (Gentner, 1980) discussed earlier within the Structure Mapping: Domain and Mapping Specification section of this review. Concept mapping addresses all three. Theoretically, concept mapping is a direct descendent of Ausubel's theory of subsumption. Subsumption is based upon domain hierarchy, and it structures concept mapping to align with both structure mapping and conceptual metaphor.

Concept Maps

Concept maps, as developed by Novak and based upon Ausubelian theory, are primarily hierarchical. In contrast to written or spoken messages, which are "necessarily linear sequences of concepts and propositions", "knowledge is stored in our mind in a kind of hierarchical or holographic structure" (Novak & Gowin, 1984, p. 53). Although concept maps can be employed by individuals as a learning strategy, as envisioned by Novak, they were first invented to (a) represent what a learner knows and (b) chart changes in learner's mental models.

Novak and his associates (Novak, 1990; Novak & Gowin, 1984; Novak & Musonda, 1991) developed concept mapping during a twelve-year, longitudinal study, refining it as an empirical method used to track changes in learners' mental models of science domains. Learners were first tested in first or second grade, when the treatment group received aural instruction in specified science concepts. Over the progression of the students' maturation from elementary school to high school graduation, trained research assistants conducted Piagetian-like interviews with each learner. The researchers taped and transcribed the sessions. Then researchers charted each learner's domain knowledge, using concept maps. Each map represented the consensus of two or three researcher's interpretation of the structure of one learner's domain knowledge at the time of the interview. The researchers organized learner's concepts hierarchically, subsuming concepts according to the relevant relationships specified by learners. Integration of learner's domain knowledge was measured by (a) the number of levels of the hierarchy (How inclusive is the most subsumptive node?), (b) progressive differentiation (What are the relationships between one concept and another?), and (c) integrative reconciliation (What are the cross relationships between one branch of the hierarchy and another?).

The topological similarity between concept maps and the systematicity principle proposed within Gentner's structure mapping should be obvious. This should not come as a surprise. If, as Lakoff suggested, categorization functions at the root of human cognition, then both human cognitive systems (such as metaphor) and the tools developed to represent their propositional linkages (such as concept maps) should allow for and exhibit those categorization structures that have been distinctly identified human. This would include hierarchical, radial, and graded category memberships.

While Novak (Novak & Gowin, 1984) proposed a framework for a concept map scoring scale, he admitted that any scoring scale, including any one particular scale developed for concept maps, must confess "a certain degree of subjectivity" (p. 105) and/or arbitrariness. However, Novak argued, the arbitrariness or subjectivity within a particular experiment or educational environment would not bias the results unless research should indicate a bias toward a particular set of learner characteristics.

Novak (1984) proposed four scoring components.

1. Score all valid relationships (connections from one node to another).

Rationale: We can get an index of the level of a person's knowledge in a domain by counting the number of valid propositions (Novak & Musonda, 1991, p. 129).

2. Count the number of valid hierarchy levels. Multiply them by a pre-determined weighting factor derived from the number of concepts available within the domain. The number is determined by the learner's level of development and the instructional content.

Rationale: "More levels in an individual's concept may signal greater differentiation of concept meaning – and more sophistication" (Novak & Musonda, 1991, p. 129).

3. Score valid cross-links at 3 times the value of the hierarchical level.

Rationale:

> Interlinkages (when correct) among key concepts in different segments of a concept map are taken as evidence of some degree of integrative reconciliation and hence scored higher than the inclusion of more examples of simple superordinate to subordinate concept relations achieved through simpler subsumptive assimilation processes (Novak & Musonda, 1991, p. 127).

4. Score each valid example.

The power of the concept mapping lies in its flexibility: Each individual learner brings a background that is, to some degree, unique in its sociocultural, physical, affective, and intellectual characteristics. Although individual learner's concepts maps may be compared to a scoring model map, the concept map instrument affords valid and reliable scoring, even when a concept map is idiosyncratic to an individual learner (Markham & Mintzes, 1994; Novak, 1990; Novak & Gowin, 1984; Novak & Musonda, 1991; Wallace & Mintzes, 1990).

As Novak (1984) advised, scoring is flexible and can be developed to meet the instructional context. Novak has published alternative scoring rubrics (Novak, 1990, p. 128). Wallace and Mintzes (1990) added branching (the number of vertical conceptual threads) to their scoring categories. Markham, Mintzes, and Jones (1994) also used branching as a scoring category, because "branching in a map represents progressive differentiation of domain knowledge" (p. 94).

Design

The foregoing review suggests that computer interfaces, modeled to represent the concrete analog of a relational analogy, might assist learners in constructing an integrated mental model of an abstract conceptual domain. To design and develop a metaphorical interface, an

instructional designer would select a target and a metaphor and create an instructional product based upon structure mapping principles. Analogical Designs, summarized below, guides the designer through a seven-step model for use in the design, development, and evaluation of content-based metaphorical interfaces employed in computer-mediated instructional settings.

1. Identification and selection of conceptual domain: Identify and select the targeted domain. Candidates for metaphorical interfaces must comprise complex conceptual domain concepts. Designers may partner with subject matter experts (SMEs) or conduct the analysis of the conceptual domain themselves if they have sufficient domain knowledge. Acceptable domains are abstract, complex, and challenging to learners. SMEs should be drawn from both subject matter and pedagogy experts.

2. Specification of target domain: Map the target domain according to its objects and their relations. Again, SMEs may be employed to assist the designer when content domains and/or their application to instruction are unfamiliar or too technical for the designer. Adequate specification of the target domain requires a bit of housekeeping. After the initial specification of the source domain, examine the map for strands (branches) that duplicate functionalities and converge at the same place. For example, a map might contain a branch for a modern society and a branch for a technological society. If both labels represent the same concept and will function according to the same relationships within the domain, then they should be combined into one node. Otherwise, they will map from many in the target domain to one concept within the source domain, creating a homomorphism. Isomorphic straightening at this stage will eliminate problems at later stages of the design model. Isomorphic straightening is the first of three Analogical Designs housekeeping tasks.

While specifying a domain, the designer may notice that terms employed by experts are really metaphors. For example, within educational philosophy, functionalists couch their representation of the relationship between school and society in terms of its underlying biological metaphor by using terminology such as "survival". This effect may be due to conceptual metaphor and theory constitutive metaphor, which may cause metaphors to be deeply embedded within a conceptual domain. It is helpful to identify metaphorical terms early on. This housekeeping task is labeled metaphor cleansing. Designers should bring these terms to the attention of domain and pedagogy experts. Together the team should select adequate target domain terminology to represent the underlying concept.

3. Selection of metaphor: Select the metaphor candidates. Where possible, use Schön's approach (an analysis of the target discourse) or Lakoff's (conceptual analysis), to reveal metaphors already embodied or conceptualized within the target (Lakoff & Núñez, 2000; Schön, 1993; Schön & Rein, 1994). Metaphors candidates may also be collected through spontaneous metaphor or metaphor elicitation techniques (Cortazzi & Jin, 1999).

It may be the case that an underlying metaphor communicates intellectually without actually specifying a concrete domain. This is an important design issue. Rendering a metaphor as an interface according to Analogical Designs requires a concrete source domain. Once a metaphor has been selected, additional work may be required to translate a source domain from a superordinate level to that of a more basic-level object (Lakoff, 1987; Rosch, 1978, 1983). Again, this step is necessary because people interact with basic-level objects on the psychomotor level. People form metaphors from basic-level, concrete domains to more abstract domains. For example, educational philosophers define the underlying functionalist metaphor as A SOCIETY IS AN ORGANISM. Although the underlying metaphor is transparent, it maps society on to an abstract

source (organism). One cannot see or touch an organism. Organism is still an abstract concept. Taking this source to the basic-level would require identification of apt concrete organisms at the basic-level. If it met relational requirements entailed by the cross-domain mapping, a specific type of organism, such as the social honeybee or the flatworm, might serve as an adequate basic-level analog.

Re-casting a source domain at a concrete level is the final Analogical Designs housekeeping task. It is labeled basic-leveling.

4. Specification of mapping: Define source and map from target to source with a view toward entailments (Lakoff, 1993; Lakoff & Johnson, 1980, 1999) and the assumptions that flow from the metaphor (inferences and candidate inferences, see Gentner, 1983, 1989, 1993; Gentner & Markman, 1995, 1997; Gentner & Schumaker, 1986). This work follows the logic and procedures of the task analysis employed within many Instructional Design models (Smith & Ragan, 1993). Carroll and Mack (1999) outlined a similar process: (a) identify candidate or composite metaphors, (b) detail matches, (c) detail likely mismatches, and (d) identify design strategies to manage mismatches (p. 77).

Within Analogical Designs, cross-domain mapping is constrained by the structure mapping principles: isomorphic mapping and parallel connectivity. The designer uses the structure of the target domain (as specified within step 1 and modified by isomorphic straightening, metaphor cleansing and basic-leveling) to highlight and dictate salient relational structure within the source domain.

For example, the functionalist perspective of the relationship between school and society holds that institutions and practices within traditional societies perpetuate the society through informal education, while technological, modern societies perpetuate through formal education.

The designer would use the relationships between education and institutions and practices as a pattern with which to select salient features of a source domain and shape the relational structure between them. If the designer used a flatworm as a concrete analog for the traditional society, the designer would search for a characteristic of the flatworm that relationally corresponds to informal education. One such characteristic is the flatworm's ability to split itself into two identical entities. What information has been learned by the original flatworm is passed on, identically, to both new organisms. Thus, the designer selects flatworm replication as analog to informal education and looks for flatworm analogs to institutions and practices that will allow relational connections to flatworm replication. Figure 4 illustrates the process of mapping specification. Each cross-domain line represents an isomorphic correspondence between a target domain concept (oval) and a source domain concept (oval). The relational structure of the target domain constrains and directs the structure of the source domain. Question marks indicate concepts the designer must uncover, within the source domain, to correspond to a target concept and set of inter-concept relations existent within the target domain.

Dyad concept pairs are numbered (see Figure 4). Numbering the concepts assists with tracking the development process as each source concept becomes a metaphorical episode within a multimedia instructional title.

5. Creation of conceptual episodes: Create a multimedia episode for each concept. Each episode is designed over a metaphoric graphical interface derived from one concept's source-target mappings (the dyad pairs connected by the cross-domain lines in Figure 4). Lakoff's body of research provides convergent evidence that primary metaphors result from a cross-domain mapping between sensorimotor stimuli and subjective or abstract domains. Furthermore, the evidence suggests that creation of conceptual metaphors is a natural, automatic, low-overhead

mechanism; that it is basic to everyday thought (Lakoff & Johnson, 1980, 1999; Lakoff &

Núñez, 2000). Because a computer-mediated environment allows relatively complete control of

the learning environment (the computer can only project the images and connections designed

into the instruction), a researcher can control the stimuli and design source-target connections

within the graphic interface that (a) reinforce association between relevant objects and relations

and (b) actually link from the source (the interface) to the target (content) in replication of the

map-able inferences and candidate inferences between the source and target domains. To control

for modality effects, only visual cues will be instantiated within the learning environment

designed for this study.

Figure 4. Specifying the cross-domain mapping.
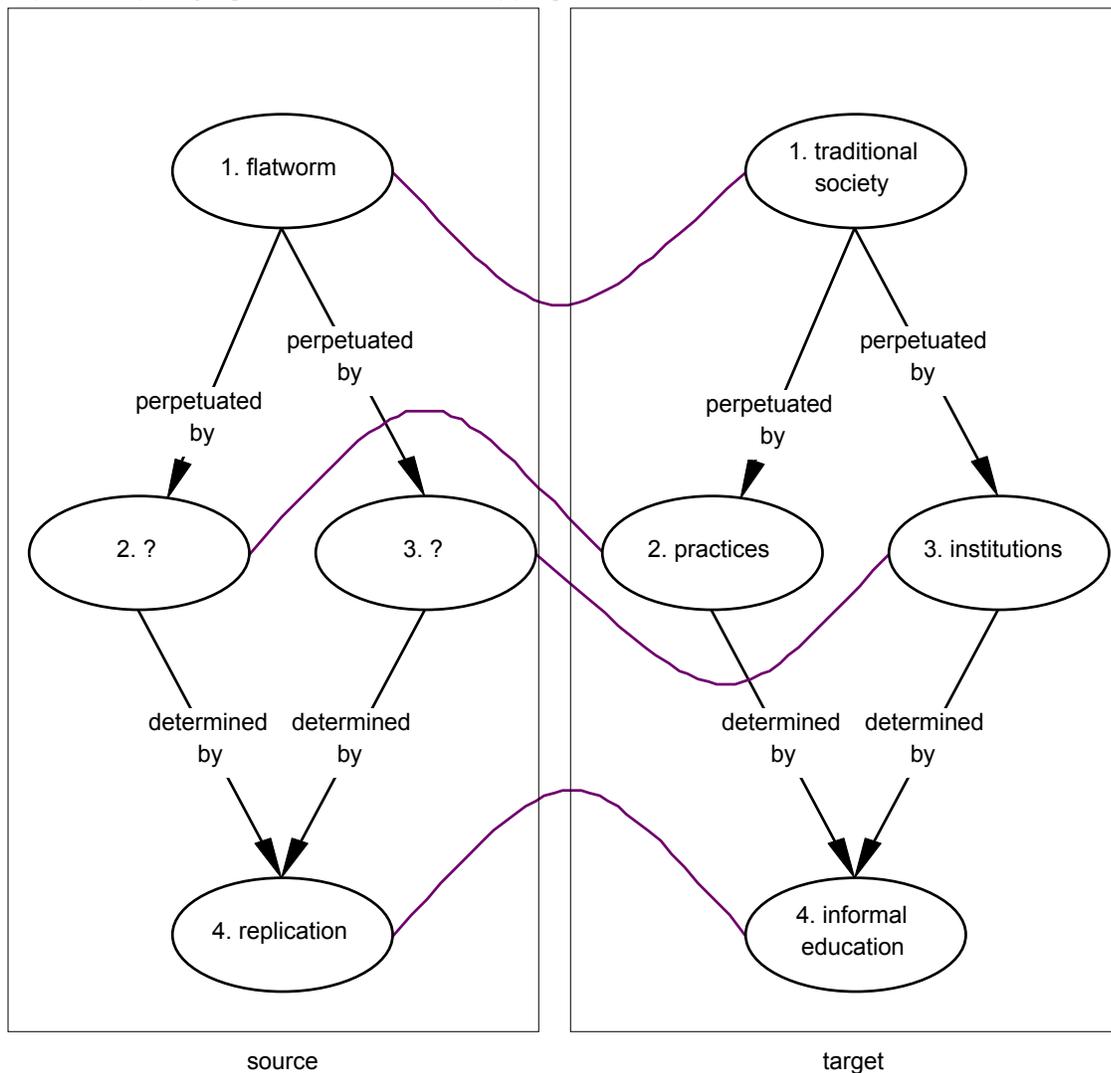
source   target

Figure 4. The lines connecting nodes from the source to the target illustrate the isomorphic correspondences between source and target nodes. The designer's task is to identify appropriate source domain concepts to replace the question marks. Numbering the dyad pairs helps the designer to track the isomorphic relationships through design and development of conceptual episodes. The concept numbers are also used by raters when they identify target concept concepts within participant protocols during assessment evaluation.

6. Control/treatment testing: Test the effectiveness of the metaphorical interface against a control (non-metaphorical interface instruction with identical content) by running participants through the instruction. Gather user posttest protocols for analysis. It is important that assessment items tap each learner's mental model of the targeted domain. Too, as Jonassen stressed, assessment items should be designed to tap far transfer (Jonassen, 1981) rather than rote learning (Ausubel, 2000). Analogical Designs has developed two types of essay-type questions for assessing changes in mental models of conceptual content. Both ask the learner to apply their knowledge of the targeted concept within a new context.

Conflicting model: The first type of essay assessment item uses a conflicting or changed model format. I developed the changed model concept directly from Dedre Gentner's suggestions during our conversation at the American Educational Researcher Association's annual meeting in 2000. The target domain concept map is key to this process. The researcher examines the concept map, selects one to a few concepts, and creates a hypothetical situation in which those concepts or the relationships between them are changed. For example, to test a learner's mental model of the functionalism-traditional society domain, a probe might present a hypothetical civilization in which a traditional society employs formal education (as opposed to informal education). The probe would describe the hypothetical society and ask the learner to detail the ways in which it agreed or disagreed with what the learner has learned about the functionalist's perspective of a traditional society. The probe is presenting a parallel model that conflicts with the one presented during the instruction. The learner's job is to align the two models and discriminate those differences.

Position analysis: The second type of assessment probe used by Analogical Designs uses an expert's position statement (about a paragraph in length) containing components that align

and/or disagree with the targeted concept. Once again, the designer uses the target domain concept map to identify those critical components. The method is parallel to that used for the conflicting model probe. The learner must identify and explain how components within the position statement align or disagree with the targeted domain. For example, a statement by John Dewey expressing an opinion about the relationship between school and society could be used as a position analysis probe to assess learners' mental models of a traditional society.

7.   Protocol analysis: Conduct protocol analysis. Employ trained raters to construct concept maps from participant protocols (Novak, 1990; Novak & Gowin, 1984; Novak & Musonda, 1991) and score participant protocols according to a predetermined hierarchy. Protocol analysis involves a few steps: identification, mapping, and scoring.

Training: Analogical Designs raters work in dyad teams. Each grading unit trains as a pair from the start, to develop a common discourse set, grammar, and mental model. Team members individually work through the same instruction and assessment items to be completed by targeted learners. Then team members practice grading protocols, discussing rationale for rating decisions until each individual member achieves competency level at rating a standard assessment probe. Currently, rater proficiency is set at raters achieving 90% or better agreement with a pre-specified concept mapping of the rater assessment protocols.

Identification: First, the raters must parse through the participant's protocols, identifying all concepts from the targeted domain. Analogical Designs raters use a highlighter to identify target concepts within a protocol (see Figure 5). Then each concept is identified with a number. The number corresponds to the number originally assigned to the concept dyad pair within Step 4: Cross-domain mapping (see Figure 4).

Figure 5. Sample of highlighting and numbering applied to an excerpted protocol segment.

<div style="border:1px solid black; padding:10px;">

        1   6   9

In a ==traditional society==, each person works toward the ==goals== of the society. ==They work as==

                                    10   6   9

==parts (role differentiation)== functioning in ==solidarity== to meet those ==goals. Role differentiation==

</div>

Each rater records highlighted concepts on a record sheet and organizes them into a concept map for the single protocol.

Mapping: Each rater draws a concept map sketch for each of a participant's individual protocols. Then each rater uses concept nodes (index cards labeled with target map concept and numbers) and relations (colored linkage rods) to build a model of all the relations and concepts present within a participant's set of protocol responses (see Figures 6 and 7). By consensus, the rater dyad compiles one summary concept map for each participant, incorporating all maps constructed by raters from the information contained within the individual protocols produced by the participant.

Figure 6. Analogical designs straw mapping.

Figure 6. Analogical designs uses index cards, labeled with concepts and their concept map numbers, as the concept map nodes. Colored straws serve as relational connectors between concepts. We have found it helpful to store the cards in an accordion file, in numbered sections. Most raters prefer to organize concept cards by concept number, rather than alphabetically.

Figure 7. All of the concept representing a response to a single probe are linked in the same color.
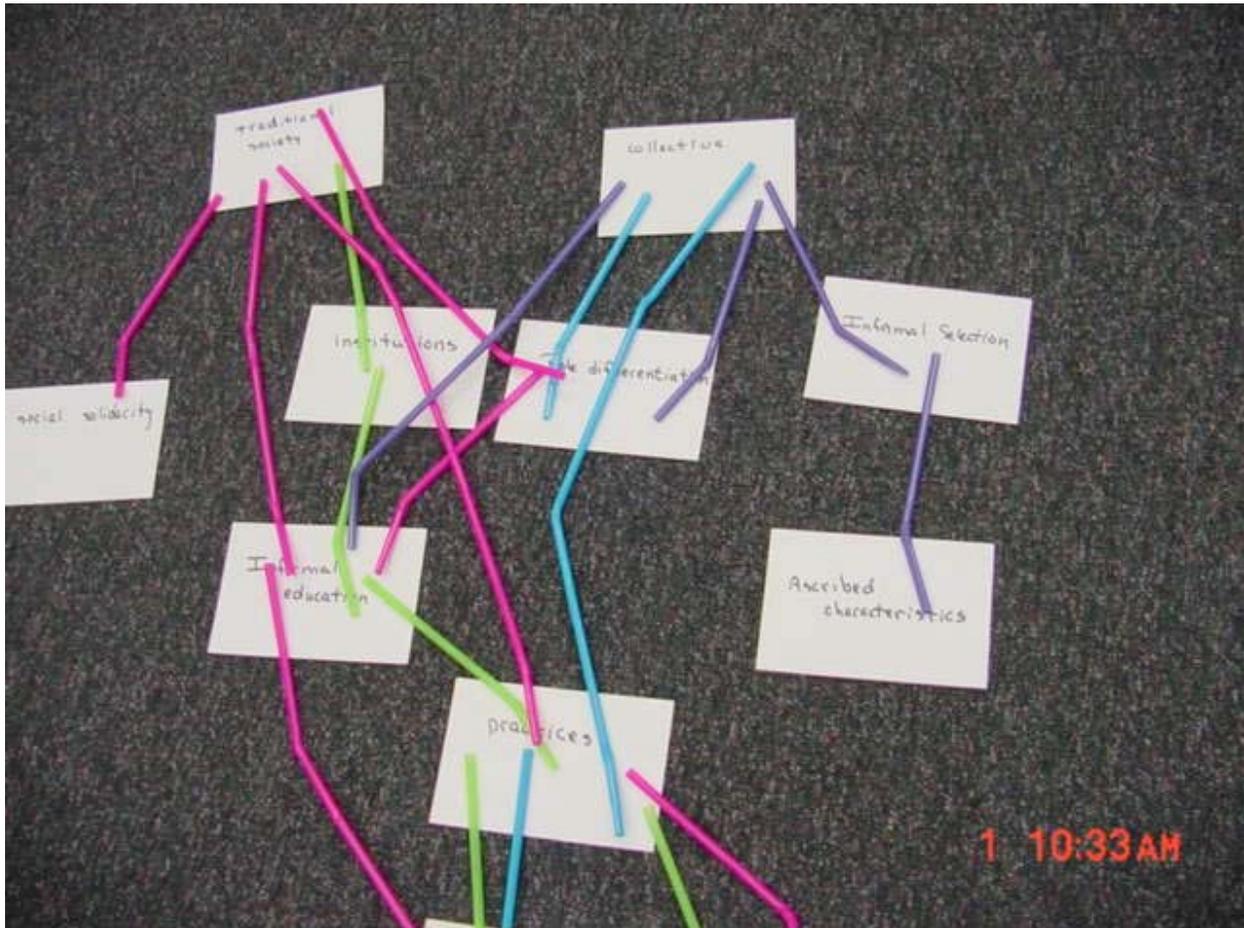
Figure 7. Each participant has completed a set of probe responses. Each response is assigned one color. All of the relational connections for the concepts contained within that probe are joined by connectors of the same color. The connector rods are divided into two parts by a corrugated section. The short portion acts as the arrow head, signifying the direction of the relationship. Connection rods can be joined together, when necessary, to span any large distances between nodes.

Scoring: Raters enter the final versions of the maps into Inspiration. Hard copies are printed out for scoring and documentation purposes. Analogical Designs scores concept maps using (a) the number of concepts (extent of knowledge), (b) the number of branches (progressive differentiation), (c) the number of hierarchical levels (subsumption), and (d) the number of cross-links (knowledge integration). The nature and structure of the targeted conceptual domain determines the weighting scale for each of the scoring categories.

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Summary

Grounded in research and theory accrued from cognitive science (Dunbar, 2001; Gardner & Winner, 1979; Gentner, 1977, 1983; Gentner & Gentner, 1983; Holyoak & Thagard, 1989, 1997; Kintsch, 1977, 1989; Kintsch & Greeno, 1985; Lakoff, 1987; Lakoff & Johnson, 1980, 1999; Rosch, 1978, 1983), education (Brown & Clement, 1989; Lawson, 1993; Lawson et al., 2000; Novak, 1990, 1992; Novak & Gowin, 1984; Novak & Musonda, 1991; Petrie & Oshlag, 1993), philosophy (Boyd, 1993; Kuhn, 1993), instructional design (Jonassen, 1981; Jonassen, Beissner, & Yacci, 1993; Rieber & Noah, 1997; Rieber et al., 1998), human-computer interaction (Carroll & Mack, 1999; Madsen, 1994) and policy analysis (Schön, 1993), the Analogical Designs Model may allow instructional specialists to oversee the design, development, and assessment of computer-mediated instructional environments that employ content-based metaphors to enhance learners' mental models of a targeted concept.

Chapter 3: Methodology

Appropriate design and assessment of metaphor-enhanced learning environments remains a frontier within instructional technology (Berkley & Cates, 2000; Rieber & Noah, 1997; Rieber et al., 1998). In response, this proposal suggested a theoretically and empirically supported methodology, an application of what is known about metaphor, to be used within the evolving technology of computer-mediated instruction. The complete design model can be outlined in seven steps:

1. Identification and selection of target domain

2. Specification of target domain

3. Selection of metaphor

4. Specification of mapping

5. Creation of conceptual episodes

6. Control/treatment testing

7. Protocol analysis

Construction of the content-based metaphorical interface employed for this study required implementation of the entire model, consisting of both the design (steps 1 – 5) and assessment (steps 6 and 7) components.

Design Components

Step 1. Identification and Selection of Target Domain

Domains that are rich in predicate structure are suitable candidates for selection as target domains (Gentner, 1989; Gentner & Schumaker, 1986). For the purpose of this study, the search was for a rich, complex domain, one that might be difficult for the targeted population

(undergraduate and/or graduate students within a department of Teaching and Learning) to understand. Functionalism, as defined by Feinberg and Soltis (1998), is a complex concept, one of three philosophical frameworks that often shape stakeholders' perceptions of the relationship between school and society. Educational controversies and movements toward educational reform occur within the context of social, political and cultural factors (1998). Educators who must modify their practice to conform to changes in expectations are at risk of "frustration, disenchantment, and alienation" (p. 10). It might be helpful for educators to develop an understanding of the common frameworks that shape stakeholders' perspectives of the relationship between school and society. This insight might aid them in dealing with policy orientations and shifts. Therefore, functionalism is not only a rich conceptual domain; it has some pragmatic pertinence to educational practitioners and the preservice educators from which this study's participants are to de drawn (1998). For these reasons, functionalism was selected as the candidate for the target domain within this study. Adoption was confirmed after specification of its predicate structure.

Step 2. Specification of Target Domain

Chapter Two: The Functionalist Perspective on Schooling of *School and Society* (Feinberg & Soltis, 1998) presents a concise, self-contain definition and discussion of the concept of functionalism. It was written as a textbook for preservice educators, and the content and level of presentation is well suited to the subject pool selected for this study (preservice teachers). The chapter, then, served as the discourse and subject-matter expert for the target domain, functionalism.

Chapter Two: The Functionalist Perspective on Schooling discussed 55 individual sub-concepts. These are listed alphabetically within in Table 2. The next step in specifying the

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domain was to identify the hierarchical structure that Feinberg and Soltis (1998) used to connect the concepts. The concept map visual tool was employed to illustrate the relationships within the domain (see Figure 8). Within the concept map, concepts are illustrated as nodes, enclosed within rectangular boxes. The lines that run between nodes illustrate relations between concepts. Concept maps also allow for identification, labeling, of the relations. It is important to label relations because, according to structure mapping, cross-domain mappings are constrained by the isomorphic relations occurring in both source and target (Gentner, 1983, 1989; Gentner & Markman, 1995, 1997) . Within this design model, these relations are used to dictate and constrain the concept map for the source so that it maps exactly to the target.

Table 2. Functionalism Concepts Present in *Schooling in America,* Chapter 2: The Functionalist Perspective on Schooling, by Feinberg and Soltis.

8. achieved characteristics	9. achievement	10. adaptive
11. adjustment	12. assimilation	13. attitudes
14. complex (society)	15. compulsory (education)	16. democracy
17. democratic principles	18. dysfunctional	19. economic
20. economic development	21. economic life	22. equal opportunity
23. formal	24. frame	25. functionalism
26. goals	27. habits	28. hidden curriculum
29. highly technical economy	30. human capital	31. independence
32. industrial	33. informal education	34. institutions
35. loyalties	36. modern meritocracy	37. modern society
38. modernization	39. norms	40. political
41. political development	42. political life, system	43. political socialization
44. practice	45. primitive (traditional) society	46. role differentiation
47. school	48. selection	49. simple society
50. social	51. social life	52. social solidarity
53. socialization	54. society	55. specificity
56. stage theory	57. survival needs	58. survival needs
59. tolerance for diversity	60. training	61. United States
62. universalism		

Table 2. These concepts are listed alphabetically. The numberings assigned within this table serve only to aid viewer's visual differentiation of concept phrases. They do not correspond to concept's function or location within any one concept map.

Figure 8. Concept map of the functionalism domain.
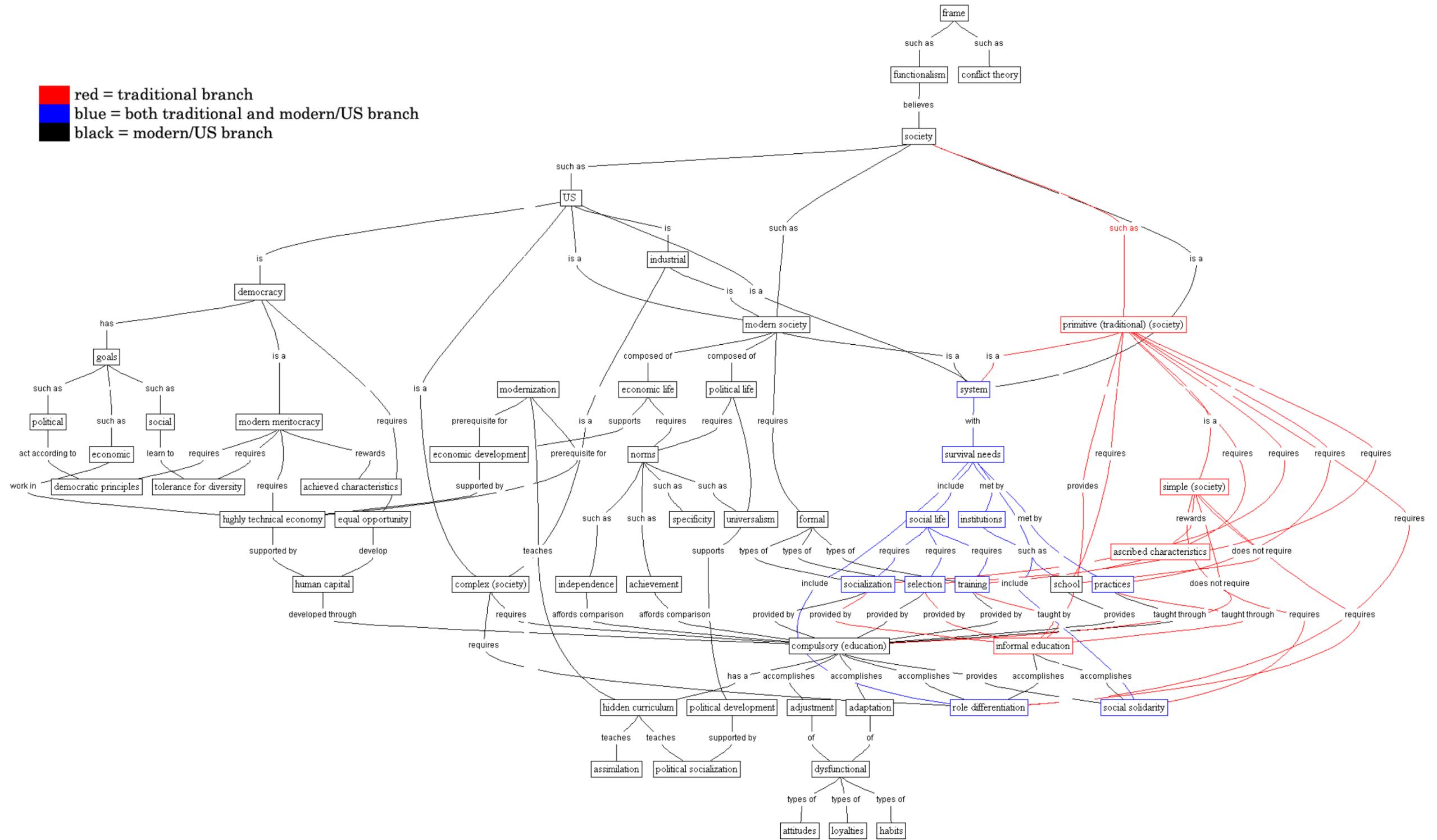
Figure 8. This is the map version before isomorphic straightening. Notice that some of the branches are relationally redundant. Three content experts approved this concept map as a reasonable representation of the conceptual domain, as defined in "Chapter 2: The Functionalist Perspective" within the book Schooling and Society by Walter Feinberg and Jonas F. Soltis.

Although this study is specifically concerned with the domain of functionalism, Chapter Two: The Functionalist Perspective on Schooling defined functionalism as one of three frames, or philosophical perspectives. Therefore, the concept *frame* was indicated at the highest predicate level of the concept map, subsuming all other categories, including the concept of functionalism. In order to place the frame and functionalism in perspective, a second philosophical view, conflict theory, is also illustrated as a major branch within the penultimate predicate level of the concept map. Because this study does not address the domain of conflict theory, that branch is indicated but left incomplete.

Once the concept map for functionalism was complete, it was sent to two in-house specialists, faculty members at Virginia Tech, for review. Both Dr. J. W. Garrison and Dr. M. Boler approved the map as an appropriate conceptual representation of the content within the Feinberg and Soltis chapter. Chapter author, Dr. W. Feinberg (Professor of Educational Policy, University of Illinois at Urbana-Champaign), also reviewed and approved the concept map.

The original map (Figure 8) was modified according to the principles of isomorphic straightening. The self-contained nature of each of the subdomains allowed me to construct the revised map in two parts. The first contains the concept map for the traditional society, composed of 13 concept nodes (see Figure 9). The second contains the map for the complex society, composed of 35 concept nodes (see Figure 10).

Figure 9. Revised functionalism map: Traditional society.
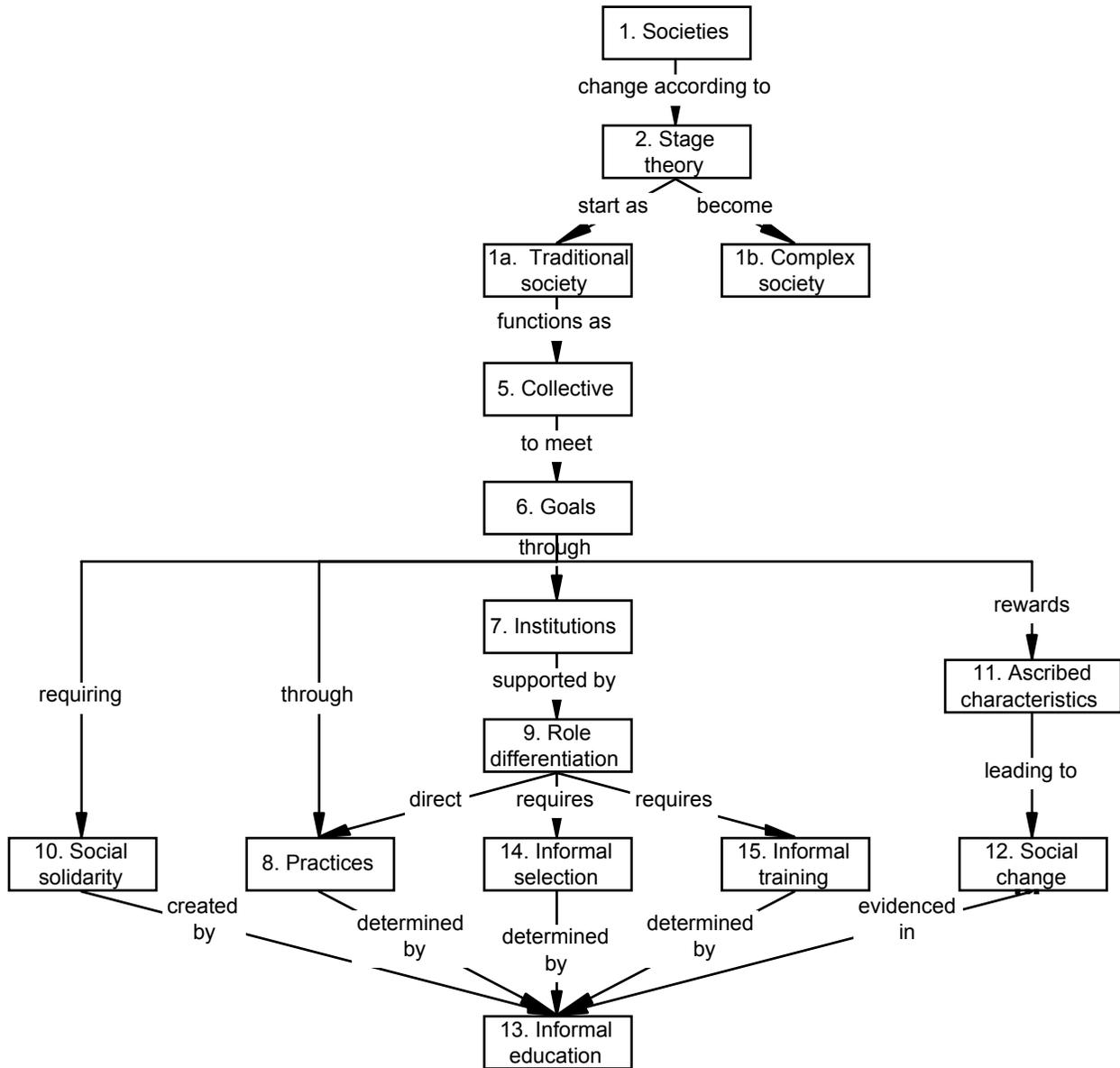

Figure 9. This map is the traditional society component of the functionalism concept map after isomorphic straightening. The concept node numbers will be used in episode development and during protocol rating.

Figure 10. Revised functionalism map: Complex modern society
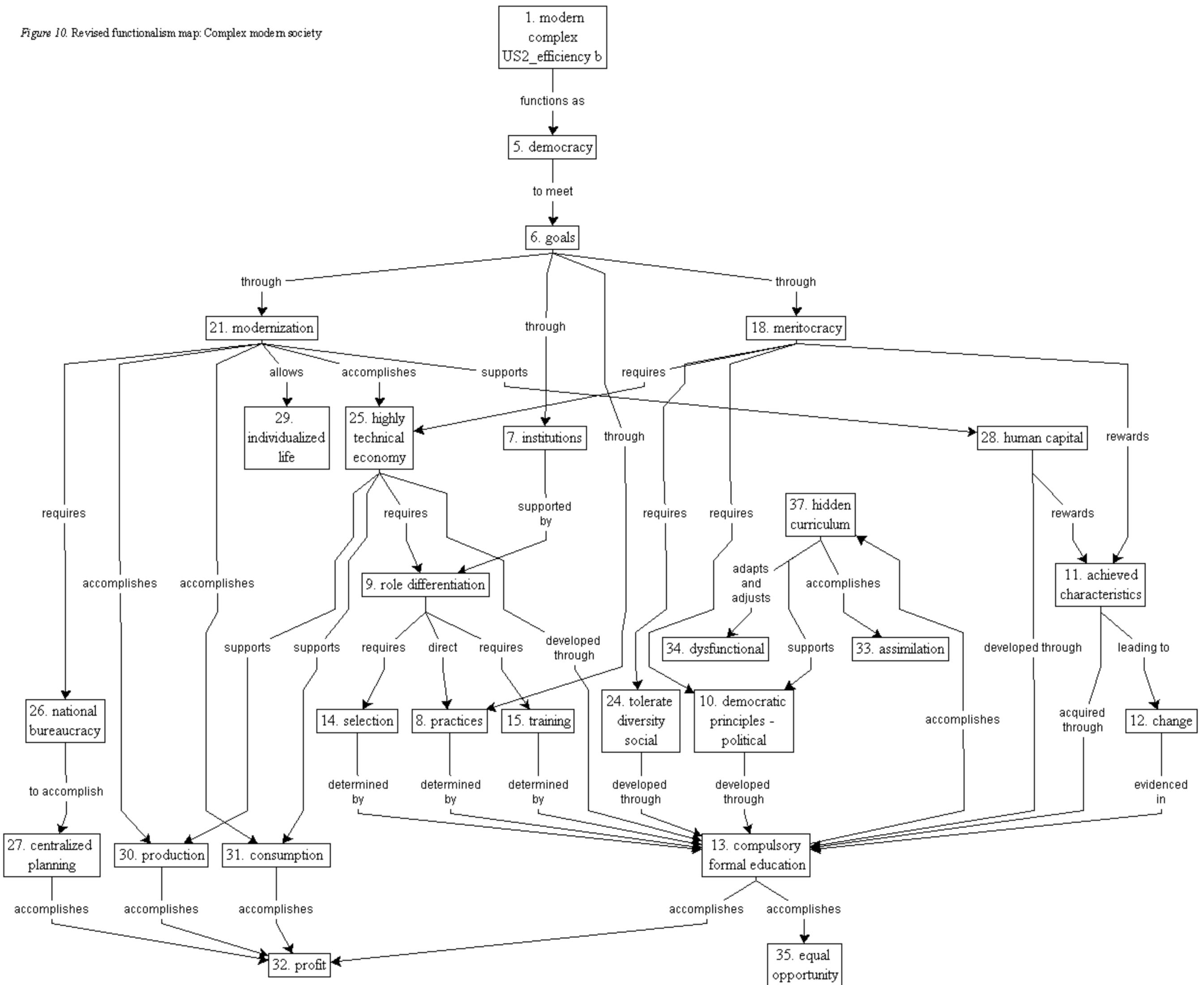
Step 3. Selection of Metaphor

At this point, the design model calls for an examination of the discourse representing the targeted domain, uncovering the underlying metaphor through analysis of entailments evident within arguments and assumptions (Schön, 1993; Schön & Rein, 1994). In this case, the discourse is the text of Chapter Two: The Functionalist Perspective on Schooling (Feinberg & Soltis, 1998)*.* The text yielded easily to analysis, as Feinberg and Soltis began the chapter by explaining the metaphor:

> Functionalism is a general theoretical orientation about how social events and institutions are to be viewed. . . . Its basic insight, however, is drawn from the field of biology. Functionalists note that the various systems of biological organisms serve different survival functions. In mammals, for example, the stomach, small intestine, and other organs digest food, while the heart pumps blood, thereby brining oxygen from the lungs to different parts of the body. . . . Carrying this insight from the biological to the social sphere, functionalists argue that if we want to understand a certain social practice or institution, we must consider the way in which it serves to further the survival of the social system as a whole.
>
> Just as the different parts and behaviors of an organism can be understood in terms of the function they serve in meeting the needs of survival, so, too, the functionalist argues, can the practices and the institutions of a society be explained in terms of meeting certain social survival needs. (pp. 15-16)

Therefore, the underlying metaphor is A SOCIETY IS AN ORGANISM.

One component of functionalism, stage theory, suggests that modernization is a process through which primitive societies develop into complex, technological societies (Feinberg &

Soltis, 1998). In order to accommodate this concept, two sub-metaphors, or entailments, were necessary: A TRADITIONAL SOCIETY IS A [   ] AND A COMPLEX SOCIETY IS A [   ].

Step 4. Specification of Mapping

The premise of this study is that a content-based metaphorical interface, acting as a concrete environment, will help a learner to construct an integrated cognitive model of a targeted, abstract conceptual domain. The key, for this stage of the design model, is the word concrete. While *organism* is the actual source domain of the metaphor, the concrete origin of the educational psychologist's definition and use of the term functionalism, and while the term might serve as an adequate source domain when delivery of the instructional metaphor is verbal (spoken or written), this design model requires instantiation of a metaphor as a computer-interface, a concrete environment (note: this study limits the environmental stimulus to the iconographic in order to control for modality effects). Therefore, the source domain must derive from basic-level concepts (Rosch, 1978, 1983) . Organism is not a basic-level concept. It cannot be imaged. For this reason, the actual source domains employed within this instructional title derive from the secondary metaphors: A TRADITIONAL SOCIETY IS A [   ] AND A COMPLEX SOCIETY IS A [   ].

At this stage, the task for the designer is to examine the source domain (organism) and locate a basic-level source concept. This housekeeping task is known as basic-leveling. In the case of functionalism, the division into both traditional and complex required two basic-level concepts. The metaphor's entailments (e.g., STAGE THEORY IS EVOLUTION, PRACTICES AND INSTITUTIONS ARE ORGANS SUPPORTING THE SURVIVAL OF THE SYSTEM) dictated a number of parameters.

Humans construct primary metaphors based upon mappings from the environment to a subjective or abstract concept. Learners, working through a computer-mediated instructional title set over a content-based metaphor, should also construct their mappings from the source and to the target. However, the metaphorical interface is constrained by the content—the target domain.

Furthermore, isomorphism (Gentner, 1983, 1989; Gentner & Markman, 1995, 1997; Gentner & Schumaker, 1986) stipulates a one-to-one mapping between relations in the source to relations within the target. That is, at most one relation from the target may map on to one relation within the source, and vice versa. This structure mapping parameter is easy to understand when applied to an instructional situation: a learner might find it confusing if one relation from the source mapped to two or more relations within the target.

Therefore, the instructional designer must create elaborations of the cross-domain mappings (that is, revised concept maps) through the use of feedback loops that run both forward and backward, from source to the target and from the target to the source, constrained by the dictates of isomorphism. The instructional designer creates a metaphoric interface that models, as exactly as possible, the relational structure of the target domain.

Earlier, this discussion defined highlighting as a consequence of metaphoric mappings in which the cross-domain mapping determines which aspects of the target and source domains are relevant. In order to maximize isomorphism between relations within the source and the target, the designer must highlight just those relations within the source that map isomophically with pertinent relations within the target. Additionally, to accommodate isomorphism, the interface might dictate a presentation structure in which multiple target domain concepts that do validly map on to just one source concept are subsumed within just one conceptual node.

An example within Soltis and Feinberg's presentation of functionalism (see Figure 8) might be the concepts traditional society, primitive society, and simple society—which would all map on to the simple organism. Or the concepts United States, complex, technological, and modern, which would all map on to the base-level concept for complex organism. Isomorphism dictates that concepts within the source/target dyads must map in one-to-one correspondence. Although the maps were evaluated for isomorphism at every design step, isomorphic straightening was begun during step 2 (see Figure 9 for the isomorphic map for the traditional society and Figure 10 for the isomorphic map of the complex, modern society).

Finally, there are instances, within the Feinberg and Soltis presentation of functionalism, in which they have simply adapted and accepted a concept from the source domain as a label for its counterpart within the target, without inclusion of terminology specific to the target. Two examples from their description of functionalism (see Figure 8) would be the strings *system* and *survival needs*. In such cases, it is necessary for the instructional designer to select apt target correlates (such as the entailments A COLLECTIVE IS A SYSTEM and SOCIAL CONTINUITY IS SURVIVAL NEEDS).

With these precepts dictating choices and decisions, the following entailments and concepts were pertinent to the selection of the two basic-level target concepts selected to represent traditional and complex societies:

1. Many functionalists believe in stage theory, that societies develop from traditional (also labeled simple or primitive) to modern (also labeled complex or technological). Mapping constraints require, then, a relationship between the two basic-level organisms. Evolution must allow progression from one to the other, over time. One characteristic of organisms that evolved over millions of years was the coelom (a fluid-filled space which cushions the internal organs

and frees the muscles for movement without changing the shape or position of the internal organs). Flatworms (planarians), which appeared on the earth about 600 million years ago did not have coeloms. Social honeybees, appearing on earth about 35 million years ago, were equipped with fully functional coeloms. The coelom helps to account for the complexity of social honeybee movement and behavior.

2. According to functionalism, all societies require solidarity and role differentiation. Complex societies are so specialized that local units (such as the extended family) cannot provide the instruction necessary for individuals to execute the tasks necessary for the economic survival of the community. Complex, highly technological societies require a means of formal education. In contrast, individuals within the immediate traditional society community can provide the role models and apprenticeships necessary to train members for that society's tasks. This is informal education. One can highlight aspects of the flatworm and social honey bee domains to map on to these concepts: (a) The planarian's organs and behaviors (e.g., the simple bi-gangliated nervous system which supports a photoreceptor eye spot eye and directs the animal to moves away from light and toward chemicals emitted by rotting meat, Essenfeld, Gontang, & Moore, 1996) are less complex than the social honeybee's organ systems and behaviors (e.g., a nervous system that supports a complex eye, complex communication such as the waggle dance, and individual bee's progressions through stages representative of elaborate division of labor, Seeley, 1985) and (b) An individual planarian, splitting itself in half and regenerating the missing components (fragmentation), informally reproduces its simple learned and genetically acquired information. In contrast, the complex array behaviors exhibited by the social honey bee colony, from nurse tasks it executes at youth to the mature roles of forager and scout are learned as formal, hard-wired instruction present in the colony's genomes.

Highlighting allows the designer to concentrate on relevant, supportive concepts and images, such as images of planarian asexual reproduction.

Use of biology as a source domain for this mapping required consultation with a number of biologists to insure the accuracy of the source domain. Those who served as subject-matter experts were Jenny Duscheck, zoologist, science writer and co-author of the college biology textbook *Asking About Life;* Auburn High School biology instructor Charles K. Jervis; Virginia Tech entomologist Richard D. Fell; and Virginia Tech pathobiologist Anne M. Zajac.

Figures 11 (flatworm for traditional society) and 12 (social honeybee for complex, technological society) illustrate mapping from source domain (organism) to the target domain (society). These maps are based upon the general functionalism map, but the source and target domains have been refined to follow the constraints imposed by structure mapping. That is, mappings of relations are unique and the domains exhibit identical subordinate structures (Gentner, 1983; Gentner & Markman, 1995).

Figure 11. Final concept map for the source domain: Flatworm.

Figure 12. Final concept map for source domain: Social honeybee
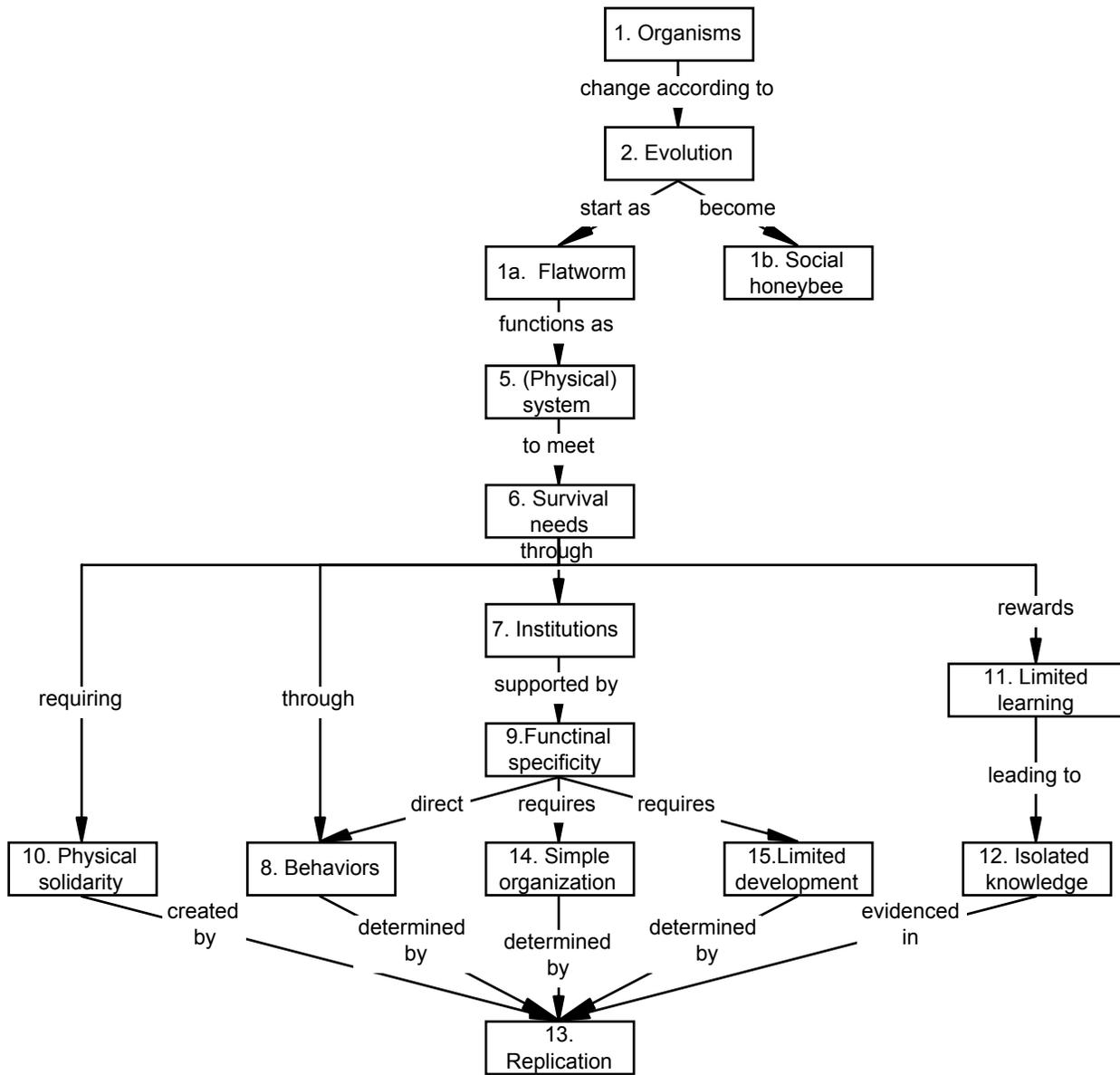
Figure 13 contains an excerpt from the source domain: Organism. Figure 14 contains an excerpt form the target domain: Society. As revised to confirm to the constraints of structure mapping, the relational structure of the two maps is identical. Across the two figures, objects within the source domain that occupy identical relational position as objects within the target domain are assigned the same number. For example, *functional specificity* occupies the same relational role within the organism map as *role differentiation* occupies within the society map. Each is numbered 9. These concepts, then, that are assigned the same number are the cross-domain mappings.

Figure 13. Organism map excerpt.   *Figure 14.* Society map excerpt.
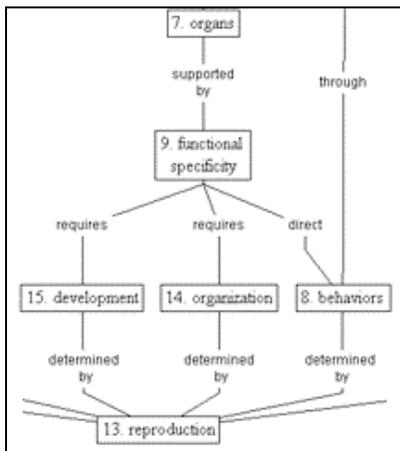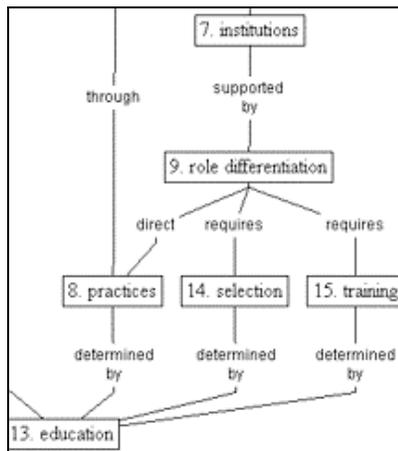
Creating the final source domain concept maps required refinement to include those concepts relevant to either the traditional society (see Figures 9 and 11) or to the complex society (see Figures 10 and 12). One again, the procedure is to work from the target and back to the source. However, the feedback loop is continuous throughout the design process, as the actual

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characteristics and relations existent within the source domain inform the mapping. Once again, within both the planarian/traditional and social honey bee/complex concept map sets, the relational structures (as evidenced by concept numbering and the lines indicating the relational connections) are identical.

Step 5. Creation of Conceptual Episodes

> *Theoretical considerations.*

The premise behind this design model is that the computer interface presents a negotiable environment for the learner. Accepting that people normally construct understandings of subjective or abstract concepts by constructing metaphors that map from concrete experiences to abstract or subjective ones (Lakoff & Johnson, 1999), the model assumes that a concept-based metaphorical interface will help learners to construct understandings of complex conceptual content when the learners construct mapping from the interface to the content. Remember, the mappings are constructed from source node to target node based upon relational systematicity (Gentner & Markman, 1997). Recall, as well, that the source subdomains developed for this study (flatworm and social honeybee) were created such that they are in perfect structural alignment with the target subdomains (functionalism: traditional society and functionalism: complex society). Therefore, to embody the relations, the interface must function according to the relational paths within the source concept map. Navigation through the multimedia title should be structured according to the source domain's conceptual paths. In other words, the interface is developed such that the sequential flow between concepts in the source domain's concept map (see Figures 11 and 12) becomes the logic behind the sequential flow of the interface links. To the extent that it is developmentally possible, the computer-based instructional interface derives directly from the source concept map.

Feedback loops.

It appears that many of the steps implemented within the design of metaphorical interfaces require feedback loops. One was the source/target loop necessary for domain specification (see step 4: Specification of Mappings, within this section). Specification of the multimedia title (leading to the storyboards, rapid prototype, and final title development) also requires a loop. At this step, the loop is between the superordinate levels of the source domain concept map (concept 2. Evolution, is an example of a superordinate level, see Figures 9 and 11) and the most subordinant, most specified level of the map (concepts 10. Limited number of behaviors; 14. Simple organization; 15. Development; 12. Isolated and limited; and 13. fission-splitting are examples of subordinate-levels, see Figures 9 and 11). The most subordinate layers are important because they are the most concrete. Recall the discussion of basic-level concepts (Lakoff, 1987; Rosch, 1978, 1983). Humans tend to categorize at the basic-level, the level at which they interact with the environment. It follows, then, that an interface intended to engender user categorization and relationship-making would derive from the most basic-level of the domain hierarchy. However, design decisions derived from subordinate concepts must also support higher levels of the domain. It appears that subordinate concepts equate to decisions about cast selection (the images slated for inclusion within the computer screen). Superordinate concepts tend to drive organizational decisions about content modules (the multimedia correlate of book chapters). However, the images and interface screens must concretely represent both superordinate and subordinate concepts. Again, navigation is controlled by the relational links between nodes. Each major navigational strand corresponds to an interface module.

It is important to note, here, that modules are driven by characteristics of both content and functionality. Within the interface designed for this study, content determined many of the

set, cast, and navigation parameters (see Figure 15). However, functionality considerations also dictated screen structure and title organization (see Figure 16). This interface contains three modules constructed according to functionality: (a) metaphorical scenes, (b) presentation of text-based content, and (c) evolution sequences. However, those templates are embedded within the overall navigational logic dictated by the source domain's relational strands and links. Additionally, the metaphorical images and scenes are omnipresent. Once again, design considerations were systemic and informed by feedback loops between the three complementary components.

Specification of interface metaphor set, characters, acts, and scenes.

Was it merely coincidence, or did it follow that an interface designed from a metaphor, to support that metaphor, should require a design metaphor? In any case, design of the functionalism interface issued from the application of a very specific metaphor, a theatrical metaphor: THE INTERFACE IS A STAGED PRODUCTION. Again, is it coincidence or a logical consequence that the authoring tool *Director*, one of the driving engines of the multimedia industry (Roberts & Gross, 1999) also employs the theatrical metaphor for its interface? In any case, specification of the functionalism interface was conceived through the use of a stage, a cast of characters, and a script of acts and scenes (corresponding to Director's score).

The title was conceived as a hybrid between a film and a play in which the designer could manipulate lighting and position of characters and alternative points of view toward set.

The metaphorical interface contains two screen templates: (a) the interface scene (see Figure 15) and (b) the content text (see Figure 16).

Figure 15. The Interface scene screen.	Figure 16. The content text screen.

The interface scene is meant to convey the metaphor iconographically. In addition to the text labeling the Help button, the only additional text on the interface scene screens labels the specific target and source concepts. Navigation from the interface scenes proceeds from the button at the right-hand side of the screen: For both the flatworm and for the bee segments of the title, this button is an image on the right side of the screen. This image contains the base concept of either informal or formal education. For the flatworm it is the flatworm fragmentation. For the social honeybee it is the gene (double helix DNA) that contains the animal's hardwired behavior.

1. Flatworm scene. As the navigation progresses, the worm splits (replicating through regeneration). Each degree of splitting corresponds to a concepts hierarchical level within a concept strand. There are 13 concepts within the flatworm source concept map.

2. Social honeybee scene. As the title progresses the DNA double helix splits. Each degree of splitting corresponds to a concepts hierarchical level within a concept strand. There are 35 concepts within the honeybee source concept map.

Navigational progression through this title is determined by source domain relationship strands, progressing down a complete branch before leaping to another branch segment and controlled by the program (software). The user has temporal control (the freedom to decide when

screens change), but little control of destination. From here, the movie automatically navigates to the interface content text screen (see Figures 15 and 16). This screen contains 6 sections, plus the Help and Navigation buttons.

1. Thumbprint picture highlighting functionality

2. Metaphor (i.e, A [TARGET CONCEPT] IS A [SOURCE CONCEPT].)

3. Source concept label and description

4. Target concept label

5. The learner's task: (e.g., Briefly, describe the metaphor connecting A (source concept) and B (target concept).

6. Thumbnail: splitting flatworm or double helix serving as next button

When the user has completed the task (item 5), the user will click the button (item 6).

The title is divided into two acts. The first (the flatworm segment) contains two major scenes (the evolution sequence through the appearance of the flatworm and the flatworm scene). The cast list requires flatworms to perform the following functions:

1. 1 large flatworm for body systems – especially the nervous system to the photoreceptor eye

2. 1 large flatworm highlighting chemorecepetor response toward decaying food

3. 1 large flatworm for photoreceptors away from light

4. 1 large flatworm – cute and alone –to approach and eat food

5. Smaller flatworms of various sizes to move toward decay

6. Smaller flatworms of various sizes away from light

7. Fragmented flatworms

The actual cast could, and did, consist of fewer actors, each playing more than one functionality role. The number of characters on the screen at any one time was determined by aesthetic considerations.

Additional cast members are: food source, plant life, light/shadow, splitting flatworm for menu bar and next icon, solar system, lightening, pond, and animals for each evolutionary stage (e.g., coral, paramecium, jelly fish).

Scene 1.1 corresponds to the metaphor STAGE THEORY IS EVOLUTION. This thread occurs twice, once at scene 1.1 and once at scene 2.1. Scene 1.1 occurs just after the title screen and its text screen (which presents a rationale for studying functionalism). It leads to the flatworm sections. During the evolution sequence, pertinent years (e.g., 4.5 billion years ago) flash on the screen, followed by environmental changes or animal life that appeared at that time.

1. Solar system at 4.6 billion years ago

2. Lightening and water on earth at 2.5 billion years ago

3. Life forms begin to flash over pond at 1.5 billion years ago

4. Flatworms appear at 600 million years ago

Scene 1.2 represents A TRADITIONAL SOCIETY IS A FLATWORM. It contains the main flatworm scene and support images screens. Each flatworm concept map node (see Figure 11) is illustrated by an incident occurrence within the main image and its companion text screen.

Act 2 details the components of A COMPLEX SOCIETY IS A SOCIAL HONEYBEE COLONY. The honeybee cast members include

1. waggle dancer 1 and waggle dancer 2. Waggle dancer 2 is used to illustrate swarming, (node #26). It can be the same graphic as the waggle dancer 1 that is used for communication (node #8).

2. Nectar/pollen gatherer

3. Drone removal by workers

4. Drone, queen, worker bees (for sex roles at node #14)

5. Queen thumpers (workers), who don't let queen rest until she swarms

6. Worker roles (nurse, builder, receiver—all in nest; forager—at flower, waggle dancer, giving pollen to receiver). These have anthropomorphic props—such as a bee nurse cradling baby bee or a clipboard for the receiver bee, or the builder bee with construction tools).

7. Internal view with nervous system (eye and ganglia)

8. Queen and 4 drones for mating flight

9. Defender bee.

10. Pheromone spreading

Honeybee colonies (hives) include

1. The main hive, in a tree with a cut-away at the front of screen for most illustrations and bee activity. This hive winters through snow and lives in spring, allowing 3 swarms and pumping of the queen; food storage; sex roles; worker stages; receipt of pollen; and defense of hive.

2. The second hive is established at concept #27. This hive dies out during the winter.

3. Hives 3 and 4, which do not have to be very distinct.

Cast members also include the swarm (the same swarm can be used for node #27 and as well as twice for two node #12 swarms), the DNA/gene double helix, splitting, and a predator.

Scene 2.1 is the second part of the interface that corresponds to the metaphor STAGE THEORY IS EVOLUTION. It occurs after the conclusion of the flatworm sequences and before the start of the bee sequence. The evolutionary stages within scene 2.1 are listed below, with animals that might appear at that stage:

1. Snail at 500 million years ago

2. Fish at 400 million years ago

3. Alligator and dragon fly at 350 million years ago dragon fly

4. Turtle at 230 million years ago

5. Dinosaur, palm tree, ferns at 180 million years ago

6. Bees and trees (oak and maple-like) at 65 million years ago

Scene 2.2 represents A COMPLEX SOCIETY IS A SOCIAL HONEYBEE. It follows the honeybee concept map.

Concentration on traditional component of functionalism domain.

Design plans and assessment items were completed for both the traditional and modern societies. All traditional society episodes were completed, and a number of episodes were completed for the complex, modern society. However, pilot testing indicated that it took participants about 90 minutes to complete the 24 episodes and assessment items required for the traditional segment, alone. In consideration of the concentration and time demands a complete treatment of functionalism would place upon the participant, my committee members agreed, unanimously, to allow me to concentrate the experiment on solely the traditional component of the functionalism domain. Therefore, the remainder of the methodology and results sections will concentrate on the traditional society component of the functionalism domain.

Assessment Components

Step 6. Control/Treatment Testing

This study proposed to test the effectiveness of a content-based metaphorical interface that supports an instructional unit concerning a complex conceptual domain. One way to test the

hypothesis is to develop two multimedia titles delivering equivalent instructional content about a conceptual domain. One should be developed over a content-based metaphorical interface. The other should use a metaphorically neutral interface (see Ausubel, 2000).

In the case of this study, the domain is functionalism, as defined by Feinberg and Soltis (1998). Development of the two titles was controlled such that both the content and the navigational logic were consistent. The difference between the two instructional titles was confined to use of the interface metaphor. While the control title used screens displaying a concept map and its corresponding text for each episode, the treatment title's interface displayed a metaphorical episode and its corresponding text. Treatment and controlled versions were designed such that all corresponding treatment and control episodes displayed the exact same length of time. The text screens were organized in 5 sections (see Figure 17), identical except where modifications were necessary to accommodate the metaphor or non-metaphor-based treatment of content:

1. Episode: The control picture is an image of the concept map, centered at the episode concept and the treatment illustration is a still from the metaphorical episode.

2. Source: The control source statement is a listing of the concepts that connect to and from the episode concept. The treatment source statement is description of the relevant aspects of the control episode. It is important to note that any information provided within the treatment source statement acts as an advance organizer and is not directly addressed by any of the assessment items. For example, there was no assessment item that asked a question about flatworm replication (see Figure 17). This is in accord with Ausubel and Mayer's recommended methodologies for testing the effectiveness of advance organizers (Ausubel, 2000; Mayer, 1979).

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3. Target: The target statements were identical.

4. Activity: The activity statements were identical except the word "metaphor," used in the treatment is replaced by "concept" within the control version of the instruction.

5. Metaphor: The treatment version displayed the metaphor statement as a label. The control version displayed the episode concept as a label.

The experiment tested learners' mental models as constructed during 24 computer-mediated, instructional episodes. Figure 18 contains a selection of screen captures from the episodes as presented by either the metaphorical and control conditions. Both treatment and control groups completed the same assessment probes. The interface designed for the assessment probes was metaphorically neutral (button navigation).

Figure 17. The text screen components
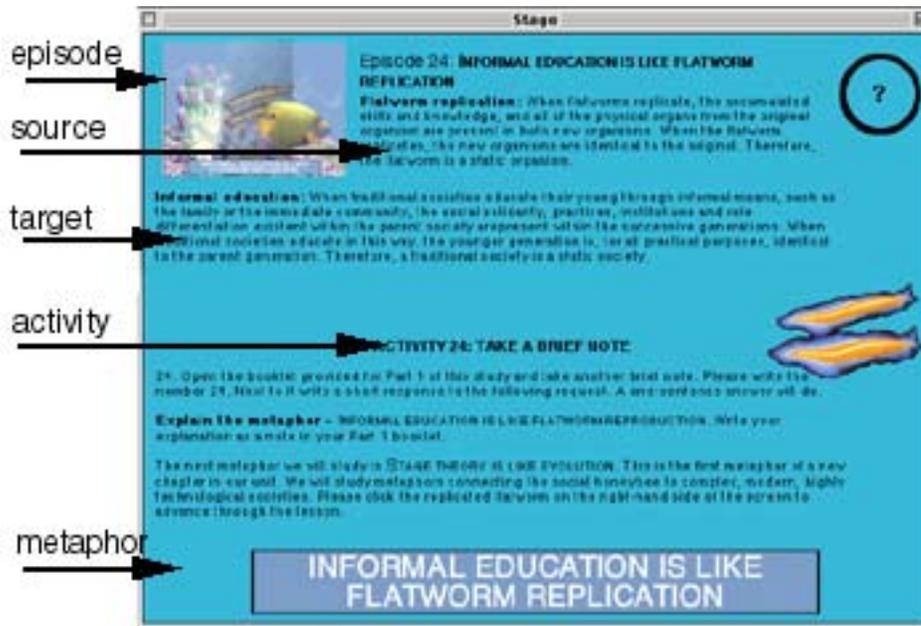
Figure 18. Screen captures of a representative sample of treatment (metaphorical interface) episodes stills and a control episode still.

Node 9 Treatment. ROLE DIFFERENTIATION IS LIKE FUNCTIONAL SPECIFICITY	Node 9 Control. Role Differentiation
Node 7 Treatment. INSTITUTIONS ARE LIKE ORGANS	Node 14 Treatment. INFORMAL SELECTION IS LIKE SIMPLE ORGANIZATION
Node 15 Treatment. INFORMAL TRAINING IS LIKE LIMITED DEVELOPMENT	Node 13 from 15 Treatment. INFORMAL EDUCATION IS LIKE FLATWORM REPLICATION
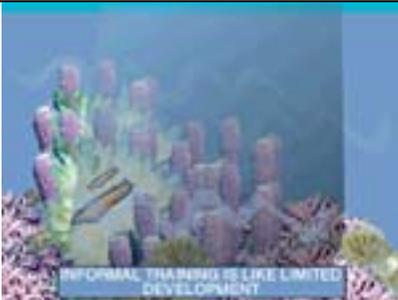
Participants.

The 58 study participants were drawn from three classes of 4th and 5th year pre-service teachers. Participation in the study was optional. Students participated either to fulfill a course research requirement or as an enrichment activity. All participants completed the session during a three-hour block conducted in place of a regularly scheduled class meeting. All but two of the participants were females. Ages ran from 20 to 21. One 25-year-old had participated in data collection but elected not to complete the assessment activities.

Institutional Review Board approval.

Dr. David M. Moore, Virginia Tech Institutional Review Board (Human Subjects Chair), approved this project for exempt status on November 19, 2001. Approval (IRB #01-527) was granted for the period of one year. Approval for an additional year was granted on August 21, 2002 (IRB #02—406) for an expanded version of the study. In addition to the episode tasks and four assessment questions, the Board also approved inclusion of a cognitive abilities test and a word association task.

Participants were randomly assigned to either the treatment or control versions of the title. Participants proceeded through the computer-mediated instruction individually and at their own pace. The instruction required participants to (a) navigate through the title, (b) read information, and (c) write either a definition paraphrase (the control group) or the details of a metaphoric mapping (treatment group, see Loewenstein et al., 1999; Thompson et al., 2000).

After completion of the multimedia title activities, participants, provided with (a) a test packet referenced to the participant's treatment assignment) and (b) a list of all functionalism concepts, drafted written narratives in response to probe questions. Some of the probe questions followed Gentner's suggestion, asking the equivalent of: "If conceptual node X was missing, how

would this effect the rest of the conceptual domain?" This approach, labeled the conflicting model within an earlier section of this paper, was used to design the following assessment probe:

Imagine a traditional society named Clarisanto. When young people in the Clarisanto culture reach the age of 14, they must pass through the trials: The trials are like a fair, in which each of the Clarisato elders sets up a booth. The Clarisato young complete a session with each elder, each young person executing one task for each elder. Based upon the results of a young person's efforts at all of the tasks, the Clarisato council decides which training and trade each young person should enter. How does this traditional society differ from the one presented within the definition of functionalism? Compare and contrast education and survival needs for the Clarisato (traditional) and complex societies.

Assessment of participants' model of the functionalist approach to describing the traditional society contained two conflicting model probes. The second probe design, the position analysis probe, was used to design two more assessment probes for the functionalist approach to the traditional society. The complete versions of all four probes included within the assessment for the experiment are listed within Appendix A.

Students were allowed five minutes to respond to each probe question. After the time had elapsed, the next question probe replaced the first, until all four probes had been delivered. This procedure had been used successfully by Reese (1998) with 6th-grade students in a pilot study investigating the effectiveness of metaphorical interfaces. Reese had also pilot-tested the entire control/treatment methodology during a session conducted in April, 2002. All of the multimedia program elements and experiment components worked as planned during the pilot, and no revision was required before the actual experiment was conducted.

It took participants an average of 90 minutes to complete the instruction and posttest items.

Step 7. Protocol Analysis

Two raters trained and work as a dyad.

Training.

The rater training session began with a review of the business end of the rater training. I finalized the training schedule. The two rater candidates agreed to financial compensation details ($750.00 upon completion of all participant protocol ratings), and expectations (e.g., date for completion of ratings) were finalized. Rater candidates were required to complete training and pass the rater qualification examination. They were not compensated for time spent in training.

To learn the content, the rater candidates individually completed the treatment version of the functionalism multimedia (content-based, metaphorical interface). They also completed the four post test assessment questions.

Then I met with the two candidates. Each candidate received a rater notebook and a set of rating supplies. We reviewed the contents of the rater notebook:

1. Concept maps: Functionalism traditional society source and target maps

2. Directions: Materials list and directions for scoring and rating protocols

3. Score sheet: A sample scoring sheet

4. Table of functionalism part 1 analogs: Source and target terms and equivalent terms. The table contains a column with ample space for each member of the rater dyad to add equivalent identifiers to the target concepts as they work through training.

5. Text: The entire text from the treatment version of the instruction

6. Probes: The four assessment probe questions

7. Practice protocols: 21 sets of protocols (complete answers to the four assessment probes, collected during a February pilot test and the April pilot test).

8. Sample concept maps: These seven were labeled to correspond to assessment probes. I had prepared them during analysis of the participant protocols collected during the two pilot tests. They demonstrate various conditions (cross-links, non-integrated, non-connected branches, levels, and misconceptions).

9. Episodes: The collected set of screen captures and corresponding metaphor statements for the 24 instructional episodes contained within the instruction

We also reviewed the rater supplies:

8. Relational links: a package of colored, bendable straws (see Figure 6).

9. Concept cards (see Figure 6).

10. An accordion file (see Figure 6).

11. Highlighter marker

The raters prepared their set of 13 concept cards, one to correspond to each of the 13 target domain concepts (see Figures 7 and 9). They also prepared the card index (accordion file), to house the concepts, according to concept number (e.g., see Figure 4). We also discussed the rating sheet and how to complete it.

Next, we used a complex protocol as an example and worked through the entire rating process, from locating and highlighting concepts to constructing the concept map (highlight, number, rating sheet, straw mapping). As we worked, raters discussed terminology they had highlighted within the sample and added equivalent identifiers, when necessary, to their individual table of functionalism part 1 analogs.

Each rater then rated his/her own set of protocols, and then rated each other's protocols. After the completion of a set of maps, we reviewed the maps as a group, raters made revisions to the highlighting, numbering, and concept maps. Then we used the scoring key to score the final maps. We (a) reviewed a protocol that contained no related concepts and (b) reviewed two additional protocols. This session ran 4.5 hours.

I met with the raters for a second session. This session ran 2 hours. We completed two more practice protocols. Then the raters opted to take the rater qualification test. In order to qualify, each rater had to prepare a final concept map that scored 90% agreement with an answer key concept map, prepared before the training sessions had begun.

Raters did not meet competency level of 90% agreement during their first qualifier round. We reviewed their answers and completed one more practice protocol. Raters completed a second protocol rating, for the following protocol, prepared from a pilot test participant's answer to semantic probe #1

> In a traditional society, each person works toward the goals of the society. They work as parts (role differentiation) functioning in solidarity to meet those goals. Role differentiation allows individuals to meet their responsibility to the society. The society reflects how well each person does their job (role differentiation) and how well those parts function as a whole (social solidarity) in meeting the society's survival goals. The role is often chosen by informal selection.

The answer key concept map is pictured in Figure 19. This time, each rater met competency level, with a score of 100% agreement.

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The rater dyad met for a brief third session to review map consolidation and the procedure for entering the dyad consensus concept map into the concept mapping software program. We used Inspiration, available through http://www.inspiration.com .

Figure 19. Example of rater training concept map answer key.
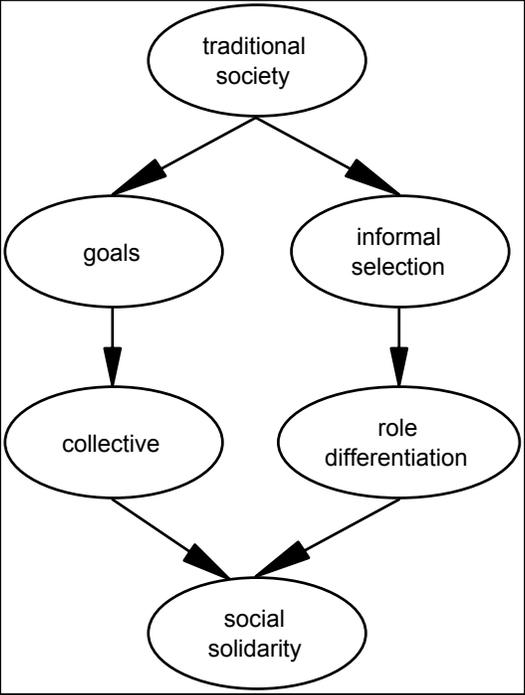
Protocol evaluation and scoring.

Although the raters were familiar with the study's premise, they were blind to participants' random assignment and identity. Each rater had access to a copy of the rater notebook. Raters independently identified, highlighted, and labeled (using concept numbers, see Figure 14) target concepts present in each protocol response within a participant's response set and created a concept map for each participant's responses. Raters parsed protocols for only the 13 target domain concepts. Concept metaphorical analogs and equivalent identifiers were also coded. Raters ignored incorrectly represented concepts. Raters ignored concepts that were simply listed without meaningful connections. Raters ignored all other content, except to use it to connect among identified concepts during the concept mapping. The rater dyads came to consensus in construction of one final concept map representing the participant's protocols. Finally, the raters entered the concept map into a concept mapping software program.

I used a predetermined scoring rubric, based upon previous concept mapping rubrics in the literature (Markham & Mintzes, 1994; Novak, 1990; Novak & Gowin, 1984; Wallace & Mintzes, 1990) and developed from the structure of the source domain concepts, to score the concept maps prepared by the raters. The concept map components were weighted as follows:

1. Concept node = 1 point each

2. Hierarchy levels = 1 point times the number of levels

3. Branches = 2 points times the number of branches at the horizontal level of the map at which the number of branches is the greatest

4. Cross-links = 4 points times the number of cross-links.

Because participants developed responses to four probes, and because the final map was a composite of four individual maps, each concept-to-concept relationship could be represented up

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to four times on the composite concept map. Multiple iterations of a concept-to-concept

relationship were drawn with one dotted connector line labeled with the number of connections

represented by the relationship (see Figure 20). Multiple iterations were counted as one unit

when branches were scored, but counted as multiple links when cross-links were scored.

Figure 20. Compiled map illustrating concept-to-concept relationships.
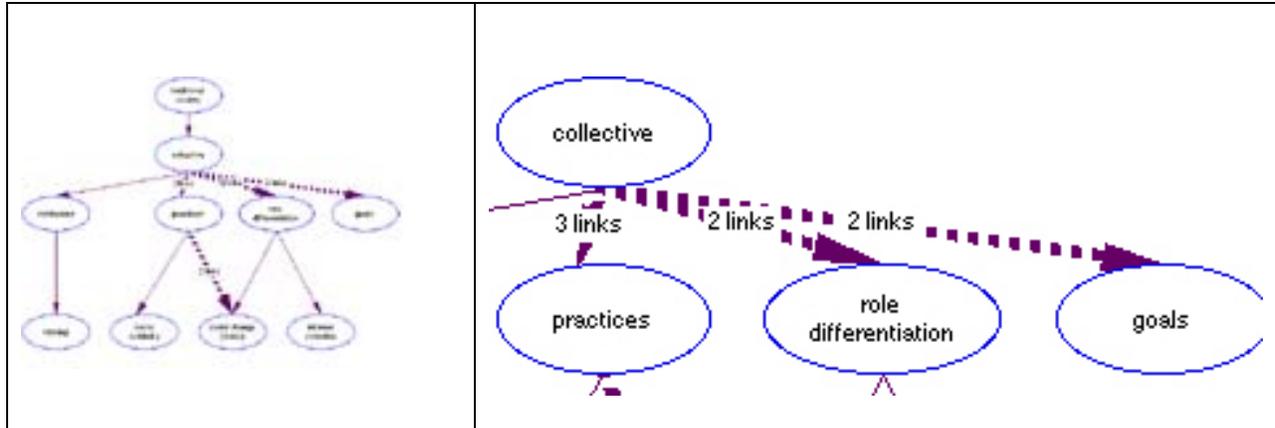
Figure 20. One completed composite concept map is pictured in the box on the left. Lines indicate
concept-to-concept relationships. Solid lines represent the presence of one instance of a relationship
specification within participant protocols. Dotted lines represent multiple instances. The enlargement of
the central portion of the concept map, pictured at the right, illustrates the labeling system for multiple
instances of concept-to-concept relation specifications over the set of a participant's four protocol
responses.

Again, the concept maps were coded so that I was blind to both the identity of students

and their study condition assignment. Each participant's composite concept map received a total

score.

Chapter 4: Results

To review and summarize, for each of the four probe questions, each rater parsed each participant's protocols into concepts and created a concept map that connected the concepts according to the relationships specified by the participant within that probe response. The rater team then discussed each response within each participant's response set, came to consensus about the concepts present within each question response, and revised each individual response concept map. The rater team then prepared a participant's compiled concept map, using the set of rater tools (straws and concept cards), as described within the methodology section. When multiple maps contained a specific node-to-node link, the evaluators labeled that node-to-node link with the number of multiple links it represented. The rater team entered the final map into a computer using the Inspiration concept mapping software and printed a final concept map for each participant. I evaluated the compiled map based upon four subscore sums: number of concepts (nodes); number of hierarchy levels (levels); number of unique branches at the densest level of the map with links with multiple links counting as only one branch (branches), and number of cross-links with multiple links counted (cross-link). This allowed me to compute two sets of map scores, an unweighted subscore sum and a weighted subscore sum. The weighted score is the final map score, with subscores weighted nodes times 1, levels times 1, branches times 2, and cross-links times 4. The unweighted sum is simply the sum of the subscores.

In this chapter, I will present the results of a *t*-test addressing the original hypothesis that the metaphorical interface would significantly enhance learners' mental models of the targeted domain. I'll define a subscale-to-node ratio and use it to test the relative sensitivity of the concept map subscales. I'll conclude the results section with a brief overview of selected participant protocols.

I have included all participant protocols (see Appendix C) and the corresponding concept maps (see Appendix D) within the appendices. I have also included a table (see Appendix E) that lists participant ID numbers, interface condition assignment (concept map or metaphor-based) and concept map scores. The table contains hyperlinks that connect (a) from each table participant ID number to the corresponding participant protocol response set in Appendix C and (b) from each table listing of a participant's final concept map score to the concept map raters constructed from that participant's protocols (Appendix D).

Did the Metaphor-Enhanced Interface Engender Richer Mental Models?

Final map scores were the weighted sum of the subscores: nodes + levels + branches (X2) + cross-links (X4). Significance values from Lavene's Test of Equality of Variance were high (i.e., $p > .05$) for all analyses, so I was able to assume equal variances for both the control and treatment groups. Independent samples t-tests (alpha $= 0.05$) showed no significant difference between the control and treatment groups on time to completion, $t(54)=1.2, p>.05$; the subscale scores, $t_{node}(55)=.14, p>.05, t_{level}(55)=-.48, p>.05, t_{branch}(55)=-.63, p>.05, t_{cross-links}(55)=-.75, p>.05$; or on the final composite final map score, $t_{map\ score}(55)=-.72, p>.05$ (see Table 3). Learners who completed the metaphor-enhanced learning environment took an average of 6 minutes longer to complete the study session. Their protocols evidenced an average of 0.07 more nodes and 0.15 fewer levels than did the control group; the mean difference on these two subscores is almost zero. Concept maps constructed from the treatment group protocols evidenced an average of one less cross-link. The treatment group scored an average of 6 points lower on the final concept map score, with a 95% confidence interval between –24 (treatment lower than control) and +11 (treatment higher than control).

Table 3. Results of *t*-tests for subscores and final map score.

Dependent variable	$\overline{X}_{control}$	$\overline{X}_{treatment}$	$\overline{X}$	SD	t	df	Sig. (2-tailed)	Mean difference*	95% Confidence Interval of the Difference	
									Lower	Upper
Time	1:47	1:53	1:50	:19	1.18	54	.24	.06	-.04	.16
Node	9	9	9	2	.14	55	.48	.07	-.98	1.1
Level	4	4	4	1	-.48	55	.63	-.15	-.74	-.46
Branch	7	6	7	3	-.63	55	.53	-.53	-2.1	1.1
Cross-link	10	9	9	6	-.75	55	.45	-1.3	-4.8	2.1
Final Map Score	67	61	64	33	-.72	55	.48	-6.4	-24.1	11.4

*Mean difference = (treatment – control)

Investigating the Concept Map Structure

Subscale-to-Node Ratio

In order to tap semantic memory and domain integration, as opposed to rote recall of labels, I had provided participants with a list of the 13 functionalism concepts (the target domain concepts: stage theory, traditional society, collective, goals, social solidarity, practices, institutions, role differentiation, informal selection, informal training, ascribed characteristics, social change, and informal education). Participants were prompted to use this list as they prepared their responses to the four assessment prompts. Therefore, it was possible for test-savvy participants to prepare an essay-type response by simply listing concepts, whether or not that participant had integrated the concepts within a mental model of functionalism. Because the raters isolated and labeled all concepts and then prepared concept maps according to the connections present within a response set, I have been able to isolate a relationship between the mean number of concept nodes present within a group's protocol sets and the mean number of levels, branches, or cross-links.

This is the subscale-to-node ratio. For each subscale, it is composed of an individual's subscale score in the numerator and number of nodes denominator. To understand the ratio, it is helpful to make an analogy to business, in which the ratio might be composed of revenue (R) in the numerator and expenditures (E) in the denominator (see Equation 1). The larger the fraction, the healthier the relationship, balance (B), between revenue and expenditures.

$$B = \frac{R}{E} \tag{1}$$

In the case of the subscore-to-node ratio, the larger the fraction, the greater the domain integration. Thus,

$$I = \frac{S}{N} \tag{2}$$

where I = integration, S = subscale score, N = number of nodes.

A low subscale-to-node ratio would indicate a disjoint mental model.

Adjusting for Possible Weighting Bias

It is possible that the strength of the cross-link-to-node ratio could be biased by the fact that I allowed scoring of multiple cross-links when multiple links ran between a concept node pair (see example of multiple cross-links in Figure 20). Specifically, each participant produced four independent posttest responses. Each could contain a specific node-to-node relational link. Therefore, there could be a maximum of four relational links between a specific node-to-node pair. While I had not scored for multiple links when branches were scored, I had counted multiple links for cross-link scoring. To investigate an unbiased node-to-subscore ratio, I adjusted the cross-link scores so that multiple node-to-node links counted as only one cross-link and used this score when calculating the cross-link-to-node ratio.

A Fourth Node-to-Subscale Ratio: Considering Propositions.

The scoring system for this study counted the number of nodes (concepts) as an indication of domain knowledge. Novak and his research teams had counted the number of relationships (node-to-node connections, labeled propositions) to represent a learner's domain knowledge (Novak & Musonda, 1991). To see how a proposition subscore might compare to nodes (domain knowledge), levels (differentiation), branches (differentiation), or cross-links (integration), I counted the number of valid propositions within each participant's concept map, scoring each proposition link only once, even if a concept map indicated that a specific link had been specified in more than one protocol response (see Figure 20). Thus, I used an unweighted proposition score to calculate an unbiased proposition-to-node ratio, akin to the unbiased cross-link subscore and the branch subscore.

Investigating a Simplex Structure

A simplex is a mathematical model that can be used to describe variables that are hierarchical, ordered by increasing complexity (Guttman, 1955, 1969; Jöreskog & Sörbom, 1996). For example, researchers have studied the underlying simplex structure of Bloom's Taxonomy (Hill & McGaw, 1981) and moral judgments (Lind, 2002). If the subscale ratios are arranged in order by the mean difference between high and low achievers, they suggest a progression from level ($\overline{X}_{(high-low)} = 0.03$), through branches ($\overline{X}_{(high-low)} = 0.2$), through propositions ($\overline{X}_{(high-low)} = 0.55$), and terminating with a maximal mean difference for cross-links ($\overline{X}_{(high-low)} = 0.72$). The picture provided by the subscale-to-node ratio suggests a simplex progression for the concept map scoring mechanism, progressing from level, to branch to cross-link. However, a simplex structure would predict and require that the Pearson product correlation

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between neighboring stages (such as levels and branches) would be higher than correlations between non-neighboring stages (such as levels and cross-links). Pearson product correlations between the subscores do not support the simplex structure. For example, Table 4 illustrates that, progressing from the diagonal, the level to branch correlation is smaller than the level to cross-link correlation. Other arrangements of the subscale correlations (for example: excluding the node subscale, selecting only the metaphor or concept map group, or excluding the proposition subscale) also contradict the simplex assumption of decreasing correlations from the diagonal.

Table 4. Pearson product correlations[a] between Subscales across interface conditions.

	1	2	3	4	5
1. NODE	—	.520**	.617**	.578**	.740**
2. LEVEL		—	.370**	.619**	.594**
3. BRANCH			—	.808**	.889**
4. CROSS-LINK				—	.907**
5. PROPOSITION					—

** Correlation is significant at the 0.01 level (2-tailed). [a] Listwise N=57

How Alike Are the Subscores?

All the subscores, including the proposition scores, are significantly and positively correlated at $p <.01$, using a 2-tailed Pearson product. However, the correlations range from small to very large. The correlation between level and branches is the lowest (r=.37). The correlations between node and level (r=.52), node and branch (r=.62), level and cross-link (r=.62), level and proposition (r=.59) are all moderate. The node to proposition correlation is bordering the high range (r=.74), and the correlations between branch and cross-link (r=.81), branch and proposition (r=.89), and cross-link and proposition (r=.91) are all quite high. Coupled with the subscale-to-node ratio results, these high correlations beg two questions: Are the subscale scores significantly different from each other? Are the subscale-to-node ratio tendencies significant?

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Testing the Concept Map Structure: Is the Interaction Between Subscores and Achievement

Significant?

Comparison of the subscore mean differences suggests that propositions and cross-links were more sensitive indicators of rich domain integration than the level and branches subscores. High Pearson product correlations between the proposition, branch, and cross-link subscores suggest that one or more of these subscales might provide redundant information. Therefore, I divided the 57 participants into high (N=28) and low (N=29) achievement according at the median score of 27 on the unweighted concept map sum (node + link + branch + cross-link), and I conducted a 2 X 2 X 4 multivariate mixed design analysis with Achievement (low and high) and Interface Condition (Concept Map vs. Metaphor) as the between-subjects factors and the four subscale-to-node ratios derived from the link, branch, proposition, and cross-link (unique, unbiased version) subscores as the within subjects factors. I used Achievement specifically to test its interaction with Subscore and ignored any main effect for Achievement.

This design also allowed me to investigate for Subscore redundancy by testing pairwise comparisons. I used the Bonferroni procedure to correct for possible Type I errors.

A non-significant Box's Test of Equality of Covariance Matrix, $F(30, 6787)$=1.27, p =.148, suggests that the data meet the assumption of equal variance-covariance matrices across the cells formed by the between-subjects effects (SPSS Inc., 1999). I report the Pillai's Trace statistics, as they are considered robust. The main effect for Subscores was significant, $F(3,51)$=249.64, p<.01, η^2= .94; however, interpretation of the main effect and mean differences is influenced by the significant interaction between Subscore and Achievement, $F(3,51)$=33.42, p< .01, η^2= .66. The remaining interactions were not significant: $F_{interfaceXsubsore}(3,51)$=.281, p>.05; $F_{subscoreXachievementXinterface}(3,51)$=.081, p>.05.

Levene's Test of Equality of Error Variances produced non-significant F statistics for each of the four subscales, evidence that the data met the assumption of equal variance across the cells (SPSS Inc., 1999). I used the Bonferroni correction procedure; pairwise comparisons were significant for all pairings except for branch and cross-link. However, examination of the interaction between Subscore and Achievement, (see Figure 21) reveals that the characteristics of the two distributions are quite different. On average, the low achievers' cross-link-to-node ratio was their lowest ratio. The proposition-to-node ratio was their highest. That is, participants developed far fewer cross-links per node than they did branches, links or propositions. In contrast, on the average, the high achievers' cross-link-to-node ratio was second only to their proposition-to-node ratio. Figure 22 illustrates the relative mean differences between high and low achievers' subscore-to-node ratios. The cross-link mean difference is the largest, followed by the proposition mean difference. The level-to-node mean difference is the smallest of the four ratios. The figure also illustrates the ratio of the two mean differences, D_r, which I formed by dividing a subscore dyad's (subscore high and low means) mean difference by the mean of the dyad means (see equations 3 – 5), to correct for any floor effects:

$$D = \overline{X}_{High} - \overline{X}_{Low} \tag{3}$$
where D = mean difference, $\overline{X}$ = subscore mean

$$M\overline{X} = \frac{\overline{X}_{High} + \overline{X}_{Low}}{2} \tag{4}$$
where $M\overline{X}$ = mean of the subscore dyad means

$$D_r = \frac{D}{M\overline{X}} \tag{5}$$
where D_r = ratio of the two mean differences

The patterns within the mean differences are heighted by the ratio of mean differences version. Cross-links are twice as sensitive to differences between high and low achievement as propositions, 3 times as sensitive as branches, and 15 times more sensitive than levels.

Levels measure hierarchical differentiation, such as causal relationships (e.g., one hierarchical pattern found in multiple participants' protocols was social collective → informal education → role differentiation → static change). Branches measure a learner's ability to differentiate domain concepts into conceptual strands (e.g., the strand for institutions vs. the strand for ascribed characteristics, see Figure 9). It appears that learners can state hierarchical differentiations, whether or not they hold richly connected domain models. Ability to sort relationships into strands requires a richer domain understanding than levels; it is about 4 time more sensitive to differences in low and high achievement than levels. Propositions are dyads, relational connections between two concepts (e.g., *goals* are met through *social solidarity*). The greater the quantity of relational connections, the richer the mental model. High achievers record more propositions. Cross-links are evidence of domain integration, what Ausubel (1963, 2000) defined as integrative reconciliation. Within expert model of the traditional society component of the functionalism domain used for this study, cross-links occurred for every branch because all branches converge at informal education (see Figure 9). Whenever a learner makes connections between disparate branches, the learner constructs a cross-link. The ability to identify cross-links, to make relational connections between concept strands, was the primary difference between high and low achievers.

The subscale-to-node ratio provides its own illustration of the average structural relationships between the concept map nodes and the subscales for this domain and this population (see Figures 23, 24, 25, and 26). For example, Figures 25 and 26 illustrate hypothesized concept maps constructed according to the treatment high and low achiever subscore-to-node ratios. Figure 25 illustrates a map constructed according to the treatment low achiever mean ratio for cross-links. It contains seven concept nodes and two cross-links. Figure

26 illustrates a map constructed according to the treatment high achiever mean ratio for cross-

links. It contains seven concept nodes and seven cross-links. The high achiever map exemplifies

greater integration than does the low achiever map.

Figure 21. The interaction between Achievement and Subscore-to-Node Ratio.
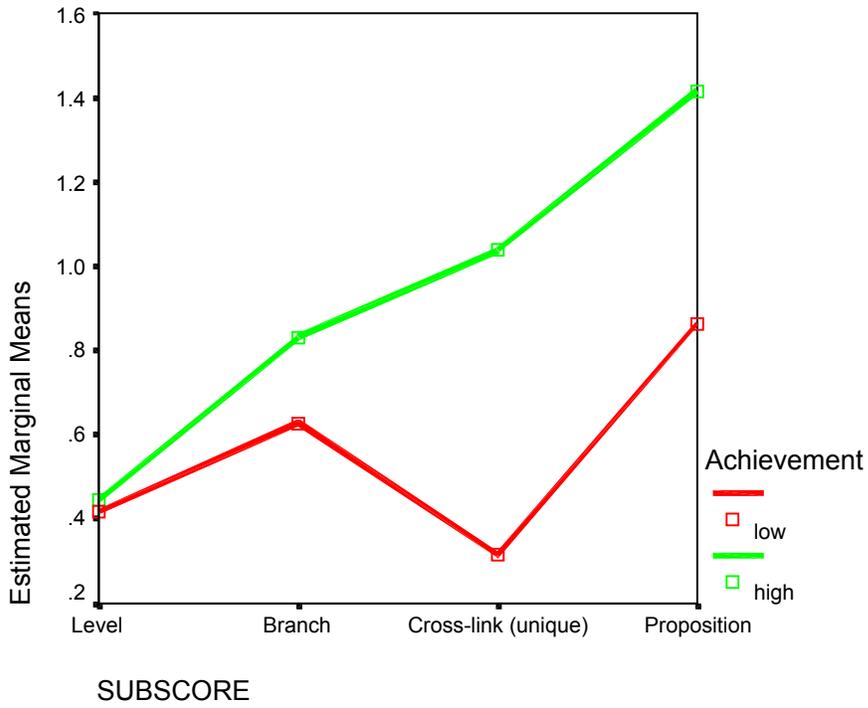

Figure 21. The median score for the unweighted sum of the node, level, branch, and cross-link subscores was 27. Low achievers earned 27 or less, while high achievers earned 28 or better. I calculated the subscore-to-node ratio by dividing a participant's subscore total by that participant's number of concept nodes. Only unique cross-link relationships counted toward this subscore total.

Figure 22. Mean differences and ratio of the two mean differences between high and low achievers on the subscore-to-node ratio, unbiased and unweighted.
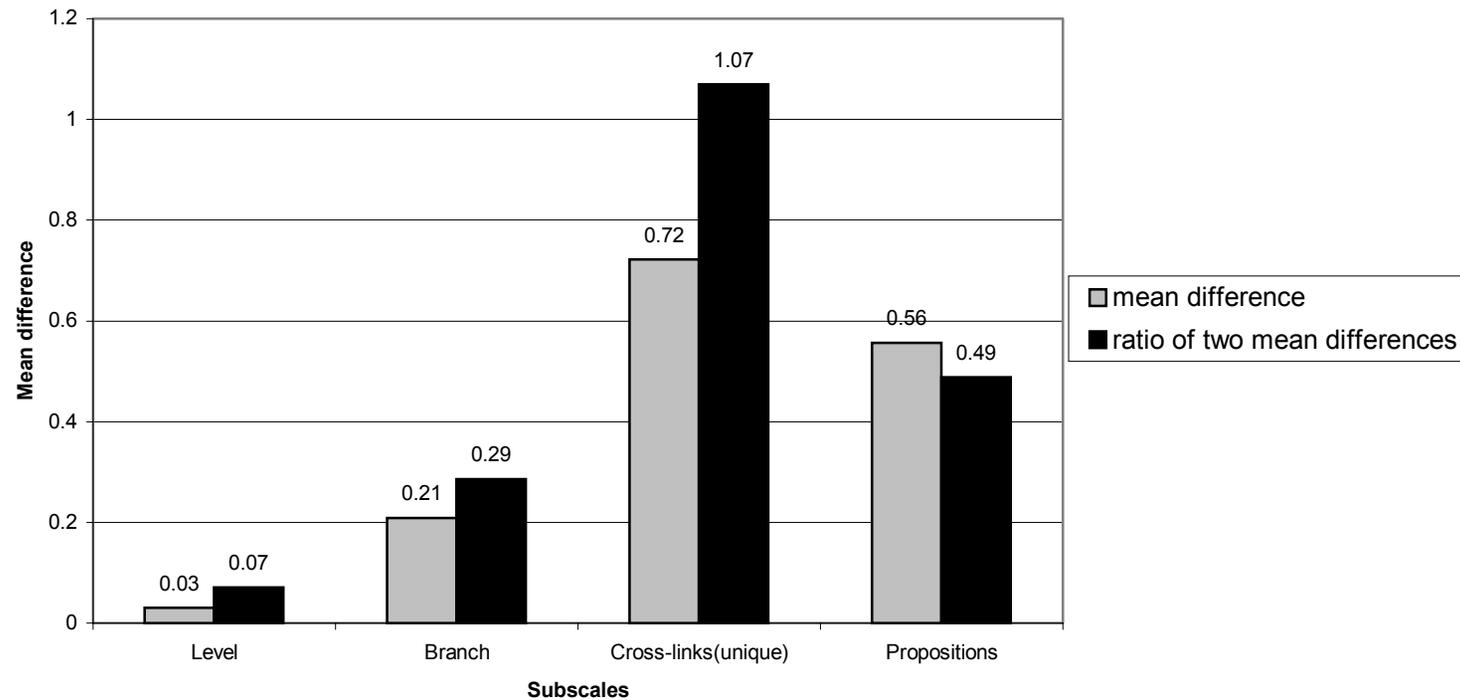
Figure 22. Gray bars represent the mean difference between low and high achievers for one of the four subscale-to-node ratios. The cross-link mean difference is the largest, followed by the proposition mean difference. The level-to-node mean difference is the smallest of the four ratios. The pattern is the same for the ratio of the two mean differences (mean difference/mean of the high/low dyad means), represented by the black bars.

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Figure 23. Hypothetical concept map showing the average proportion of levels to concept nodes.
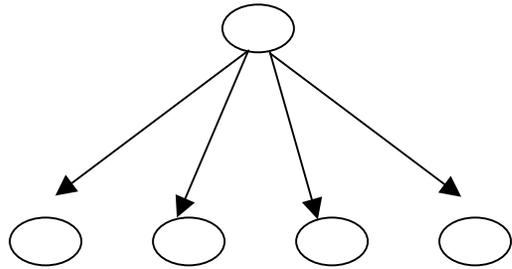
Figure 23. There are 2 levels and 5 nodes.

Figure 24. Hypothetical low achiever (treatment) concept map showing the average proportion of branches to concept nodes.
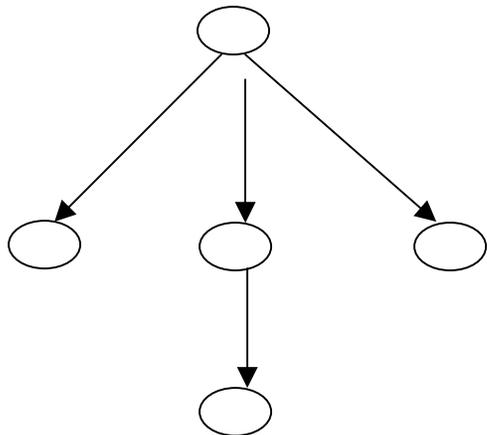
Figure 24. There are 3 branches and 5 nodes.

Figure 25. Hypothetical low achiever (treatment) concept map showing the average proportion of cross-links to concept nodes.
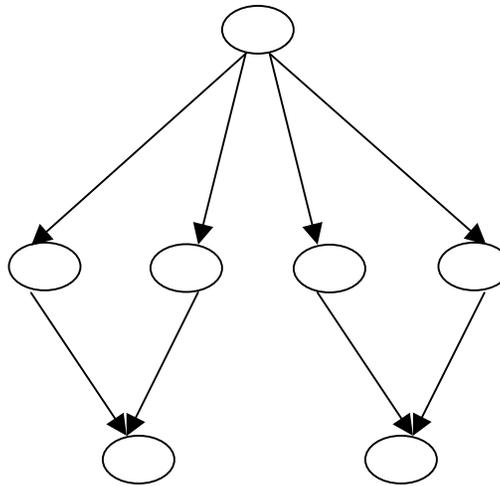

Figure 25. There are two cross-links and seven nodes.

Figure 26. Hypothetical high achiever (treatment) concept map showing the average proportion of cross-links to concept nodes.
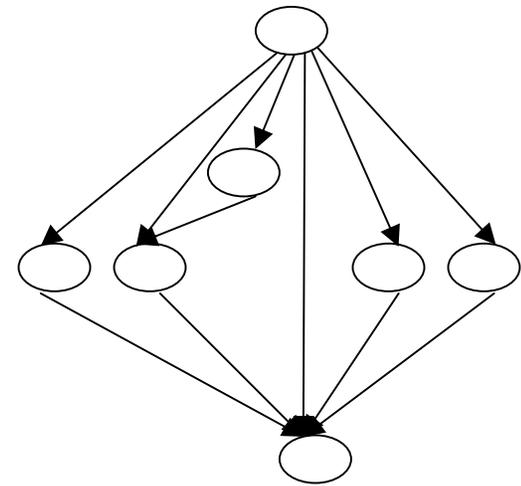
Figure 26. There are seven cross-links and seven nodes.

Although I had used the Achievement factor to test the interaction and not its main effect on Subscores, I wanted to run a parallel analysis in which the criteria for Achievement did not depend directly upon the subscores that comprised the Subscore factor. Therefore, I also ran a parallel analysis, Analysis 2, using the median (10) of the proposition subscore to divide participants into high (N=27) and low (N=30) Achievement. I did not include the proposition subscore as one of the within-subjects factors. Though main effect for Subscore remained significant, the F statistic decreased, and the interaction effect within the second analysis was a bit stronger than the Subscore main effect, $F_{Subscore}$ (2,52) = 40.61, $p < .01$, $\eta^2 = .61$; $F_{SubscoreXAchievement}$ (2,52) = 41.42, $p < .01$, $\eta^2 = .61$. The other main effects and interactions remained the same as when level of achievement had been determined by the unweighted sum of node, level, branch, and cross-link subscores (Analysis 1). The mean differences between high and low Achievement on Subscores for Analysis 2 is almost identical to that produced within Analysis 1 (see Figure 27 and Table 5). According to the subscore-to-node ratio, cross-links remain a more sensitive indicator of the difference between high and low achievement than the other two subscales (levels or branches). These findings duplicate the results explained within the previous analysis.

Figure 27. Subscore-to-node ratio, Achievement groupings determined by proposition median.
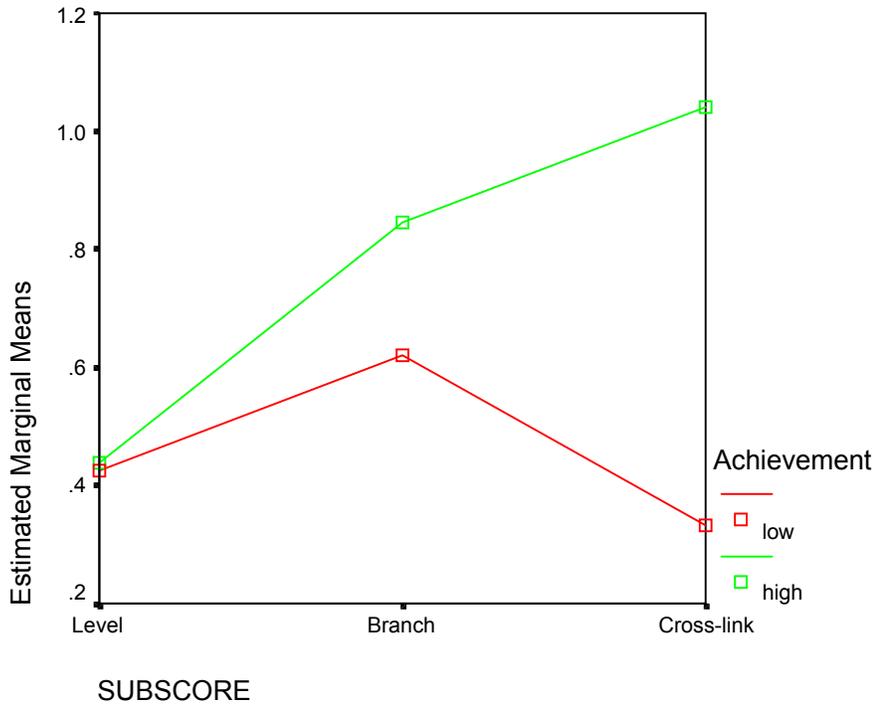
Figure 27. Recalculation of interaction between Achievement and Subscore, using the Proposition subscale as the measure of Achievement.

Table 5. Comparison of mean difference between Analysis 1* and Analysis 2**.

Subscore	Subscore Mean**		Subscore Mean Difference by Achivement	
	Low	High	Analysis 1*	Analysis 2**
Level	.42	.44	.03	.02
Branch	.62	.85	.20	.23
Cross-link	.33	1.04	.72	.71

Note: * Analysis 1 divided participants into low (*N*=29) and high (*N*=28) achievers based upon the median of the sum of the unweighted subscores (nodes, levels, branches, cross-links)

**Analysis 2 divided participants into low (*N*=30) and high (*N*=27) achievers based upon the median of the proposition subscore.

Meeting the Challenge: Qualitative Observations

I reviewed the participants' protocol sets (Appendix C) once again, before drafting this section. The assessment tasks (the four essay questions) had been intellectually demanding. The prompts required participants to read and process complex, challenging, unique, and novel probe questions. Participants were required to draft responses, with the aid of a list of the 13 concept terms. And they were required to read and respond to each prompt within a five-minute time limit. Given the time constraint and complexity of the probes, the protocols and corresponding concept maps produced by the higher scoring participants (Appendix E) contain an impressive amount of information (see, for example, the participant 153 protocols and concept map).

Engaging Pragmatic Motivations

Still, achievement (for both the weighted and unweighted sums) is normally distributed within the sample (Kolmogorov-Smirnov is NS). The normal distribution afforded the statistical testing of (a) the effect of interface condition (concept map or metaphor-enhanced) on Achievement (see earlier section) and (b) the interaction between Achievement and Subscale (see earlier section). However, an instructional designer would aim for criterion-level achievement results (mastery) with a large negative skew. A brief survey of selected participant protocols provides some evidence that pragmatic considerations might account for some of the distribution spread.

As I had discussed within the literature review, the learner's goal orientation has been shown to influence analogical reasoning, either before or during the mapping stage (Holyoak & Thagard, 1989). In order to establish a pertinent learning goal for the preservice teachers who participated in this study, I had opened the functionalism learning environment with an episode

that detailed the goal of the instruction: to introduce the learner to the functionalist perspective,

one of three orientations toward the relationship between school and society:

<div style="border:1px solid black; padding:1em;">

1

Investigating Functionalism

As a teacher, you will come into contact with many stakeholders (e.g., parents, school boards, politicians, or administrators) who hold conflicting opinions on policy issues. Examples of two conflicting views might be

1. Children should explore and enjoy learning without standardized testing.
2. Children should study only the basics, accountable through SOLs.

A stakeholder's position on an educational issue is often the result of an underlying philosophical orientation toward the relationship between school and society. Although philosophical orientations drive decisions, individual stakeholders are often unaware of their own philosophical orientations.

The more you, the professional educator, understand about the philosophical orientations of diverse points of view, the better prepared you will be to deal with policy shifts and conflict resultant from philosophical perspectives about the relationship between school and society.

Functionalism is one of three recognized approaches used to describe the relationship between school and society. This multimedia title will help you to define functionalism.

Activity: Take a Brief Note

Open the booklet provided for you for Part 1 of this study. Please write the number "1". Next to it, write a short answer to the following question. A one-sentence answer will do.

Why is the study of functionalism relevant to you, the professional educator?

The next section will tell you how this lesson is organized. It will provide instructions for how to think about what you see on the screen and what will be expected from you as you work through the lessons. This multimedia title is probably a bit different from anything you've ever done before.

Please click the arrow at the right to advance through the lesson.

Functionalism is a concept, an idea. It is an abstract noun. You can't see it. . . . You can't hear it. . . . And that makes it difficult for us to talk to each other about Functionalism.

But, the object of this lesson is for me to talk to you about functionalism in a way that helps you to understand it. . . .

</div>

Participants' responses to the learning tasks (such as participant responses to the question in

episode 1) are beyond the scope of this study. However, comments within participant protocols

such as "NOTE: Part 1 [the instruction] seems to convey bias beliefs or inferences, not

definitions. Maybe this was purposeful, I just wanted to point it out" (participant 152, Q1)

suggest that, for some participants, the designer's instructional goal had not become the

individual's personal learning goal. While pragmatic considerations may or may not be important if an advance organizer takes the form of a concept map, it is certainly an important consideration when the organizer is metaphor-based. In the case of this study, sixty-five percent of the participants were drawn from a Multicultural Education undergraduate class; the remaining participants had completed a similar class during the previous academic year. Learners immersed within a study of conditions that might disenfranchise students within a pluralistic society might well rebel against the functionalist's orientation as elitist or hegemonic if (a) the learners were unschooled in consideration of philosophical approaches or (b) the learners assumed the goal of the instruction was to convince the participants to adopt functionalism as a personal belief. The struggle some students waged against functionalism was reflected when they contrasted the perspective against their personal practice orientation, instead of responding to the probe. The excerpt below is from a response to assessment probe 2:

> You have to decide if you want your students to be just like the society in existence or if you want them to change and make it better. Personally I want my students to know more than I do and to go out and make a difference in the world. (Participant 115, Q2)

> Pragmatic orientation is also affected by motivation: a goal cannot be a goal unless one is motivated to achieve it. The protocol set produced by participant 148 reflected a lack of motivation. He wrote, "I really don't know – it seems that the longer this session lasts the more sleepy I get; this is by no fault of yours; however the time period of 9 – 12 is not the most conducive for creative, research like collegiate/intelligent thought at least for me" (Participant 148), although he completed his participation in the study in place of his regularly scheduled class meeting time. In other words, if he had not been working within the study, he would have been in class.

Using the Metaphor to Structure the Content

There is evidence that participants exposed to the metaphor-enhanced learning environment used the flatworm source domain to structure and discuss aspects of the targeted functionalism domain. Table 6 is a list of the three metaphor analogs used by participants in assessment protocols. The three source domain concepts are (a) the flatworm, (b) replication, and (c) survival. No source domain terms had been included within the particpants' list of functionalism concepts, available to them while drafting responses to the assessment protocols. None of these source domain terms were present within the protocols produced by participants exposed to the concept map treatment of the interface.

Table 6. Examples of metaphor analogs used by participants in assessment protocols.

Metaphor	Participant Statement
A TRADITIONAL SOCIETY IS LIKE A FLATWORM.	Participant 141, Q3
INFORMAL EDUCATION IS LIKE FLATWORM REPLICATION.	Participants 139: Q2, 147: Q4, 149: Q2
GOALS ARE LIKE SURVIVAL NEEDS.	Participants 147: Q3, 151, Q3.

Use of the metaphor analogs within the protocols did not correspond to increased achievement in concept map score. The four participants who used the analogs scored below the group mean (N=57) on weighted map scores. Only one of the four scored above the mean on either the cross-link-to-node or proposition-to-node ratios, while each of the four scored at or above the mean in number of nodes. These results suggest that these individuals did not hold particularly integrated mental models of the functionalism domain.

Chapter 5: Discussion

Cognitive scientists accept two complimentary metaphor theories. According to conceptual metaphor, people use what they know about concrete experiences to help them understand the subjective and complex (Lakoff & Johnson, 1980, 1999). According to structure mapping, people build cognitive bridges from concrete and/or familiar domains to abstract and/or less familiar domains according to parallel relational structures that exist in both domains (Gentner & Holyoak, 1997; Holyoak et al., 2001). The larger and more integrated the source and target domain relational structure, the more likely it is to map between the domains. I combined those theories with advance organizers (Ausubel, 1963, 2000; Jonassen, 1981) and concept maps (Novak, 1990, 1992; Novak & Gowin, 1984; Novak & Musonda, 1991) and applied them to the design, development, and assessment of two parallel computer-mediated learning environments. My premise: That a formal approach to metaphor-enhanced learning environments would increase control over design elements and resultant learner gains.

Both environments developed for the study were based upon identical domain structure, content and identical navigation. The first used a wide view and close-up view of a concept map as its advance organizer. In place of the views of the concept map, the second provided concrete animated episodes for each subconcept within a concrete source domain. I had used structure mapping principles to constrain the development of the source domain structure such that it was relationally identical to the targeted functionalism domain. I had hypothesized that the metaphor-enhanced environment would help learners to construct richer mental models of the targeted content, which was functionalism. However, there was no significant difference between the level of achievement of the concept map group and the metaphor-enhanced group. As applied

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within the Analogical Designs model developed for this study, the formalism of structure

mapping did not enhance the richness of the learners' mental models of the functionalism

domain. A more formalistically structured connection between source and target did not increase

learner gains.

Scoring Concept Maps: Application Within Research and the Classroom

Novak and others (Markham & Mintzes, 1994; Novak & Gowin, 1984; Novak &

Musonda, 1991; Wallace & Mintzes, 1990) have described concept map scoring procedures that

involve differential weighting of the concept map attributes (subscores). Analysis of the

subscale-to-node ratios within this study indicated that propositions and cross-links are much

more sensitive to differences between high and low achievement than levels or branches. The

number of nodes within a concept map is an ambiguous indicator. Both low and high achievers

can produce protocols that mention a great quantity of concepts. The greatest difference between

high and low achievement is the amount of integration represented within the map. Nodes appear

to serve as indicators of richness and integration, but only when used as a ratio in conjunction

with the other subscales. If these findings can be validated across domains, they provide

empirical support, rationale, and direction for subscale weightings. While consideration of

relative subscale sensitivity may impact subsequent research, the real impact of the finding

concerns direct application within classrooms whenever concept maps are used for assessment.

To the extent that we can generalize from preservice teachers at the upper undergraduate

level and the graduate level, subscale sensitivity also provides some pedagogical insights. Given

instruction, it is fairly easy for learners to link key concepts hierarchically. Concept map

translations of high and low achieving participants' protocols evidenced very little difference in

achievement for hierarchical discrimination. Learners are also pretty capable of organizing

domain concepts into conceptual strands (branches). However, those individuals with rich mental models of the domain (high achievers) constructed more relational connections between pairs of concepts (propositions). Therefore, instruction should be designed to help students to make relational connections between concepts.

Finally, these results indicate the greatest dissimilarity between high and low achievement is the ability to integrate disparate conceptual strands (cross-links). Results from the simplex analysis preclude any explanations that suggest learners progress through a stage of differentiation on their journey to domain integration (i.e., the subscales are not hierarchical). High achievers might be predisposed toward integrative reconciliation. Or, both the concept map and metaphor versions of the functionalism instruction might have interacted with their individual characteristics helping high achievers to form cross-links. Using only the data reported here, any explanation of high achievers' cross-link accomplishment is pure speculation, a subject for further investigation. However, results do suggest that the low-to-average achievers found it 4 to 15 times more difficult to integrate domain knowledge than to differentiate.

Ausubel had suggested that "the principle of integrative reconciliation in programming instructional material can be best described as antithetical in spirit and approach to the ubiquitous practice among textbook writers of compartmentalizing and segregating particular ideas or topics within their respective chapters or subchapters" (1963, p. 80). Integrated instructional materials should help learners to integrate content. In the case of this study, every aspect of the instruction (e.g., the computer interface, the text narratives, and the images) reinforced the central fact that every strand converged to the same concept—informal education (see Figure 9). The domain was highly integrated, as all concepts converged to one node. The interface was highly integrated.

Even within an instructional environment in which integration is ubiquitous and highly implied, low-to-average achievers' mental models evidenced lower subscore-to-node ratios for cross-links than for the any of the other three subscores. While metaphor and concept map advance organizers, coupled with the text narratives and the interface navigation, enabled high achievers to form cross-links, low-to-average learners, even at the graduate level, seem to need help in making those connections. These results suggest that, for some students, implicit integration might not be good enough. Low-to-average students might need to have those connections explicitly stated through didactic exposition and reinforced through practice and feedback.

Lessons Learned

As applied within this study, theory did not work as predicted. This leads one to question why. Assuming the metaphor theories bequeathed by cognitive science are correct and can be applied to instructional environments, one can consider three possibilities.

1. Computer interfaces, as currently designed, cannot form a virtual concrete reality for the user.

2. The Analogical Designs formalism incorrectly applies conceptual metaphor and/or structure mapping.

3. The study lacked power.

If the power could be improved to the extent that results supported the hypothesis, the results would also support (a) that computer interfaces provide a concrete reality and (b) that Analogical Designs is a valid application of the two metaphor theories. Seven ideas come to mind.

Richness Versus Replication

Analogical Designs assessment scoring measures the richness of a learner's mental model. It does not compare the learner's mental model to the expert model. It is possible that either the concept map condition or the metaphor condition enabled participants to construct mental models that more accurately integrated the expert model. There are two techniques available which may facilitate the comparison.

In the first, the individual concepts (13 for the traditional society) serve as the unit of analysis (Reese, 2003). The participant concept maps are scored for the number of connections per concept, and aggregated across the concept map group and across the metaphor group. The aggregate totals per concept for each group are regressed on the total connections per concept for the expert map (the one used as the basis of the instructional design) and the two models are compared. A different analysis, using a repeated measures design, would allow comparison between-concepts (repeated observations) for the concept map, metaphor, and expert models scores.

I am also proposing the use of Pathfinder Networks (PFNETS). PFNETS are an application of graph theory, " the mathematical study of structures consisting of nodes, with links connecting some pairs of nodes" (Schvaneveldt, 1990, p. 297), which generates a network that can mathematically represent a set of concepts and its inter-concept relationships. The Pathfinder software (PCKNOT) will generate similarity ratings between pairs of networks. I propose to use the present data to generate similarity ratings for all participants, comparing them to the expert model. The similarity ratings would be statistically analyzed with interface condition as the independent variable and similarity rating as the dependent variable.

Both methods would investigate learner replication of the expert model. It is possible that replication may provide more statistical power than richness.

Content and Development Expertise: Feedback and Revision

Reflection upon the design process as it materialized during this project led me to some revision of the Analogical Designs model. Although subject matter experts (SME) had reviewed both my functionalism domain concept map and the revised traditional and modern societies concept maps, and although I had consulted with biology content experts in creating the basic-level metaphors (A TRADITIONAL SOCIETY IS LIKE A FLATWORM and A MODERN SOCIETY IS LIKE A SOCIAL HONEY BEE) and designing and developing the episodes, I realized that SME feedback and subsequent revision is important at every step of the design and development process. Too, adequate development of engaging animations requires the talents and expertise of professional graphics arts, animators, and multimedia architects. The full, revised model is described in Reese (in press). I suspect that the power of the functionalism title would increase if the prototype I designed and developed were reviewed by a team of SMEs, animators and multimedia architects, revised, and re-developed. I envision three types of improvements:

1. Animation characters, tested for learner appeal, could help to create affective bonds between the learner and the cast.

2. Pedagogy and content experts could review for clarity of message in communicating the concept.

3. Analysis of learner protocols for each subconcept could identify the episodes that failed to adequately communicate the concept.

Evaluation and feedback would reveal subconcept metaphors that failed to engage or communicate to the learner. These could be revised and redesigned. For example, within this

study, learners' episode task protocols across both the metaphor and concept map interfaces, evidenced a misunderstanding of "practice". Brown and Clement (1989) had observed that learners' prior knowledge can often interfere with learning new concepts. Although the functionalism instruction dealt with practice in the sense of "shared set of historical and social resources, frameworks, and perspectives that can sustain mutual engagement in action" (Wenger, 1998, p. 5), many participant protocols from both the metaphor-based and concept map treatments indicated that learners persisted in conceptualizing practice in the sense of "practice makes perfect". Were this study to serve as formative evaluation and were development of the functionalism title to continue from this point, designers, SMEs and developers could enhance the practice episode until it enabled learners to successfully discriminate between their preconceived notion of practice and the expanded meaning necessary to incorporate the term within the functionalism domain.

Pragmatic Considerations

In an authentic learning situation, if undergraduate and graduate preservice teachers were actually required to learn the principles of the functionalist approach to the relationship between school and society, there would be some motivation to truly engage with the content and use it to accomplish the goal of learning the concept. Pragmatic considerations direct highlighting (see highlighting section within the literature review). Pragmatically engaged learners would be less apt to erect conceptual roadblocks (see protocol examples in the results section). In such a case, the metaphor-enhanced advance organizer would serve as an aid in accomplishing the goal. Because pragmatic considerations are so important in real-life applications of analogical reasoning, it follows that experimental participants who had not actually connected the goal of understanding the functionalist perspective to their own personal goals might demonstrate less

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achievement than one invested in the learning objective. I envision two types of motivators. First, functionalism might be incorporated as required content within a multicultural course or educational philosophy or education in America course. Learners faced with an authentic learning task might approach the functionalism learning environment with greater motivation to engage with the analogy. Another approach, suitable for laboratory situations, would be to promise a bonus payment for participants whose protocols produced a concept map that evidenced a pre-specified level of achievement or percentile ranking in comparison with the rest of the participants. Pre-experiment generation of goal orientation might add power to the experiment.

Advance Organizers Accomplishing Their Job

Concept maps and metaphors are both advance organizers. In the case of this experiment, they presented identical concept domain structure. It is possible that, in the case of this experiment, both organizers did their job and did their job well. However, the experiment did not include a true control condition in which there was no advance organizer. Therefore, it is impossible to tell whether achievement was any greater than achievement would have been if the participants had simply read Feinberg and Soltis' narrative. I envision an expanded version of the study with additional conditions:

- Read only – participants read the applicable pages of text
- Concept map and read – participants work through the concept map version of the advance organizer then read the text
- Metaphor and read – participants work through the metaphor-enhanced version of the advance organizer then read the text

- Concept map only – participants work through the concept map version of the learning environment

- Metaphor only – participants work through the metaphor-enhanced version of the learning environment

Assessment would proceed as already authored. The additional conditions would allow comparisons to baselines that might isolate the contribution of the advance organizers. This might increase the power of the study.

Longitudinal Study

It is possible that any differences in achievement between the concept map and the metaphor-enhanced groups might take the form of long-term integration within semantic memory. If the metaphor-enhanced interface afforded a stronger scaffold than the concept map interface, longitudinal follow-up, using the same set of assessment questions, should show a difference between the two groups in the amount of salient content the learner can draft into a set of protocol responses. I plan to conduct a follow-up data collection via email and analyze the second round of data in comparison to the first.

Isolate the Characteristics of High Achievers

While there was no significant difference in achievement between the concept map and metaphor-enhanced groups, there was a great difference in high and low achievement. These differences were reflected in the interaction between Subscales and Achievement in which the greatest mean differences between high and low achievement were earned for cross-link and proposition subscores. What characteristics describe the differences between high and low achievement, and are these characteristics parallel for both groups (i.e., those who worked

through the concept map interface and those who worked through the metaphor-enhanced

interfaces)? In addition to the assessment protocols collected during part 2 of the study session, I

also collected

1. Part 1 episode protocols: learners' responses to the 24 episode practice questions

2. Part 3 paired word association ratings: This will be analyzed using PFNETS.

3. Part 3 overall IQ and subscore results: 56 participants completed an IQ test with subscores of

pattern recognition, classification, analogy, arithmetic, general knowledge and logic.

These additional data sources should allow me to prepare profiles of the average concept map

and metaphor high and low achievers. While I will look for salient differences, it is also

enlightening to note learner characteristics that do not distinguish between low and high

achievement. For example, Participant 125 participated in the metaphor condition and scored the

second lowest map score of 15 (the lowest score was one point lower, at 14). The 15 corresponds

to a z-score of -1.46. Yet, this participant scored an IQ of 125. Compared to the entire group of

participants, this IQ translates to a z-score of 1.04. It is a higher IQ score than that of the

individual, also from the metaphor group, who earned the highest map score (concept map score

of 162, z-score $_{map\ score}$ of $+2.9$, and z-score $_{iq}$ of $+.55$). Obviously, general IQ does not account

for the difference in achievement (richness of mental models) evidenced between these two

individuals.

Future Directions

I have discussed ideas for increasing the power of the existing study. Including an actual

control that does not provide an advance organizer might help to isolate any effect due to the

organizer. I also stressed that adequate design and development of metaphor-enhanced learning

environments requires the coordinated efforts of a team of content, pedagogy, design, animation,

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and multimedia experts. Feedback and revision, throughout the design and development process, is essential to the integrity of the relational structures of both the source and target domains, and the cross-domain mappings. I suggested an alternate view of the concept map data, one that used PFNETs or connections per node to compare learners' mental models to the expert mental model. I provided some intimation that learner characteristics that distinguish high and low achievement might be different for participants who completed the concept map learning environment than for participants who completed the metaphor-enhanced learning environment.

Through analysis of the subscore-to-node ratio, I found a dissociation between concept map subscores for high and low achievers. Compared to levels and branches, cross-links and propositions appear to be more sensitive to domain richness and integration. This result provides direction for researchers and educators who use concept maps as an assessment tool. When the instructional goal is richness of the learner's mental model, the subscale-to-node ration could help educations and researchers to assess the relative sensitive of concept map subscales. It may also help educators to help their students to self-regulate. If valid propositions and cross-links are rewarded (i.e., they yield higher grades), engaged learners will seek to create these connections among domain concepts and to verbalize and visualize the connections within concept maps and prose narratives. Pedagogically, the dissociation suggests that learners with characteristics similar to those of the low-to-average participants require explicit instruction in order to achieve the level of domain integration average-to-high achievers can achieve through implicitly integrated instructional materials.

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Appendix A: The Assessment Items

Assessment Probe One

Educational theorist A wrote

Within the flickering inconsequential acts of separate selves dwells a sense of the whole which claims and dignifies them. In its presence we put off mortality and live in the universal. The life of the community in which we live and have our being is the fit symbol of this relationship. The acts in which we express our perception of the ties which bind us to others are its only rites and ceremonies. (Boydston, 1988, p. 227)

Consider this statement with respect to your definition of functionalism. Describe the ways in which the statement lies in philosophical alignment with functionalism. Please be specific in describing the aspects of functionalism that agree with the statement. Write as detailed a comparison as time will allow. You may use your list of functionalism terms to help you develop your answer.

NOTE: *This prompt address*es *practices and institutions, and democratic principles.*

Assessment Probe Two

Educational theorist B wrote

It is obviously through education that habits are formed and culture transferred from one generation to another. But it is also through education that those habits of deliberation, critical inquiry, dramatic rehearsal, and empirical verification can be created, and the "cake of custom" can be, as it were, shaped before it hardens. . . . education, because it can affect the child before traditional habits are fully ingrained and

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capitalize upon the plasticity which still remains, offers a route to the reconstruction of the world. Education may be a force either for freedom and growth or for bondage and stagnation, depending upon how we use it, but if it is not to be the former, it will inevitably be the latter. (Murphey, 1988, p. xx)

Considering this statement with respect to your definition of functionalism. Describe the ways in which the statement lies in philosophical alignment with functionalism. Please be specific in describing the aspects of functionalism that agree with the statement. Write as detailed a comparison as time will allow.

You may use your list of functionalism terms to help you develop your answer.

NOTE: *This prompt address*es *difference between traditional and modern society, change versus static, democratic principles, meritocracy, hidden curriculum.*

Assessment Probe Three

Mayco is a large, isolated country, about the size of Australia. The climate and vegetation support the people and their agrarian life style amply, the year round. If prosperity is measured by health, security, and nourishment, the Mayco are a prosperous people.

The Mayco are a traditional society. They pride themselves on the fact that they will not allow their technology to change. What works now is good, as it has been since time could be remembered. The country is physically isolated, and there is no threat of non-Maycon influence within the country (such as would result from trade or cross-cultural interaction).

Maycon society is very specialized. Each skill and task has been honed to perfection. Those who wish to enter into a trade must leave their homes and journey to specialized training centers for the duration of the training. Training usually takes ten years. The centers are dispersed throughout the country, and the society provides training for all citizens.

How would you have to modify your definition of functionalism so that you could use it to describe the relationship between education (as described above) and Maycon society? Please be specific and describe

1. What aspects of functionalism could remain the same? Why?

2. What aspects of functionalism would have to change in order for a functionalist approach to describe Maycon society?

What aspects of functionalism could not be used in a description of the relationship between Maycon society and its system of education?

Please write as specific and detailed an answer as time will allow. You may use your list of functionalism terms to help you develop your answer.

NOTE: *This prompt describes a traditional society that requires specialized training outside the home.*

Assessment Probe Four

The people of Owanka are a small community, a tribe. They spend their entire lives interacting within the tribe, meeting all of their survival needs. Central to their society is the Choosing Fair they hold every year. When each young person reaches the age of 13, he or she participates in the Choosing Fair.

Within the Choosing Fair grounds, each Master-of-a-Skill has set up a booth. A young person visits each booth at the Choosing Fair. While at the booth, the master engages the novice at a few key tasks. Each task is designed to reveal the young person's skills and aptitudes toward a specific trade.

Once all of the year's young novices have visited every booth at the fair, the Masters-of-Skills meet in council. There, they discuss each novice. Based upon the novice's display at the

Fair, the Masters determine with which master the novice will train. This training determines the young person's lifetime occupation.

Based upon this account, please use your definition of functionalism to analyze the relationship between Owankan education and society. How would you have to modify your definition of functionalism so that you could use it to describe the relationship between education (as described above) and Owankan society? Please be specific and describe

1. What aspects of functionalism could remain the same? Why?

2. What aspects of functionalism would have to change in order for a functionalist approach to describe Owankan society?

What aspects of functionalism could not be used in a description of the relationship between Owankan society and its system of education?

Please write as specific and detailed an answer as time will allow. You may use your list of functionalism terms to help you develop your answer.

NOTE: This prompt describes a traditional society that requires formal selection.

Appendix B: Institutional Review Board Exemption

Virginia Tech
VIRGINIA POLYTECHNIC INSTITUTE
AND STATE UNIVERSITY

Institutional Review Board
Dr. David M. Moore
IRB (Human Subjects) Chair
Assistant Vice Provost for Research Compliance
CVM Phase II - Duckpond Dr., Blacksburg, VA 24061-0442
Office: 540/231-4991; FAX: 540/231-6033
e-mail: moored@vt.edu

Date:　　　　August 22, 2002

MEMORANDUM

TO:　　　　John Burton T&L 0313
　　　　　　Debbie Reese EDCO 0313

FROM:　　　David M. Moore

SUBJECT:　IRB EXEMPTION APPROVAL – "Metaphor and Content: An Embodied Paradigm for Learning" IRB # 02-406

I have reviewed your request to the IRB for exemption for the above referenced project. I concur that the research falls within the exempt status. Approval is granted effective as of .August 21, 2002

cc:　file
　　　Department Reviewer:　Barbara Locke T&L 0313

Appendix C: Participant Protocols

Participant 101

Q1

This statement coincides with functionalism because of the types of characteristics that are found in different societies. Teach society has different beliefs, rites, rituals, etc., (or ascribed characteristics) that need to be brought and practiced together in order to keep that society functioning. This offers a sense of bond within a group of people.

Q2

This statement goes along with the idea of informal education that takes place within a group but then expands into the possibility of educating outside of the group. It also states that this education outside of a particular group needs to happen but if it does not then it will hinder growth. It also mentions how children or the learner can still be open to new ideas as long as their own ideas have not been "hardened".

Q3

1. aspects that could remain the same are ascribed characteristics that are developed, the practices that take place to train and the goals that are set to achieve functionalism.
2. An aspect of functionalism that would have to change?
?
I believe this society has many of the same characteristics that were described to be considered a functional . . .

Q4

Overall I believe this society envelops most of the major ideas and terms of functionalism according to the definitions given. In particular the role differentiation is very present and the ascribed characteristics that each person demonstrates is used to place in the different roles. The fair is used as an institution to experiment with the different skill and to ultimately test which skill the person has to could possible master.

Participant 102

Q1

Within a traditional society there are interactions between people. As we interact there may be common ideas to be shared. The practices that are done in the society ties us to it. Leading to the education of us all. There are things we do that determine out society standing. Such as informal selection, training, and ascribed characteristics. These may or may not play a role in our development in the society to learn. With this society can change,

with some slowly which can change our personal ties to the society we are in.

Q2

In the society we learn different practices to help us find our role. These practices can be learned from others within the society. Through practice our roles develop for what we do. How we interact with others. But if the society rewards on ascribed characteristics then some may not move up in society. With this we inherit from out parents. And if the parents role in society isn't held as important then the education of the child isn't important. There wouldn't be any social change occurring within a society that goes by this

Q3

Aspect that remains is that there are goals in a society to be reached. Through the development of training the roles/skills are learned. But even though the family you come from doesn't influence change there is very little social change in the Mayco society. It was said social change is close when rewarded by character (family background). But even through people can have a choice of role the way things are done stay the same. The practice of different roles are important to the education.

Q4

With functionalism you are given a role through training. The Owanka community allows the young to discover their abilities and rewarded or given a job based on their ability with different skills. There is great social change though because a child may come from a family that is "lower" and have the skills to be given a job in society that moves them up. At the same time the children from families higher up would have education for their advantage

Participant 103

Q1

It lies because functionalism advocates looking at many perspectives and points of view, encountering different philosophical beliefs. This statement says that collective individuals all think and work toward the good of a whole without any individual differentiation in philosophical beliefs and ideas. Everyone has a role they play for the good of a whole which differs with functionalism because with different beliefs not everyone is working toward the same goal.

Q2

Like functionalism this statement advocates for freedom and growth partly. It is saying that education can be used to encourage varying philosophical beliefs. It differs however in the fact that it also states education can be a constraint to varying perspectives

because it can referred to as bonding and stagnate. It's basically disregarding the possibility for social change through education.

Q3

Functionalism is still evident in this society because they have a perspective on how education should occur. They feel strongly regarding their philosophical beliefs. However, they are still adamant about role differentiation and solidarity within the society. Thus no social change will ever occur because they are unwilling to allow for new perspective to come into their society. They have collective goals they are working toward. The informal education occurring is not allowing/or promoting social change of any kind. Traditional societies seem to lack similarities with functionalist beliefs.

Q4

This lifestyle does not allow for individual philosophical beliefs. Children are not permitted to develop and create their own beliefs and ideas. They are forced to accept and practice those divided on by the adults of the society. They are forced into role differentiation where their ascribed characteristics have relocated them to training at a specific institution within functionalism.

Participant 104

Q1

This passage discusses the sense of the whole and this aligns itself with the collective idea in functionalism. Also stated in this passage is rites and ceremonies in functionalism, this is discussed as Practices. Practices tie in with goals, institutions, and role differentiation Also, in this passage it mentions – living in the universal. Within functionalism there is social solidarity -> all the society things/acts alike.

Q2

This passage relates closely to the ideas in functionalism that information about life within the society is passed down from a generation to generation. (Primarily by informal education). Also correlating are that what is known is passed down and it is known by elders it is not learned by young. Society is also stagnant and change is limited when education is passed down from one to another within society. This passage seems more open to changes within society than the idea of functionalism was. There is more discussion of plasticity and the route to the reconstruction of the world.

Q3

1. Society is static – in this society they do not want change they are happy with the way their society works.
2. Functionalism would change in that their training is not done by the elders within their community – they are sent to training facilities to learn. Within these training facilities they must still use informal education.
3. No idea.

Q4

In Owanka – the tribe is still training the young – probably through informal education. But – in this case (unlike functionalism) the training (role differentiation) is not determined by birth. It is to be determined by aptitude. In order for functionalism to fit into this society the role differentiation and training would have to become more selective. Like functionalism role differentiation is determined by the tribe/elders.

Participant 105

Q1

In society most people act individually, but with some regard to how their choices and actions will relate to the group as a whole. This group could be the world, the nation, the state the city, or the surrounding community. Each community has separate values and practices such as a yearly festival or founder's day celebration. How a community works together is part of this relationship.

Q2

If we rely totally on informal education students will suffer. We have the opportunity to teach and redirect practices we feel are important (or detrimental) to our community. We are try to create social solidarity among our future leaders by giving them appropriate goals and teaching then to create their own goals in the future.

Q3

1. The role differentiations should remain. Each person having extensive practice in their skill/task is good.
2. Not accepting outside influences or being open to social change might need rethought. They don't know what they are missing.
3. Informal selection could be deemed unusable because the

Q4

1. Novice getting the opportunity to try several different skills. This promotes role differentiation as masters select "worthy" pupils. The community also exhibits social solidarity as they work together and feel a strong sense of community.
2. The lack of social change would need to be addressed before applying a functionalist view to the Owankan community.
3. Ascribed characteristics

Participant 106

Q1

Practices are a part of one's being and are a part of one's community too, These practices can set a person or group of people a part making their goals much different from those in other

societies. It's being a part of a traditional, simple society that makes one feel at home.

Q2

Informal education fits into comparison with this question. Through practices, training, and working alongside an elder the young learn from others in the society. Children are so easily molded, I believe is the message, especially when in this case, everything is so simple within the traditional society. There are no set standards, so mold carefully.

Q3

a. Functionalism within the Mayco society is traditional and simple – nothing complex.
b.

Q4

1. The aspects of some sort of training going on with skilled elders and practices is a part of functionalism.
2. The idea of the booth is too structured and not simple enough. The members were not working well together and assigning roles – not necessarily by what skill liked but by what was good at.
3. The interactions between people were too one-sided. The goals for all the members were not communicated well enough.

Participant 107

Q1

This statement is like functionalism because he is saying that within each person is the whole and they aren't individuals, but a collective society. Everything is centered around the life of the community life in a traditional society. They are binded to their society and individuals don't matter.

Q2

This theorist believes that education is the way to help society evolve and grow. Education gives children to learn more than what their society alone has to offer. Because of this, children can learn and teach other. They get the training they need through formal education and social change can occur. As educators, it is important to give proper training and practice so as not to keep a static community.

Q3

Functionalism would still be that people have role differentiation because although everyone is assigned a role, they can change it if need be. The entire society is dependent on these roles and training people receive. People do have ascribed characteristics but they can be changes. The Mayco live in a static society and really only receive informal education so it will not grow more complex as time allows through education their society could possibly grow in knowledge.

Q4

The Owankan don't receive education formally, they purely learn from the tribe. Because they have no new, outside training they don't learn new skills or more about an already existing skill, they simply perform for survival. The occupation is chosen for the people. Instead of having to learn what interests them and have a job they like and will strive to do better.

Participant 108

Q1

This statement is very functionalist in theory for may reasons. The life of the community in which we live. . . " describes the relationships and practices of a society. Also the ties and rites and ceremonies describe collectivism and social practices in the community. The acts could be seen as goals carried out in a functionalist society. Finally, it is this traditional society being described that preserves the life of the community and established social solidarity within that community.

Q2

According to a functionalist, habits are formed through watching others in society in an informal manner. These lessons are passed on to future generation, like it is stated in the first sentence. The education described here is not informal, however, it seems more like the formal education taught by institutions within a society that causes change, social change.

Q3

This is a very traditional society. The Mayco people understand their societal rules and through the training in a specialized field. These people have established themselves. From a functionalist perspective these people will not undergo social change because of the strong collective goals that have been established over many years. There is a lot of informal education but no real formal institutions in this country. I see this as the main difference in way this is a functionalist community.

Q4

The education of this tribe is very informal. There are no institutions and therefore in order to learn how to function in society one must be 13 years of age and they learn a trade that is useful in the Owaka community. There is definite role differentiation in this community because each member knows what his/her is. However, there are no institutions (formal ones) and no social change which are two main functionalist beliefs. There are collective goals and strong social practices in this small, traditional society.

Participant 109

Q1

Societies have requirements (goals) members have ascribed characteristics and are informally selected for role differentiation. Informal education promotes consistency in learning practices of the community. Lack of diversity in the community leaves little room for social change. Social solidarity is upheld and embraced in the society.

Q2

Informal education promotes consistency in a traditional society. It hinders new knowledge and causes stagnation as individuals become replications of a parent generation. Individuals' training and roles are dependent upon birth rights. Informal education does not embrace freedom and growth. It embraces bondage and stagnation as the young take on the same practices as the elders and there is no room for social change in such stagnation due to social solidarity.

Q3

The aspects that could remain the same would be: the lack of technology change, individuals having specific roles in the society. The aspects that would have to change would be the modification of each skill in order to make it perfect, specialized training centers and individuals leaving home. In functionalism individuals are informally selected for roles in society. The aspects that couldn't be used would be an individual's choice in deciding what role he wanted in society and receiving specialized training for it.

Q4

In this community the idea of individuals having role differentiation can remain the same. This is necessary to meet their survival needs. Also the idea of the job becoming the person's lifetime occupation can remain the same. However, the idea of booths and individuals trying out for roles would have to change. Functionalism does not embrace this idea. Roles are informally given to individuals. Usually determined by birthright. The aspect that couldn't be used would be the Fair, discussion of each individual's skills and choosing them for roles, and the training by the novice of each master of a skill. In functionalism

Participant 110

Q1

Within the meaningless practices as individuals is a society which claims them all. In it, we put off life as our own and consider it as a whole. How we express ourselves in through our practices. Functionalism is how we work together to exist. We leave behind out individual/single lives and depend on each other to create a collective society.

Q2

It is through education, whether formal or informal, that people learn. Informally, a community may lead to tradition, stagnation, repetitiveness (like cake -> shape it before it hardens). Education is either used for freedom – to enlighten learners, or used for bondage – lead learners into ways they must act in society. If it's not used for good, education will ultimately be a negative affect on a society and on its members.

Q3

1. They are physically isolated so no threat of anyone coming in. They are prosperous based on their factors.
2. They would have to educate from multiple perspectives, not just informally learn practices.
3. Don't know.

Q4

Each person has their own role within a society, so that could remain the same. These institutions are not necessarily the person's choice, but rather to see how the society needs them. The education is informal, but their formal almost to get the 13 year old to learn a specific trade. It is informal selection in that elders observe, but only when at a booth for a limited time. It might be more useful to observe for a while.

Participant 111

Q1

This quote lies in alignment with what I have learned about functionalism. The theorist begins his quote with "acts of separate selves dwells a sense of whole". This idea goes along with role differentiation and each member of society completing their own job to benefit the whole. "We put off mortality and live in the universal" shows how practices are passed on through training and informal education to pass along what is already known, leaving little room for social change which it at all would occur very gradually.

Q2

This statement follows a current view of functionalism. We live in a more complex society than the flatworm society. Our education system should not hold us back but be a force for freedom. We do form habits and transfer culture within our education system but these should not be along strict lines regulating what we already know and passing only that along. We should use the variety that exists and work toward social change through informal observation of these that are different from us. It would be easy to be held back by our education system if we only accept particular practices and continue rewarding ascribed characteristics.

Q3

The Maycon society works as a simple society with one major difference. They do not rely solely on ascribed characteristics and informal selection. Instead, citizens are allowed to attend the type of training they choose and all citizens are allowed to receive training.
The society wishes to keep things to same – little to no room for social change which matches the functionalism idea of what we have works, so don't' change it. They are very specialized in their role differentiation and have designed a system of institutions to oversee these jobs. Their training is not informal, however. Instead they have a 10-year.

Q4

Owankan society uses their education system to keep their society going. Instead of informal selection, each young novice must participate in a survey of sorts to match him/her with the differentiated role most suited to their strengths. They also attend formal versus informal training in order to serve the occupation and meet the guidelines set up by their master (an institution). Ascribed characteristics do not appear to have a role since jobs are matched to skills each person has versus their birthright

Participant 112

Q1

He talks about "separate selves that dwell in a sense of the whole." This goes along with how functionalism describes individuals as having different roles (role differentiation) in a society but work to meet the collective goals of the society as a whole. The practices that people perform are a part of their connection to the society as a while and help define them. The rites and ceremonies or practices are what people do in order to meet their role and become a member of the while society.

Q2

To me this is talking about the informal selection and training of children to meet their role demands and conform to society. Society can become stagnant if roles are divided based on ascribed characteristics alone and not on ability or means. Social change will not happen if children must conform completely to their roles as determined by the informal selection process. The collective goals of a group may change so that new needs have to be addressed when designating roles. Institutions cannot be so bonding as to limit growth.

Q3

Training should remain the same because the members of that society have gone through the informal education process and use an apprentice-type system in order to learn roles.

Social change does not seem necessary in their society since they have found a system that works for them. They do not want

progressive change to become a more complex society so that portion needs to be removed from functionalism.

In the education of Macons all citizens receive training and are allowed to choose roles – in this case ascribed characteristics in assigning roles may not be relevant. Role differentiation is decided by the people not institutions.

Q4

In this case the institution divides and designates role differentiation. The individuals' fate is decided by the collective group. Ascribed characteristics may not play a role since ability seems to be the dividing factor. The society functions as an exit with the group goals playing the main part in individual behaviors. The training is informal education does not seem to be as long as a process or as involved as the previous example. There does not seem to be any opportunity for social change. It's come about with such a structured limiting system.

Participant 113

Q1

In a community we all assume roles that work together to help us interact with one another. Sometimes by doing this individuality can be lost. We assume these roles through informal education and observation. But being aware of these different roles in a society an educator can better assist his or her students. It is important for know where a student is coming from before you can successfully communicate with them.

Q2

In a society we learn out habits, practices, and customs through informal education. This means we take on the roles of our elders in the community. What we do with this knowledge is our decision. If we use it as a form of bondage and follow it strictly the community will never grow. If we use this knowledge to grow we can create new goals and hopefully free ourselves from the traditional views of society. A classroom teacher should try to help students set and achieve their goals so they can help the society grow.

Q3

In the Mayco society functionalism can stay the same through their informal learning. They have also set up institutions that teach specific skills. In order for the Maycon society to work with other societies they need to be willing to set new goals that might change some of their practices. The jobs assumed by the people of the Mayco society are not assumed through informal education. They must receive special education for them.

Q4

The Owanka society uses institutions to help educate new members, but the roles and jobs that the young people take on are not assumed through informal education. They are dictated by a

master-of-skill. Members of this society have to rely on their ascribed characteristics given to them at birth to perform the necessary skills to assume a job in the community.

Participant 114

Q1

This statement agrees with functionalism because it speaks of everyone being part of the same whole. It also mentions "ties which bind us" and that can be related to the ascribed characteristic aspect of functionalism.

Q2

This statement agrees with functionalism in the fact of informal education. Both concur on the idea that what is learned is passed down from generation to generation. But I think he is also saying that this allows for little social change.

Q3

1. The idea of role differentiation would remain the same, because everyone still has a "place" in the community.
2. Informal selection/education: they learn by going to training centers, not just observation.
3. Again the training/selection/education process is formal. In functionalism it is considered an informal process

Q4

1. They have goals and roles set up within their tribe.
2. The informal selection aspect would have to change because the choosing fair is a formal event.
3. The children are "tested" to see if they would do well in a certain job. They are not just given a role because their father did it before them. Thus informal selection/training and education would have to change.

Participant 115

Q1

The first sentence talks about social solidarity and how one is like the whole. Honestly, I don't feel I understand functionalism enough from session 1 to answer this and to only 5 minutes with the screen changing colors is also distracting and nerve-wracking. I don't feel like the flat worm illustrations or the explanations helped in my understanding at all. I am not that type of learner and I am sorry if this messes up your study. I have no background knowledge on functionalism and very little on flat worms therefore it was difficult for me to make any connection. Also it takes me a while to process quotes and only having 5 minutes to process and respond is a little demanding.

Q2

You have to decide if you want your students to be just like the society in existence or if you want them to change and make it better. Personally I want my students to know more than I do and to go out and make a difference in the world. I don't want things to stay the same. I want them to get better. Functionalist believe the opposite I think. They believe things should stay the same in a society.

Q3

They believe in role differentiation as well as specific training. They do not like social change and are very set in their practices. The institutions are well organized and the goals of the people are all the same. It is a traditional society with no wish for social change. They don't have informal education as their training is very formal and specialized.

Q4

Everybody knows everybody and decided your future for you. You don't get to pick what to do because that is just not how the society is run. I don't think I would like to live there because of the structure and conformity to the way it has always been.

Participant 116

Q1

Functionalism works as a whole and by breaking down its parts only then do we see the interconnectedness of individuals. It is our individual roles in a society that allow use to be really connected to the whole and give use a sense of worth, functionality and belonging. By "putting off mortality and living in the universal," it's like living for the moment and making best of a situation. Even though individuals fit within specified roles, interdependence connects and effects us all – all as in part of the whole society.

Q2

The young minds of a society are pliable and absorbent. As they observe the norms of a society through informal education and acquire its appropriate practices, social solidarity will continue and the process of functionalism, which seems to allow for only a little growth will continue. So while we build upon each generation that we want the following to know, it's only those willing to step outside the norm, who will promote social change. So is stagnation and bondage inevitable? It will take a long time to have enough "social changes" to evolve a society.

Q3

1. Functionalism would still fit best in this very traditional society, supporting the ideas of stage theory, collectiveness, social solidarity, practices, institutions, role differentiation, training, ascribed characteristics, and informal education. If these aspects

are strictly adhered to then this society can continue to live in its own box.

2. Aspects of functionalism that would have to change are the goals (because they promote perpetual movement forward), informal selection (to keep goals concrete a more formal process would have to be implemented) ---

Q4

1. All aspects of functionalism except informal selection could remain the same. Because each novice is being selected an aptitude and not ascribed characteristics, they don't fit the mold of functionalism.
2. Specify that roles would be determined by skill and ability – not just informally selected.
3. Informal education and informal selection would no longer fit this functionalism mold because novices are now selected with a criterion in mind and necessary education, I assume, would then be provided – training to improve the skill selected for.

Participant 118

Q1

First off, this doesn't make a whole lot of sense. It seems that he's saying that there is importance in the community and in oneself for belonging to a group. The "inconsequential acts of separate selves" states that there is huge importance in the community. The goals seem to lie in success of the community. . .

Q2

The first sentence is the definition of informal education in the very simple society. The rest of it talks about how a society may become stuck and dependent upon ascribed characteristics and in turn have no social change. It becomes a static community. It says that education gives us an opportunity to avoid "stagnation" and grow as a society. We have two options here: stay the same and keep traditional roles or use education as an opportunity to better oneself and in turn, the community.

Q3

In this society, education is made a choice. One can enter a training school or not. However, if one does enter a school, they are to be a master of the trade. Functionalism doesn't really contain such a category. The education that is received is informal at best, learning values and things form home. They are open to education, but only as far as trade within their society. It seems to me however, that they have become stagnant. They found something that they're comfortable with and don't want to change it. They're drawn a line, and before they can advance, they need to realize this invisible barrier and remove it.

Q4

I read a book about this. It's called the "Giver". In it, each student is assigned an occupation at the age of 12. There is training involved and the young person will advance in a trade, however,

there is no room for an advanced education on this level. The novice will only go so far before they stop. Start their own family and their children will be assigned a job, and so on, and so on. It becomes a routine. There is no room for social change.

Participant 119

Q1

The society in which we live helps to mold our knowledge and goals. Some of this knowledge may be passed down from our parents, but the impact of others and their roles also assists. This community will continue to affect our growth over time.

Q2

We normally learn from things our parents teach us, what we learn in school, and from testing things out. However, society affects how we learn too. It can change out view on ideas causing us to rethink our own view and beliefs. We need to be flexible, but also distinguish between what we truly believe as right and wrong.

Q3

An aspect of traditional functionalistic society the Mayco would be able to maintain would be the close knit society. However, since society is changing technologically they should be keeping up with it to achieve the goals the have set. This ultimately leads to success in life.

Q4

An aspect of functionalism that would be able to remain in the Owanka community would be the idea of informal education. The certain trades are being passed down among the people or reproducing. Another aspect would be role differentiation, which means that certain people hold the skills and knowledge to make a specific trade work.

Participant 120

Q1

Functionalism is based on the concept of a community as a whole unit. This statement talks about how within ourselves lies a sense of whole that "claims" us—making us feel a part of this group. We are binded together through "rites and ceremonies," which in functionalism are goals and practices. Common goals create a society that works together and creates a community. They are the requirement at a specific society.

Q2

This statement argues between the points of informal vs. formal education. Informal education would mean having learning seep

through from generation to generation—people learning through interacting within society; however, functionalism warns a society not to get stuck in that generational process because social change and opportunities within society will be slow and limited if not non-existent. This statement is saying that education can prevent some of these "generational" or ascribed characteristics from taking over society completely. This allowing people to take on different roles and permitting change.

Q3

The aspects of functionalism that could remain are the informal education – allowing people to learn through interacting in society. Ascribed characteristics are another aspect that is shown in this society through families passing down agrarian skills. Training is a BIG part of this society too. The society would need social change. They can't live in a closed off society and make no forward advances to be functionalists.

Q4

Training is a large part of this society. Education is based on training a person is a specific skill, most likely a skill they were born good at – ascribed characteristic. It allows for role differentiation – once a person finds their trade, they stay there – Everyone in the society knows their skill. Social change would need to be added in order for the society to function as a functionalist. The community cannot just limit each member to 1 task for their whole life. There needs to be a movement from developing towards developed society.

Participant 121

Q1

In a traditional society, people learn through informal education. This creates collective goals and practices that tie everyone together. This social solidarity is what the theorist is discussing in the statement where he or she says that "the ties that bind us to others are its only rites and ceremonies".

Q2

Although members of society learn practices through informal education, the theorist is saying that social change may be brought about by education concerning the importance of freedom and growth. This movement for social change must take place while children are still young and before the collective ideas of the society have completely taken root in the children's minds.

Q3

In this society, the ideas of stagnation, social solidarity, and role differentiation involved in functionalism still apply. However, this society also uses formal education and training in order to perfect the various roles. This training seems to reinforce the society's collective goals and help them to actively resist social change.

Q4

This society applies to the idea of functionalism because it is very specialized in its role differentiation and training, and it follows social solidarity and collective goals in its methods. However, role choosing seems to be based on skills rather than ascribed characteristics, so that part of the definition would have to change. Informal selection does not seem to apply to this society because the role selection process is very formal and organized.

Participant 122

Q1

Functionalism is how school and society come together to educate the young. Each individual lives in society and learns form it. They must respect its goals and social solidarity soon diminishes. The social change that comes from the institutions and community all affect an individual informal education and thus how they function in society.

Q2

Education is the main part of functionalism but the learning can be from school and society. The statement talks about training that learners must partake in to become a functioning member of society. Social change must occur or bondage and stagnation will limit the learning and education of societal member and thus cause society to not function as well.

Q3

The definition of functionalism could remain the same in Mayco because society educations however they mentioned very little of school. Training is an important aspect accounted for. The society does have goals as to fulfill the needs of its members, but it does not do any of these practices working through school. That would have to be changed for Mayco to fit the definition.

Q4

The aspects of functionalism that remain the same are training and institutions. These jobs created to help society meet its needs and the training it requires to bring new individuals into an institution. The aspects that must change are informal selection. This society has a very formal selection process, though some of the attributes are similar. Role differentiation remains the same in this society as in the because they must be different jobs fulfilled for the society to function. I think most terms could be used to describe functionalism.

Participant 123

Q1

This statement lies closely in the ideas of informal education and traditional society. Society only learns what is passed through informal education leaving all to think and act alike not in "separate selves". Society is then bound by tradition, rites and ceremonies that are passed down.

Q2

This statement also reflects informal education. "Habits (practices) are formed and culture transferred from one generation to another". It also seems to touch on social change – "cake of custom" can be shaped before it hardens. The end of the statement gives the outcome of informal education (stagnation and bondage) of the outcome of social change (and training (freedom and growth).

Q3

Informal education – they seem very set on keeping technology the same. Traditional society – same as above, no influence from anywhere else. Goals – their goals remain the same. Social solidarity –
Ascribed characteristics would need to be changed because everyone seems to have skills to perfection.
Social change could not be adapted to this society as they see no room for it. Role differentiation – everyone seems to getting training for the same thing.

Q4

Role differentiation – they seek out those with certain skills adaptive to the different areas. The novices are probably proficient because of ascribed characteristics. Goals of the tribe – they maintain the same system to ensure that survival needs are met. Social solidarity – they don't' all think and act alike but do work within the same system. Ascribed characteristics
Training definitely defines this tribe. They are key on finding who is right for certain jobs and then training them. It isn't informal because it isn't simply traits based down within a family group but within a tribe.

Participant 124

Q1

This statement is in alignment with several parts of the idea of functionalism. First of all, as a collective society every person works towards the whole of the community. The statement also deals with practices when it discusses "our perception of the ties which bind us together". These ties are the state of mind that the community shares. Living in the universal goes along with functionalism also. Everybody works towards the same goals or requirements.

Q2

This statement aligns with functionalism in that it states that a society needs education for change. The statement refers to informal education in that it states that if there is no new education, the society will never change. If there is no new education, there is no social change and causes bondage and stagnation. Without new training instead of informal training and informal selection, the society never grows.

Q3

The aspects of functionalism that could stay the same are practices, because these are more states of mind of a community and informal selection. There would definitely still have to be role differentiation so that everybody was contributing and everything was getting done. There will always be ascribed characteristics and these could still contribute to informal selection. The difference would be in the informal education and informal training. The people of Maycon are leaving their homes to go to specialized training centers. For this to be functionalism, they would learn by watching at home.

Q4

Again, informal selection and informal training do not fit into the idea of Owanka living. Children are selected by their skills. Children are not learning from observation and not training by observation, but picked and trained hands-on. Goals and practices could stay the same because the beliefs and values of everyone in the society are the same – as well as the fact that they are working toward the same whole and same responsibilities. Ascribed characteristics do not matter much in this society, it is based on performance, which means that children may differ from parents.

Participant 125

Q1

This statement is in alignment with functionalism because we are separate (social solidarity) but part of a whole (institutions). The community (traditional society) is the symbol of this. The acts that bind us to the community are the practices.

Q2

This statement is in alignment with functionalism because it talks about how habits are formed and culture transformed from one generation to another and this is informal education.

Q3

What?
A. The aspects of functionalism that could remain the same are traditional society because it is a traditional society. Training is the same.

B. Ascribed characteristics would have to change because they would not just be the characteristics you get, they Maycons would perfect their skills in training for 10 years.
C. Informal selection would not be used because anyone could be trained.
Not enough time

Q4

A. Functionalism aspects to remain the same are goals because they are like survival needs and they people of Owanka work to meet survival needs.
B. You could change training so the youth is trained at the fair instead of looking at ascribed characteristics.
C. The Choosing Fair is different because anyone can choose what they want to participate in rather than being selected by informal selection.

Participant 126

Q1

This statement agrees with functionalism in the way that functionalism also reinforces the value of society. This author is saying that each person somehow is or wants to be part of a community. Functionalism goes along by this and takes it further by saying that this desire is what drives people to do certain things and to have certain beliefs. The ties that bind people are the rites and ceremonies as this piece says and this is validated by the idea of informal education. This is where the children learn these rites and ceremonies.

Q2

This passage brings up many of the concepts of functionalism. Basically this passage is looking at informal education versus social change. This person is saying that children learn the traditions and thoughts of the past (informal education). This learning can prevent more open thought and growth. This coincides with the idea of social change. Social change is very hard to create because traditional society values qualities that maintain the status quo. Therefore, there must be institutions to balance out the informal education a children receives at home with more teaching that promote freedom and growth.

Q3

The definitions of functionalism could relate to this society. For example there is the need for role differentiation since all of these skilled roles must be filled to keep the society prosperous. This is definitely a society that is traditional and against social change. Informal education seems to be very critical since it is important that the children have the same views as the parents so that the society continues without change.

Q4

The aspect of functionalism that could remain the same would be informal education. Obviously all of these children are learning

that this is the tradition, this is what happens, so they go along with it.
One aspect of functionalism that would have to change would be informal selection. This is obviously not informal selection, it is actually quite formal. It is a heightened form of role differentiation and the process is highly regulated. It is an intense form of training that perpetuates the status quo, and is therefore working against social change.

Participant 127

Q1

A society is made up of smaller components which this author describes as us. We are a smaller part of whole. Everything we do is towards a larger goal.

Q2

Functionalism says that young members of a society do not change unless they are taught new things. In traditional societies, the young are only taught the same things and thus the society never advances. Societies will never grow unless ideas are restructured.

Q3

As in functionalism, the same skills are taught over and over again. Outside or new knowledge is not appreciated. Like functionalism the ideas of the past are taught. However, in this society it works. The society is not becoming worse. Not adapting has worked because this society is isolated from outside influences.

Q4

As in functionalism, the young are taught the same trades of the past. They interact in society and thus learn their behaviors. Functionalism would have to change because the offspring are not becoming exactly like their parents. Instead of learning the same trade they are learning the trade that is better suited for them. By doing this they can advance more.

Participant 128

Q1

The statement describes a society where individuals are part of a whole. The society must work together to meet its goals. Members do this through the practices which the statement talks about (the rites and ceremonies).

Q2

This statement relates to informal education in a traditional society. Children are taught to see and do things just like their parents do. This leads to a society of very little social change. Children are

pretty much forced into believing the same as the previous generations. This statement is saying that those children need to be taught other ideas/values before they are set in their societal ways.

Q3

Mayo is a traditional society that uses informal education that is slightly different than defined in functionalism. It is similar in that the same ideas are past down generation to generation but Mayco has specific training and selection of roles. They believe in specializing each skill and task. Education involves going somewhere else while functionalism would say children learn from their parents and experience around them.

Q4

Owanka believes just like in functionalism that there is role differentiation. Unlike in functionalism Owanka has a very formal way of making the role selection. A young person goes through simple training to help determine what lifetime career is best for him/her. Informal education would not work here in this society and neither would informal selection because this is a very skill oriented society. Occupations are given out upon skills.

Participant 129

Q1

People judge themselves based on ascribed characteristics. In a traditional society each person has a role or place in society which ties together the community. It seems like this would support informal training as well – keeping people in their place in society – not allowing them space to move and learn. This keeps society static. No one is alone we are a part of the whole that is society.

Q2

I think he is saying if we don't really educate out kids and not just informally then society will never evolve. If we don't take the opportunity to show and learn new things we will just have many generations that are exactly the same. We have to learn new things or we will be just as simple and plain as a flatworm. You bring about social change and take away role differentiation and ascribed characteristics through education.

Q3

In this traditional society everyone has the same ascribed characteristics for the most part – same race, culture, religion. They don't want to change and get more technological they are a static country. They do allows for a switch of roles by allowing people to train for a different job which means role differentiation is there but its not totally set – everyone has a job but you can change how you contribute to society. I don't think the Maycons are totally about informal education because if a father is a seed planter his son could go to school to be a picker instead –there is room for change within their certain technological limits.

Q4

This society seems very simple. No one interacts outside of this society. Therefore, there isn't much change. However a person's profession is based upon what their skills are which is interesting because it doesn't have to do with what your parents did. However, because they don't venture out to interact with others they are very socially isolated which probably stalls any real change. Owankan society educates its children based on the skills they show so each person has a job that helps society continue to fun smoothly.

Participant 130

Q1

The first part of the question refers to role differentiation because of the separate selves. This leads into the second portion of the sentence in which all of the different roles lead to one large unit which would go along with the term social solidarity. The life of the community in which we live talks about them being a traditional society. The acts they talk about are their practices.

Q2

The beginning of the statement talks about the fact that children are taught through informal education. This being through traditional customs and such. Education can also lead to social change. This coming from the fact that education can reconstruct the world before the traditional habit are fully ingrained.

Q3

The Mayco society is a traditional society which is collective in that they all have the same beliefs. There is definite social solidarity. There is role differentiation. They have certain ascribed characteristics. The things that would have to change are the things that would not work such as social change, institutions, and the stage theory would change.

Q4

The aspects of functionalism that could remain the same would be the education process. The selection process would have to change slightly to be the fact that the specific person would only be allowed to choose their career. There is no social change because that person has that job all of their life. There are goals for the apprentice and training. The social solidarity is still the same because society remains the same.

Participant 131

Q1

This talks about how within each person dwells a "sense of whole which claims' and dignifies them". In a functionalist society

people are seen as pieces of the whole picture. People define themselves by their community.

Q2

It says education is either a way of freedom and growth or bondage and stagnation. It seemed as through Functionalists felt that society in general was fairly static. What one group of people knew was passed on to the next group of people. If change or growth did occur it was over a long period of time. Educational places such as schools are one of the institution that make up the while of society. Education can affect the child early is like informal education a way.

Q3

1. Not allowing technology to change = static society. What works now is good is also a supporter of static society. Each person has a certain role in the society.
2. The fact that training is available to all citizens. Leave home for training instead of learning from others in society.

Q4

1. meeting survival needs – certain role in society (choosing fair) training determining young person's occupation instead of 2. gender/birthright – skill=important
3. gender/birthright determining role in society – Ascribed characteristics – Informal education ~ more formal

Participant 132

Q1

For a functioning society ideas must be considered. Every persons ideas and knowledge adds something to society and how it functions. The idea and the separate dwells a sense of the whole which claims and dignified them is a perfect example. Society is defined by individuals.

Q2

For social change to occur one needs to provide an open education for young children. They need to learn from unstructured areas. Basically far from the institutions. Shown through breaking the bondage idea.

Q3

These people are set using role differentiation and practices. They have a good system of modeling and practice. They do not believe in change so their goals are not very impacting. They have different types of goals. They do not believe in social change or trying to better things. They like their traditions the way they are.

Q4

This society is based on roles. Having a certain place or job is what is important. They concentrate on skills and how they apply to jobs. Training occurs one a role is choosen and it is a life long commitment. They do not belief in exploring different information. The only information that a person needs to know is about that field of expertise.

Participant 133

Q1

Society has many different parts w/ different roles for its members. Social solidarity exists in a society where everyone works together and is whole.

Q2

Functionalism says that ascribed characteristics are passed down from generation to generation. Children have informal education, where they watch others around them and learn. Ascribed characteristics can prevent people from reaching their full potential or grant other people special rights. Society will be forced to remain the same without change, if we rely on ascribed characteristics.

Q3

1. The Mayco society is still traditional. Role differentiation is evident, because the society is very specialized. The society has goals.
2, Social change would not be evident in this society. They do not want technology to advance.
3. The system of education is more

Q4

1. Institutions would remain the same, for teaching. The child learns through informal education, by watching others and learning. Training takes place through different roles. There must be available training for a variety of occupations. Role differentiation shows the different components. Social solidarity means all of the roles will work together.
2. Ascribed characteristics would have to change because the child may choose at the choosing fair. The masters determine what the child will do, but it is not the same as

Participant 134

Q1

This statement describes how people act and choose to act based on their community. Often times, people forego their individualism to function in a traditional society, the community is tied together

through collective goals and practices with little room for social change roles are defined explicitly, and that, along with ascribed characteristics define your "place' in a particular society. This creates social solidarity within the community, with little regard to individualism.

Q2

In a traditional society, functionalism (the way a society behaves/functions through stages) will create little social change. Education can be the factor that makes a change in a community. In a traditional society, mostly education is teaching the young members how to continue acting in the same practices and following the same traditions to create a positive social change.

Q3

One aspect of functionalism that could remain the same is goals. It is great that this society prides themselves on having goals of health, security and nourishment. Mayco aspects need to change. Practices, institutions, and training need to be altered for there to be social change. Through education, these aspects can change to promote growth. Role differentiation should be lessened so all members can develop individualistic skills rather than the same ones. Ascribed characteristics cannot be used to describe the educational relationship because those are characteristics that cannot be changed or altered, but the definition of them can be.

Q4

This society is extremely traditional and completely based on role differentiation, selection, and training. To determine a lifetime occupation that will be acquired through training and education at age 13 is extremely traditional. No social change will ever occur in a society such as this one, where individualism and uniqueness virtually does not exist. To change the institutions and practices of this community completely alter the dynamics. Ascribed characteristics really play a small role in this community, where the selection of your trade and skill define who you are and what you do. The society had a set of collective goals, but ones so traditional, the society is stalled and cannot grow or change.

Participant 137

Q1

The first line about separate selves and a sense of the whole reminds me of role differentiation. How there are different individuals but who, through their different roles, make the community a whole. The last line has me thinking about practices and how traditions are passed down through the community. The life of the community could be seen as its goals and requirements. When it says "we put off mortality" because of the children who will learn the values of the community. It will go on forever.

Q2

"Culture" transferred from one generation to another. This happens through informal education when the children grow up with the

same beliefs and values as the elders of the community. The last line talks about how the informal education described in the metaphor section can lead to a stagnate society, however, if the children are educated in diverse issues and beliefs then the community can grow and change.

Q3

There is still role differentiation because of the different jobs in this country, and they have certain practices and ascribed characteristics that identify their tribe however, theirs is not informal education, it is formal if they are being sent to training centers. However if these centers are still within the country, which as a whole, has shared beliefs and values then they will still learn the values they will simply learn a new skill as well. Otherwise they will learn different beliefs and values and therefore when they return to their community they may evoke change. They would have to train the people within the community for the specialized jobs in order to fit in with functionalism.

Q4

There is role differentiation because there are different jobs to be done. They have a very traditional society because they're are no outside influences. They have practices, such as the fair, etc. However, they do not employ informal selection. If a group gets together to discuss and decide the fate of the "novices" then that is more formal selection.
We don't know that they have any institutions and it appears that education is more than informal, as the masters 'train' the novices. We also have no reference to whether or not there is social change.

Participant 138

Q1

Social exchange means that knowledge is passed down through generations so there is no knew knowledge. This explains people being a whole in a society. Social solidarity is a good one too; it means that members of a society are similar because they have been exposed to the same things. Even if people are individuals with different roles, they are still a whole in society, and they are aware of it. Often they have similar goals.

Q2

Informal education means that children learn from their parents by watching and copying. Therefore knowledge is passed down like habits rather than as ideas. Social change also factors in because the habits are passed on from generation to generation and new ideas are not factored in. Goals in society will probably stay the same, as well as practices.

Q3

Role differentiation will remain the same. Certain people will have the same roles throughout their lives, and a young person will learn to take over that role when a person dies. Informal selection of roles pigeon holes people into certain roles based on social status

from birth. Social change would be a factor. In order for this society to develop, new ideas would need to be brought in. New practices and new goals would be necessary. The educational institutions of the society would have to help usher in the new ideas and goals.

Q4

Training and role differentiation would remain the same. Informal selection would have to change or wouldn't be used at all, because children get assigned roles based on skills and not social status. Informal education would turn into formal education, because young people would be apprentices of a masters of the skills they want to learn and later perform. Institutions of education would not be used.

Participant 139

Q1

We live in a traditional society where we are trained by our community. We model others are learn by observation and experiences. Here he is saying we do not use social change because we are living in the universal? However, the community works together and survives using practices, goals, and training. One person's actions or doings can affect the whole community.

Q2

Traditional society and informal education are seen here. We learn by experiencing and watching our family, community, and events. Our ascribed characteristics help determine what we are able to learn through out parents, background, genetics, etc. I don't remember the term, but we will be identical to our parents, as with the flatworm

Q3

1. goals are the same as survival skills – good health, security, and nourishment. Traditional society is also the same. We are taught by our community, etc. through modeling and observing.
2. Those who wish to enter into a trade must leave their homes and journey for training. That would have to be changed because one is leaving the community.
3. Informal education would not be used because it does not sound simple. One must move in order to acquire a certain skill, which could also mean social change? The practices also seem different.

Q4

1. Traditional society and goals remain the same. They have met their survival needs. Informal selection is the same because people are chosen to do a certain skill.
2. It is different because it seems not everyone will be doing what their parents did or do. Each skill is unique to each person.
3. Training does not seem to fit in because one should already exhibit the skill they will be chosen for informal education also does not seem to fit. We do not know if these children learn or

model from their families, community etc. They are treated and unique with their own skill.

Participant 140

Q1

Functionalism is a work describing the relationship of society to an academic setting. In this theorist's opinion, it seems like he agrees with the stage theory, which is part of functionalism. The theorist talks about living as a whole, which in my eye is like a society functioning properly as a whole. He/she also talks about fitting into the "whole" by finding a relationship to society. This is in relation to role differentiation and informal education by learning what one's role will be to allow society to function.

Q2

Functionalism refers to ascribed characteristics as passing down certain traits (gender race, culture, etc) through the family and community. This is in direct relation to this theorist's thoughts that education passes down culture. This also allows for social change, because if a child looks only at his/her family, then he/she will replace their role in society instead of helping and participating in social change, which may be needed in different time periods.

Q3

Social change seems like a big part of Mayco's culture. They allow technology to change as it is created and entered into their culture. Functionalism also includes institutions in which a higher group of people "run" society. In this case, anyone has the opportunity to learn training in order to fill a role in society. Goals are not really used in this group- or at least not talked about. Goals could help the society with a change, but they seem to only allow technology to change rather than people.

Q4

Functionalism includes role differentiation, which is very much a part of this society. Each master's role will be fulfilled by a novice at some point in time, making each role pass through the generations. Social change would not fit in this definition. Because each role will be fulfilled by a novice, and no new roles are created, it makes it impossible to change as a society. Social solidarity would have to change because each person does not contribute his/her own opinions – rather, they stick with the social norm.

Participant 141

Q1

Sense of whole, rites, ceremonies.
This refers to how functionalism can refer to a society that has members that learn from one another and become a unit. The rites and ceremonies can be construed of ways behaviors are passed

from the elder members to the younger ones. If no new behaviors are introduced the community may become static. This community has a sense of a whole that defines each member. Ascribed characteristics would be part of these rights and rituals that define the community. Live in the universal – since behaviors never change neither does society –Will it ever does if it is static?

Q2

Education can be freedom – if we teach young to embrace research and think for themselves progress can be made, changes can take place – education, in itself, will bring the community 'up to par'. If it is used as stagnation the community can't grow, all behaviors will be repeats, although you could say each individual helps make a society – they are all the same individual. So the society will not be able to grow. "Cake of custom" rituals, etc. can be passed down as ascribed characteristics, a new ones can be created where social changes can take place, non-informal education aids in role differentiation and new ideas are brought into the culture. So bottom-line – what will it be social change vs. traditional society with ingrained culture and education that doesn't grow and push society forward.

Q3

Functionalism same-> healthy and secure society, traditional society. I'm confused as to what functionalism exactly is but it seems as if this is a very static society with ascribed characteristics (the culture) and practices that make up a working society. The training is very specialized and this doesn't sound like the flatworm example because that was more simple and behaviors and training to hone behaviors really didn't tale place. It seems as if the goals were to remain isolated and unchanging – non-progressive society with some role differentiation since the exact skills and jobs are so specialized and all are needed to allow the society to function properly.

Q4

Informal education is a huge part of this because it sounds as if the young learn behaviors from the adults and the adults model to the young the way the tribe works. But then it talks about how there is a selection process where only one novice is chosen to work with each master. The young have no choice when it comes to their life path. The training that takes place is chosen by the adult, who then acts as the child's model. This society will remain traditional because it trains people for each particular practice needed for the community to survive and does not allow any differentiation from this custom. The goals seem mainly to remain a working society with function skills in particular areas and to carry on the customs and ways of the elders.

Participant 142

Q1

Like the quote, functionalism is the combination of separate sub-units by the uniting of a community (traditional society) We fit into this society by having the same goals and finding our place based on informal selection. We are joined to the community by

our shared goals and practices. We put off individualness and change for social change.

Q2

This statement does go along with functionalism because without institutions where we lean new and different things, there is no room or change of social change. Informal education, informal selection, and social solidarity all lead to stagnation. The child does become bondaged by its lineage if informal education is used. There is freedom and choice from formal education.

Q3

1. Traditional society is the community they have. They are collective and share the same goals (no technology – no change) Their practices are all similar.
2. They have institutions in which one can go to for 10 training years to be any trade they wish, not based in informal education, ascribed characteristics, informal selection or social solidarity. There is room for social change and role differentiation.
It is not based on informal education, but rather a formal institution of training. Members are not . . .

Q4

1. They are a traditional society with the same goals and practices. There is room for role differentiation.
2. It is based on formal selection based on observed skills – they are trained by there are no ascribed characteristics, there is room for social change and I would say it is both formal and informal education.
3. I think it is formal and informal because they learn from a master not just by observing a regular adult, however most of the training will be from observation and increase in responsibility.

Participant 143

Q1

In a sense, I believe, its saying that there can be a whole idea, group, or belief system, however, this whole is naturally comprised of smaller sub-categories. We live in the now instead of the future; therefore, we need to handle things in different ways we've been taught to cope and in a sense survive.

Q2

One generation learns what the previous knows and has perfected. Because of social change though those that have learned are rewarded while others are destroyed. Those who set appropriate goals will prevail.

Q3

1. Role differentiation could remain. Everyone in Maycon society must have a skill or task that is perfected.

2. They, however, seem to not believe in social change. If their society were to become unisolated they could not react because they know what they currently know and don't need to know anymore.

3. One doesn't have to be in a preset job . . .

Q4

1. Every child must seek a specialized skill; therefore, role differentiation could remain

2. They are chosen for specific areas of interest by elders and are unable to chose themselves.

3. That each person is on the same level. Depending on the type of person you are and what you are good at depends on what you'll be dealt.

Participant 144

Q1

Our lives relate much to our society. Society forms our lives, as demonstrated in informal education. We learn from each other and then pass on what we have learned bringing about very little social change. We also bind ourselves to others in this same way. Our training forms who we become, and in turn, who our offspring will become.

Q2

This statement relates to functionalism again because it is basically stating informal education and training. This relates more to training though because it effects a child before traditional habits are fully ingrained. This training determines a child's role differentiation in a society. This training usually comes about through institutions.

Q3

1. Goals are the same. They are trying to survive by social solidarity as well because as a society they all act the same.

2. Practices would be different because their role differentiation is different.

3. Informal selection because they are all expected to go into a certain trade.

Q4

Ascribed characteristics because they still have skills they are born with and this is how they assume their role differentiation.
Training would change because they are learning one specific task rather than preparing for many tasks.
Informal selection because they are given their trade based on skill, the selection is not informal.

Participant 145

Q1

This statement relates to functionalism by the compared work, practices. Practices of traditions, rites, and ceremonies all compare to the perceptions of the ties which bind us to others. These different practices dignify each person in society.

Q2

This statement relates to training and ascribed characteristics. Training youth allows them to grow, as we shape their lives. Children have ascribed characteristics which can either aid them in their learning process at school or can stagnate them. The way we train the youth will result in the success of education process, either growth or stagnation.

Q3

The technology changes could remain the same. This helps society further advance in the world.
The 10-year-training which would need to change informal education because the program does not seem simple.
Traditional society because this is not an example of a typical, learning society.

Q4

1. Role differentiation because the novices are told what tasks are good for him/her, which requires various roles for each novice.
2. Goals – because each novice would have to reach and obtain higher goals in order to succeed over the other novices.
3, Traditional society – this is very different from any other.

Participant 146

Q1

Society as a whole has acts of separate selves, such as role differentiation. Acts that we express out perception of the ties that bind us to congruent to the traditions and customs that a society embodies. The individual actions contribute the success of the community as a whole.

Q2

Education transfers knowledge from one generation to another. Education can help a society grow and achieve freedom or it can cause a society to remain stagnate and unchanging. In functionalism the society remains static as only present skills are passed down. New skills are passed down. New skills are not discovered therefore the society does not change or progress.

Q3

1. The aspects of functionalism that remain the same are the practices of the society. New skills are not acquired because currents skills are seen as sufficient.
2. Aspects that would have to change is informal education. Skills are not learned through merely watching and participating, but through special training centers.
3. Aspects of functionalism that could not be used is that of only learning from parents/current generation.

Q4

Aspects that remain the same are that each member of society is given a specific practice or role to carry out that will contribute to the benefit of the whole.
Aspects that would have to change are that members chose a role to take on or are appointed a role through discussion. This process is formal, not informal as functionalism is.
Aspects that could not be used are that role selection is not informal and that they do not learn by watching and participating, but by training from a master.

Participant 147

Q1

This statement is a lot like what we just read in part 1. The life of the community is a relationship is a lot like institutions. Putting off mortality and deciding to live in the universal is a lot like goals – working together to survive.

Q2

This statement lies in alignment with functionalism because it talks about training and ascribed characteristics. Some things are in-born and some we learn by observation along the way.

Q3

The aspects that would remain the same are that everyone is working for a common goal – survival. Their goal is to survive by educating their people for their job. Some things that would have to change are the needs for staying the same – not evolving to the next step. It seems that informal education would not be used within this system.

Q4

They have a traditional society. They are replicating their knowledge to the youth of Owanka. There is an overall institution striving for good youth. I would change stage theory, social solidarity would not help describe this place. No one works on their own.

Participant 148

Q1

Well, I am a bit tired so this is not a good response, by any means. In fact, since it's 9:57 a.m. on a Friday morning it's almost as if I should still be asleep. To get on subject, this statement falls in some alignment with functionalism For example, there is social solidarity, collective actions, ascribed characteristics, and informal selection. The "big-lofty" words are hard to understand when I'm tired so I don't think I care for this statement too much.

Q2

By the way there are several errors in this research – explanation/writing. Some numbers don't match up and some grammar is a bit wrong. Regardless, this statement (question 2) concerns goals, practices, informal selection, training, and informal education. There are a few words that are used in the statement that hint at functionalist characteristics and they slightly tell and/or support of functionalist perspective. I don't mean to be or write bitterly but being tired, and "forced" in doing this has affected my attitude. Granted I know your research is important, but this participant – me—has some factors that have affected his responses.

Q3

I really don't know – it seems that the longer this session lasts the more sleepy I get; this is by no fault of yours; however the time period of 9 – 12 is not the most conducive for creative, research like collegiate/intelligent thought at least for me. This island – which – I don't think is real, has a very closed community social and educational perspective. However, functionalism is not the answer to everything, hence if this society is fine as is so be it.

Q4

I believe this society displays social solidarity, very formal selection (which is not in functionalism), training, and some ascribed characteristics. However, the _____ society is interesting because people go and are chosen but for the most part their post (experiences and knowledge) affects how they will do at the choosing fair. Thus this statement contains some similarity to functionalism, but not entirely. As included this society does not contain absolute pristine example of functionalism, but that's fine because I believe that functionalism is a good idea/theory; but it's not the answer to it all.

Participant 149

Q1

It says no matter how much of an individual you want to be you cannot escape the informal training you've received from the traditional society from which you came. I think he's also making

some reference to social solidarity and the lack of social change when he speaks of the ties that bind us to others.

Q2

This theorist is definitely speaking about how informal education is like flatworm replication. Simply reproducing robots of the former society. He, however, has hope that social change is possible. You cannot escape from your ascribed characteristics but he thinks you can choose how you teach and that you can teach in such a way to allow for social change and growth to occur. To do so, we would have to be sure and do away with social solidarity and allow people to come together and share new ideas.

Q3

1. They have specialized training (role differentiation) for specific jobs, leave little room for change, isolated practices are passed on.

Informal education because they are getting formal training at centers.

Q4

As far as I can tell, the only thing that would change is the part about how tasks are decided. The tutorial said that in a traditional society it is understood who will do what. Here they are chosen. Everything else sounds like a place where they practice role differentiation, informal education (sort of), their practices are passed won the line of ancestors through example and they all work together as a collective.

Participant 150

Q1

In a traditional society we are one whole, but theorist is right in that we are each separate in how out separate responsibilities in society. Society is connected and tied. We give these ties to our children through informal education.

Q2

This theorist is aligned with the ideas of functionalism. It talks about children learning through society. Practices are handed down from one generation through the next by informal education. However, this education is not always "right". So our school have a chance to change how children think. So children born with ascribed characteristics are treated more equally.

Q3

Well this is definitely a traditional society. People know their role differentiation and they are informally selected and trained.

What would have to change is their willingness to change old traditions.

Social change could not be used to describe the relationship between Maycan society and education.

Q4

1. Role differentiation could be the same. The Owankans definitely know their individual roles in society.
2. There need to be more social change. No outside views come in, the Owankans are very isolated.
3. Institutions, there seems not to be one.

Participant 151

Q1

I believe this statement follows functionalism because of one The acts in which we express out perceptions of the ties which bind us to others are its only rites and ceremonies. This line is stating that we are living in our community and learning from the people around us through ritual and daily life.

I don't understand this question. I need a dictionary.

Q2

This statement follows stage theory in that people learn from whats around them and take with greater knowledge. Social change begins to occur because the next generation offers a route in the reconstruction of the world. This also shows role differentiation in that one individual can spark the change and others will follow. You can even tie goals in by saying a society may make it a goals to survive in society and try to educate the young to do so.

Q3

I would have to eliminate the idea that as time goes on they become smarter more educated in other aspects. Role differentiation can remain the same along with practices, institutions, and training. All of these are present on the society. They have perfected their system and thrived as a society because change was not needed to survive. I would eliminate stage theory and social change because there isn't much change.

Q4

An aspect of functionalism that would remain the same is informal education. They obviously have their children learning from elders and the society, there isn't much change. I would eliminate the stage theory because I don't feel they have made change toward a better society. They reached a point they liked and stopped modifying. The Owankan's do not have social change. They have people who take over but they don't have growth.

Participant 152

Q1

NOTE: Part 1 seems to convey bias beliefs or inferences, not definitions. Maybe this was purposeful, I just wanted to point it out.
This question aligns itself with functionalism, by emphasizing the importance of the whole and the implications of community. It speaks of a sense of fit in the community that may be based on ascribed characteristics and it speaks of the ties that bind us to others and our society. The word "bind" may infer a lack of social change.

Q2

This statement lies in philosophical agreement with functionalism because it points out that education should be intentional and evolving. The stagnating and hardening word picture the author creates obviously highlights the importance of social change. The traditional habits it speaks of are probably ascribed characteristics, the role differentiating and lack of education for some would also have to do with ascribed characteristics.

Q3

A. The Maycon people do formally educate their citizens but all training takes place away from home, so within their family unit there's little opportunity for informal education.
B. Functionalists would need to say that social change may not be a predictor of well-being.
C. See A. Informal training could not be used. Social change doesn't exist either.

Q4

1. The aspects of formal education could remain the same. Informal education has already begun at home by age 13. The collective group of masters works to batter choose talent and their overall goals are probably similar.
2. Social change – informal education during years 13+
3. Social change does not describe this isolated community. People are put in learning tracks.

Participant 153

Q1

This statement relates to functionalism as it is very similar to a traditional society. In this statement, everyone had a sense of community, something that united them. In a traditional society, practices and roles are passed down informally. This helps perpetuate a feeling of social solidarity because in a traditional society, nothing really exists outside of your community. Therefore, no new knowledge is accumulated and the same society is perpetuated. This is very similar to the statement on the screen

where rites and ceremonies strengthen a bond that ties a certain group together. Everyone is working for the good of the group.

Q2

Education is a powerful tool. Just like it can create growth it can also contribute to stagnation. Take for example the traditional society a functionalism describes. Through informal education, only those skills, knowledge that the elders of the community know are passed down. Therefore, no new knowledge is ever gained. In a traditional society, the goals, practices, and roles are pre-determined and there is no room for exploration. Therefore, as the statement says on screen, the "cake hardens" and the habits are ingrained and perpetuated. In order to avoid this room for exploration and growth and new experiences are needed.

Q3

First, the things that could remain the same are the goals, practices, and the sense of solidarity. Since this group is isolated its way of life is not influenced by outside sources. Also, the Mayco society believes that its way of life is just fine how it is, no change necessary. The things that are different would be role differentiation, one in Mayco has the power to choose to enter a trade and be trained. Informal selection is not used in this society. Also, social change would be small as it has no outside influences. Social solidarity is a big part as they feel they are one big community that works as one.

Q4

In this society, the definition of functionalism would have to change in some aspects. First, informal selection would be nonexistent. Some others would be that your ascribed characteristics would help determine what you were good at. Some things do fit into the functionalism definition. There are still goals and roles to meet. Social change would be slow since there is no contact with those who are not Owankan. They probably share practices and learn these through informal and education and training specific to their job. As a whole the Okwanan society is for the most part traditional (functionalistic) but does allow room to explore your talents as long as they fit into one of the predetermined roles of the community.

Participant 154

Q1

This quote represents the functionalistic idea of social solidarity: that the group thinks and acts as a whole in a traditional society. Because of informal education, the goals and ideas of a traditional society are passed from one generation to the next, therefore, "the life of the community [. . .] is the fit symbol of this relationship." In other words, social change is static because traditional values and goals are always passed down to the next generation, and there is no chance for change. The "sense of whole' in a traditional community is obvious.

Q2

In a traditional society, informal education of the young children causes education to be "a force [. . .] for bondage and stagnation." This quote describes a more advanced society in a positive light, and implies that a traditional society is too restricting for any changes to occur. In other words, the children are only taught the collective goals, practices, and institutions in a traditional society.

Q3

1. In Maycon society, the concepts of collective goals, role differentiation, practice and training are all apparent. The society has exact skills and tasks for people to learn and each person specialized n that skill/task.
2. It seems like the idea of people leaving their homes to journey to special centers does not match with the general theory of functionalism. In this Maycon environment the young cannot observe and interact with all of their elders and therefore don't get a compete training.
3. Perhaps the idea of social solidarity would not apply as much.

-Out of time-

Q4

1. The idea of a collective society living together and sharing social solidarity and common goals would apply to this group. They interact within their tribe and work together to meet their needs.
2. The main aspect that would have to change is the "Choosing Fair" process because it doesn't align with the theory of ascribed characteristics. In other words, children are not selected by birth order, gender, etc. but by their ability to complete the tasks at the fair.
3. As I just stated, the idea of ascribed characteristics doesn't apply to this description because the children are chosen in a different way, and their birth order etc, doesn't matter.

Participant 155

Q1

This statement seems to describe a primitive society in ways that are similar to the functionalistic point of view. The group puts away the idea of separate self for the goals of the whole group. The group is bound by social solidarity by traditional practices. The group continues in this manner by way of informal education with little room for social change.

Q2

This theorist believes that education alone change the dynamics of a society. The latter idea (that education can be a source of "bondage and stagnation") falls in range with functionalism and primitive societies. These traditional societies have needs and goals, and the children are educated sop that these goals can continue to be met, but this form of informal education also severely limits opportunities for social change within the group.

Q3

1. In the Maycon society roles are highly differentiated. Techniques are perfected and citizens wishing to learn a trade travel a long distance to study for years learning the trade. This keeps the trade the same throughout the society using informal education.
2. The concept of ascribed characteristics does not seem applicable here. People are able to choose specialized trades; they aren't born into the specifically.
3.

Q4

1. The tribe has social solidarity and they have survival goals that are met through their practices. Their institution, Masters of Skills, council decide who will enter into which trade for life. Roles are differentiated but not informally selected.
2. Ascribed characteristics are not involved in the choosing of a trade for a young person. A master (institution) decides based on tasks performed.

Participant 156

Q1

Each individual in a society acts alone and with others as a collective group for a common goals. The practices they participate in are the rites and ceremonies that bind them. Each individual fits with his role differentiation to make a working whole. Without that it won't succeed,

Q2

Children in society learn through informal education. They learn from what their parents have exemplified, what society has showed then, along with their peers. Through parents there is very little social change. Through education we can teach children to be free and grow as far as possible. Or, we can tie them down into the life we want them to have, keeping then from growing and developing.

Q3

Functionalism would still have stage theory, collective. And goals, along with solidarity. Because they are a united group. Functionalism would have to lose the informal education because formal education has taken over. There would still be role differentiation to fulfill all skills and a training time, 10 yeas, to learn skills. Social change would be limited if existent at all due to isolation. . .

Q4

Functionalism would remain the same with few changes. They still have a goal with social solidarity to make the tribe successful. Role differentiation is chosen by an elite few, and not by the individual. Training is done through the course of one's life Education becomes somewhat formal and somewhat informal, because it is

not merely what they would learn from their parents. Again, social change would be minimal, if at all.

Participant 161

Q1

The quote talks about how we are each our separate selves but how we all have a sense of whole. It also talks about community. We all contribute something different but we all live in the community. Each person has their own function. The acts in which we express perceptions is kind of like role differentiation. We all express ourselves differently.

Q2

Education can either free society or cause it to stagnate. This is like the ascribed characteristics term in functionalism. Also, the quote talks about how educational habits are formed and passed down. This is like how informal education is passed down with little change. This person wants education to intervene and keep kids from stagnating into their ascribed characteristics. Education shouldn't be simply passed down with little or no change.

Q3

The Mayco people seem to prescribe heavily to the ideas of social solidarity, role differentiation, an informal selection and education. Even though things are functioning well, it is also a stagnant society. Knowledge has been the same for centuries and there is no interaction between people of specific trades so that everyone can learn. Even thought everything is going along smoothly, learning is very limited. People can only know what they who have gone before then know.

Q4

The Owanka people also seem to believe strongly in ascribed characteristics. Everything seems to be very limited. They have social solidarity and a traditional society, but everything is stagnant. There isn't much hope for social change. There is role differentiation, because everyone is given a different task, but there ascribed characteristics are what determine this.

Participant 162

Q1

Functionalism is a concept that explains how goals, practices, institutions, and informal education form a connection to social change. People see themselves as individuals as well as members of a community; this is how they find out who they are. By adhering to goals and practices established by social institutions, they learn what their role in society is.

Q2

This educational theorist is implying that informal education is important in society because it ensures the transference of culture from "one generation to another". Education can be forceful or it can be learned through natural and realistic experiences. Informal education is a major part of functionalism because a children learn more from the world/society by having experiences with it more than he can learn from reading a textbook or listening to a lecture on a particular topic.

Q3

With regards to Mayco society – the role differentiation, training, practices, and institutions are established parts of the working definition of functionalism. I believe that the goals and informal education within Maycon society would have to change because they have become so defined over time – There is no room for change or progression within this society. The idea of collectiveness couldn't be used in Maycon society because the role differentiation is so great – everyone is doing their own thing while living in the same area.

Q4

With regards to Owanka society – the goals, practices, institutions, and role differentiation could stay the same and still be a part of functionalism because they are established. Social change and informal education would have to change because there's not much room for children to gain knowledge through a variety of experiences and thus pass that knowledge on to the next generation. Social solidarity couldn't be used because each member is separated with his/her own role and with limited interaction with other member of the community.

Participant 163

Q1

This statement lies in philosophical alignment with functionalism in that it speaks of role differentiation in society (separate selves working for society) and the goals of society members are trying to maintain by working and living together.

Q2

This statement lies within definition of functionalism with its discussion of generations passing down culture and knowledge. It also discusses that informal education will not bring about change and growth if we never ask questions and only stay within our own community -> such as in a traditional society. Education will become learned and a force of "bondage and stagnation" is this case.

Q3

Functionalism and Mayco society
1. functionalism that works

- role differentiation
- society's goals
- social change hard

2. functionalism that doesn't work
- not just informal education
- stage theory

Mayco education system that could not be used would be stage theory

Mayco doesn't want to change – resistant to change.

Q4

1. Functionalism remaining the same
   - Role differentiation (society seems to work by separating tasks)
   - Goals of society (will remain the same)

2. Functionalism to change
   - Ascribed characteristics and informal education
     - at 13 person gets to choose role in life
     - not passed down from family
   - Informal selection because of same reason

Participant 164

Q1

"Separate selves dwells a whole to dignify" is the basis behind a collective society. Through the practices and methods we partake, we are adapting the relationship of the society. Thus the institutions to which we prescribe determine the practices and goals of our collective society. To improve these institutions we contribute our ascribed characteristics to investigate a social change.

Q2

Education is the end result to our knowledge and ability of competency to give to society. We use it with our inherent and ascribed characteristics to initiate some social change towards the

roles and institutions within a society. If the education basis is limited by informal selection and training of individuals then the social change within the society is minimal, regardless of goals set or predetermined by the society.

Q3

Aspects to remain the same are that obviously Mayco is a collective society that has set up practices and institutions to determine roles for each member by informal selection and training. Thus allowing them social solidarity.

I don't anything has to change because they are happy with a static society resistant to social change and ascribed characteristics of its members.

Obviously because of its isolation the informal education basis is primarily survival skills for their goals. Wisdom occurs from practice and experience.

Q4

The Owanka primarily practice a formal selection process to determine their roles in society. Each one has a specific informal education to give training to a certain and specific practice within the goals of their society.

The only change evident to me would be formal to informal selection. In a functionalist society, it is rather simple and chosen for you without predisposition of skills or depth of training required.

These people obviously avoid any social change due to ascribed characteristics of their people. That goes against functionalist beliefs.

Participant 165

Not submitted

Appendix D: Concept Maps Raters Constructed From Participant Protocols
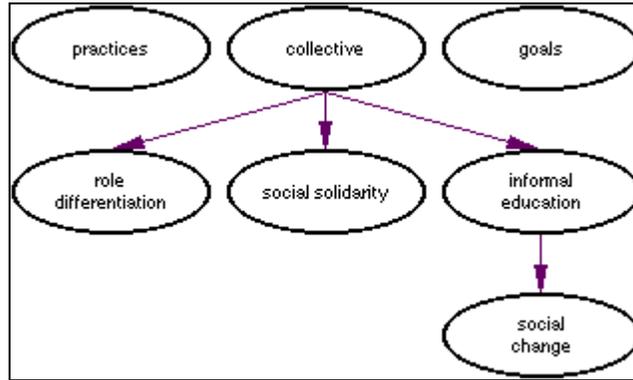
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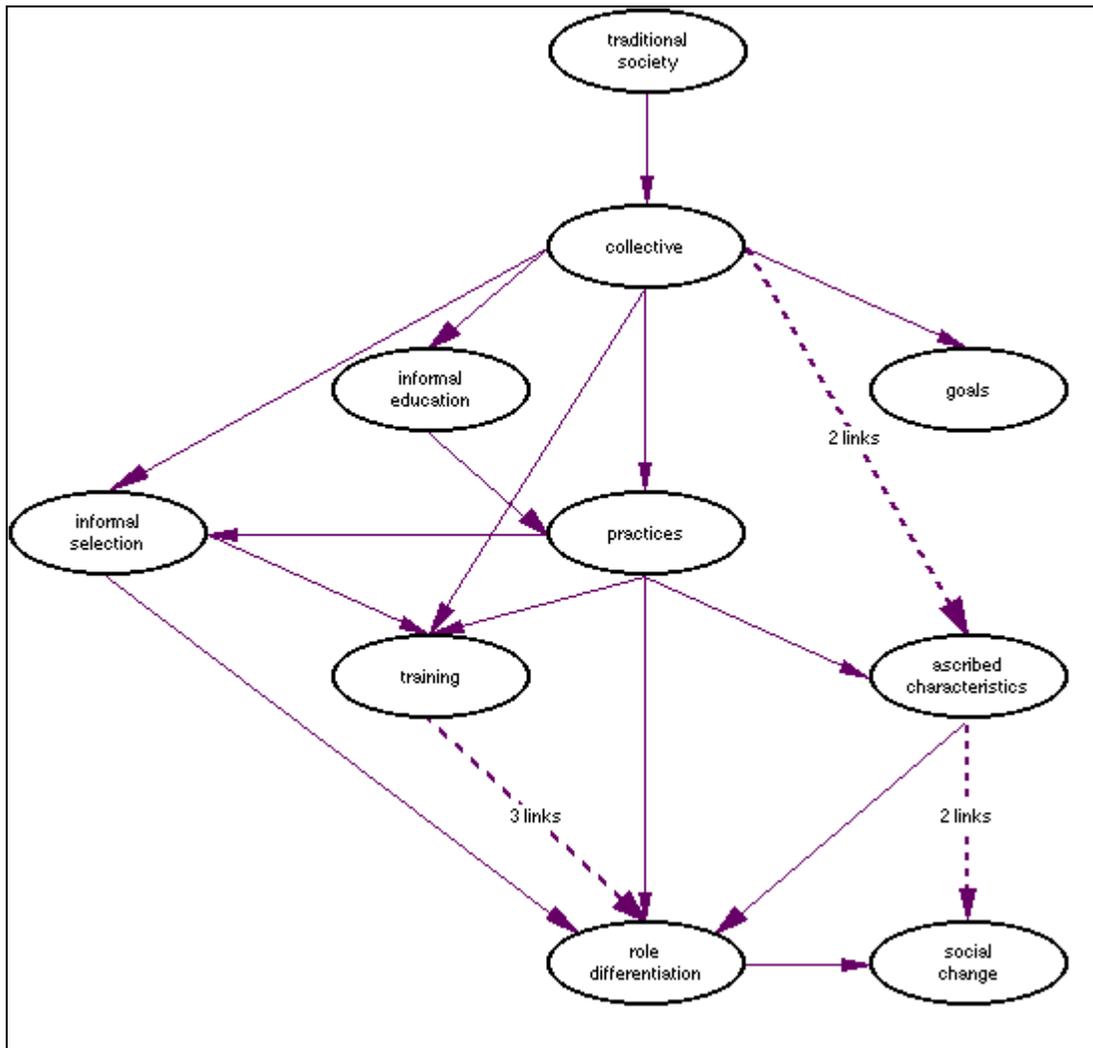
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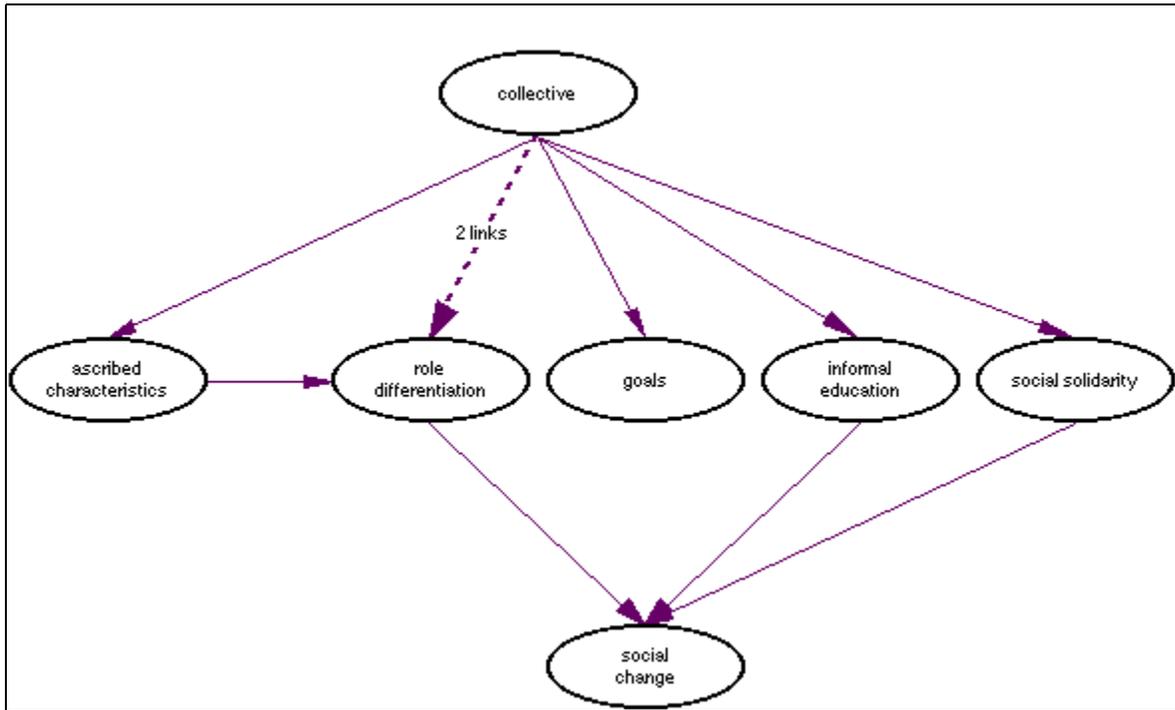
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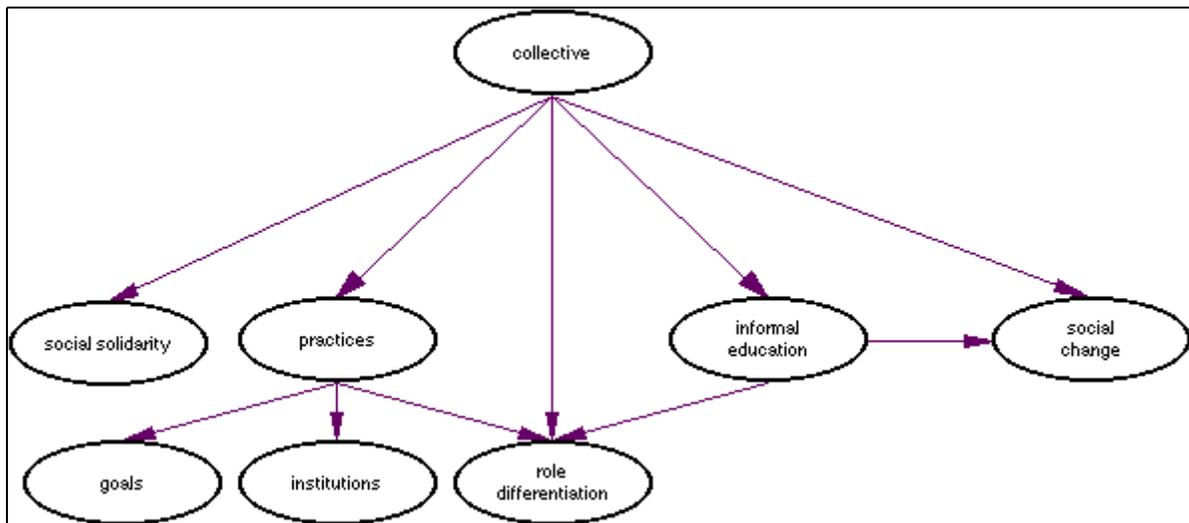
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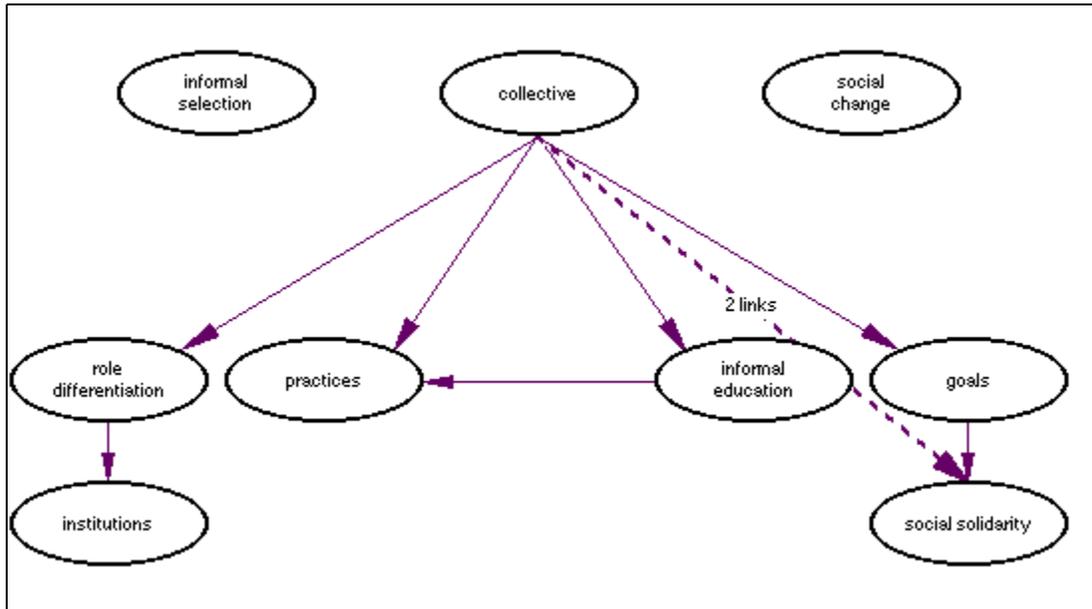
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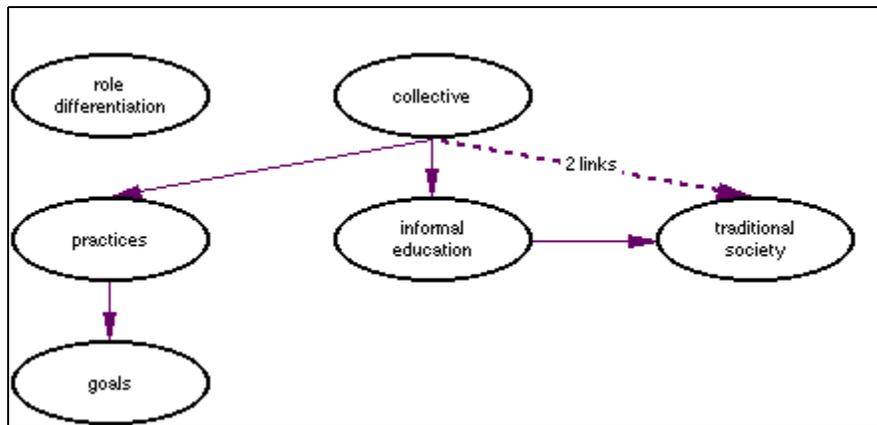
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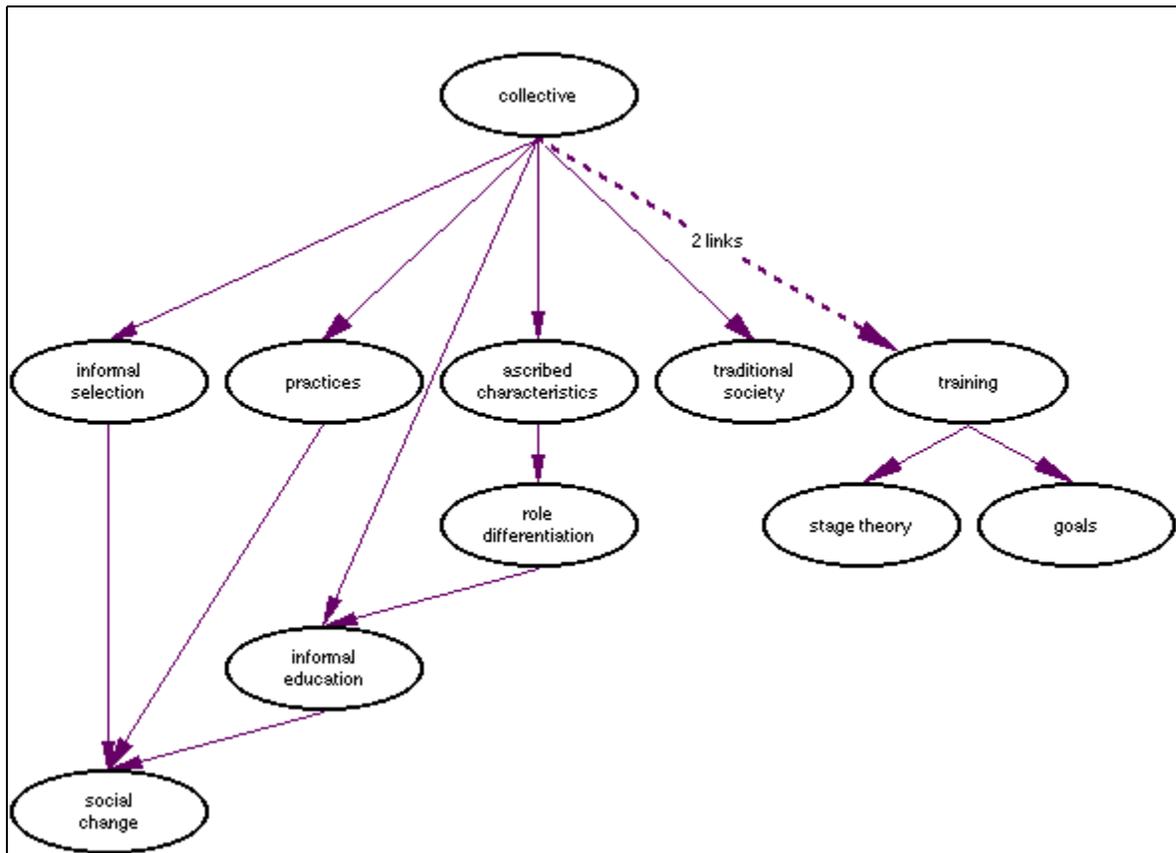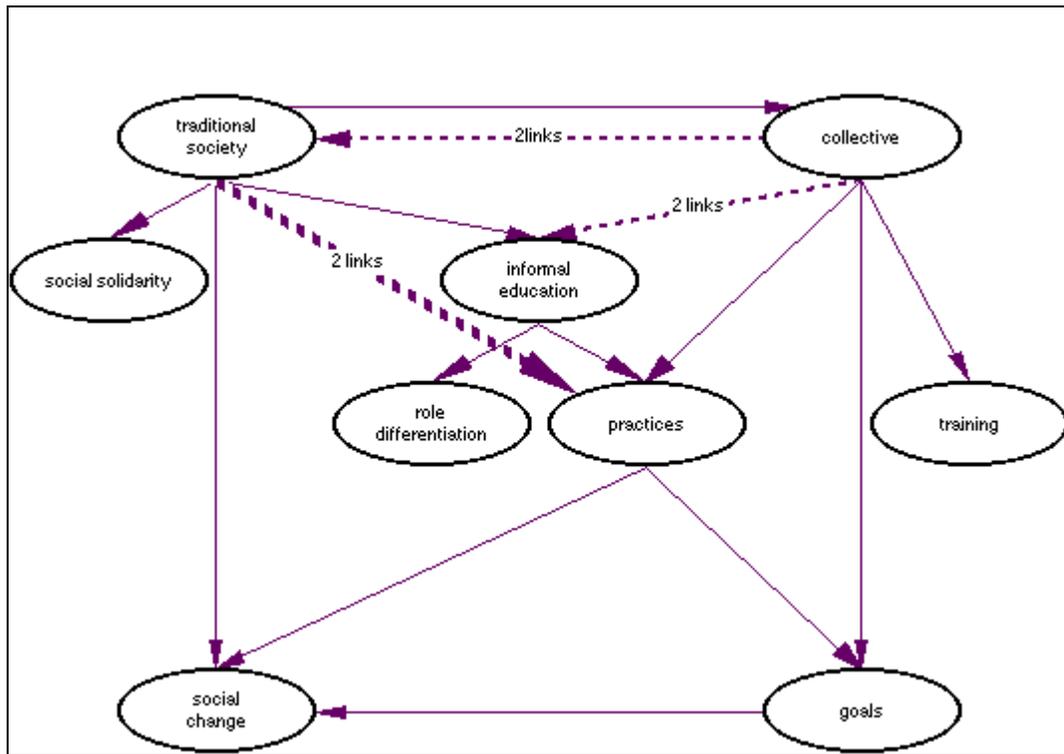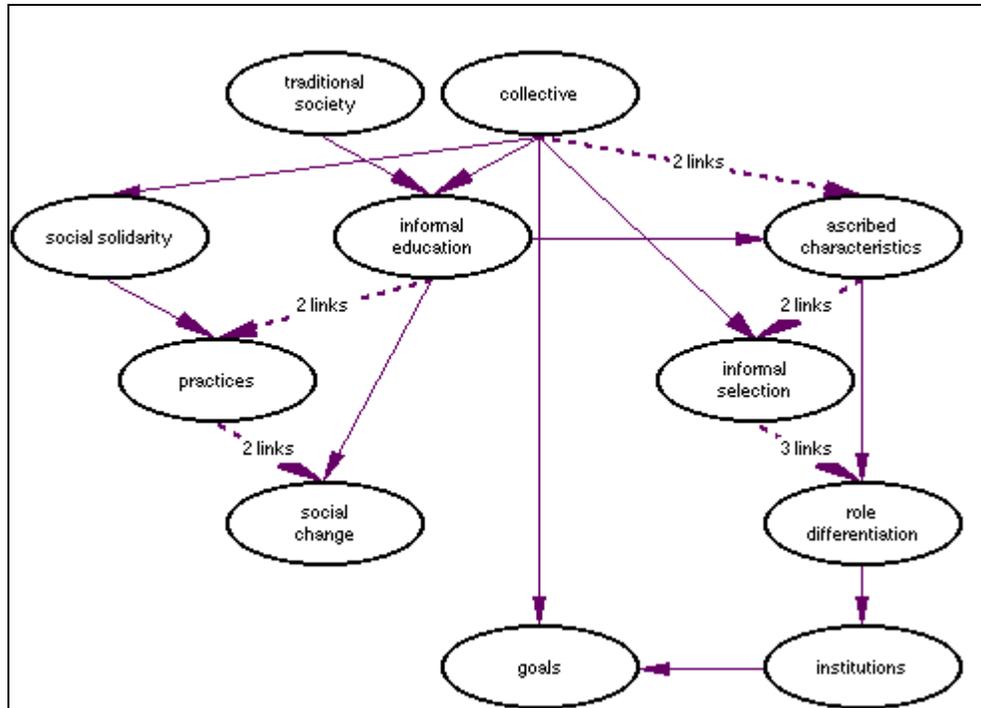
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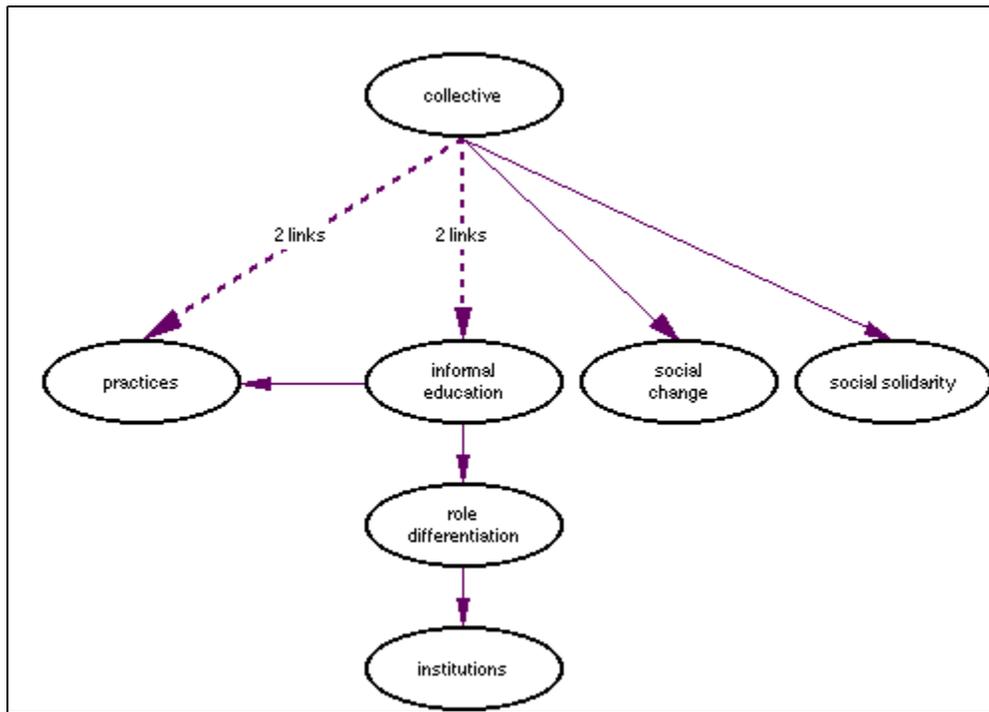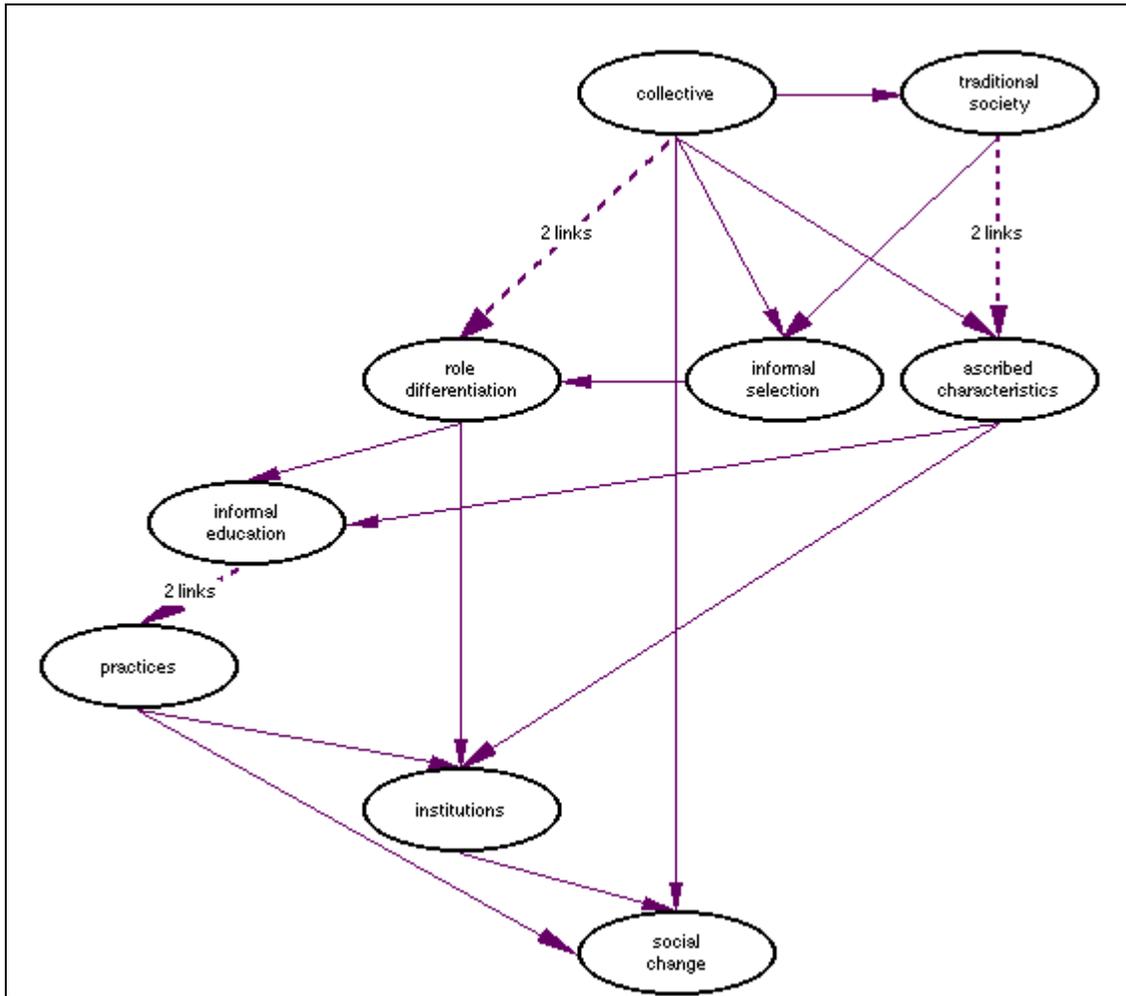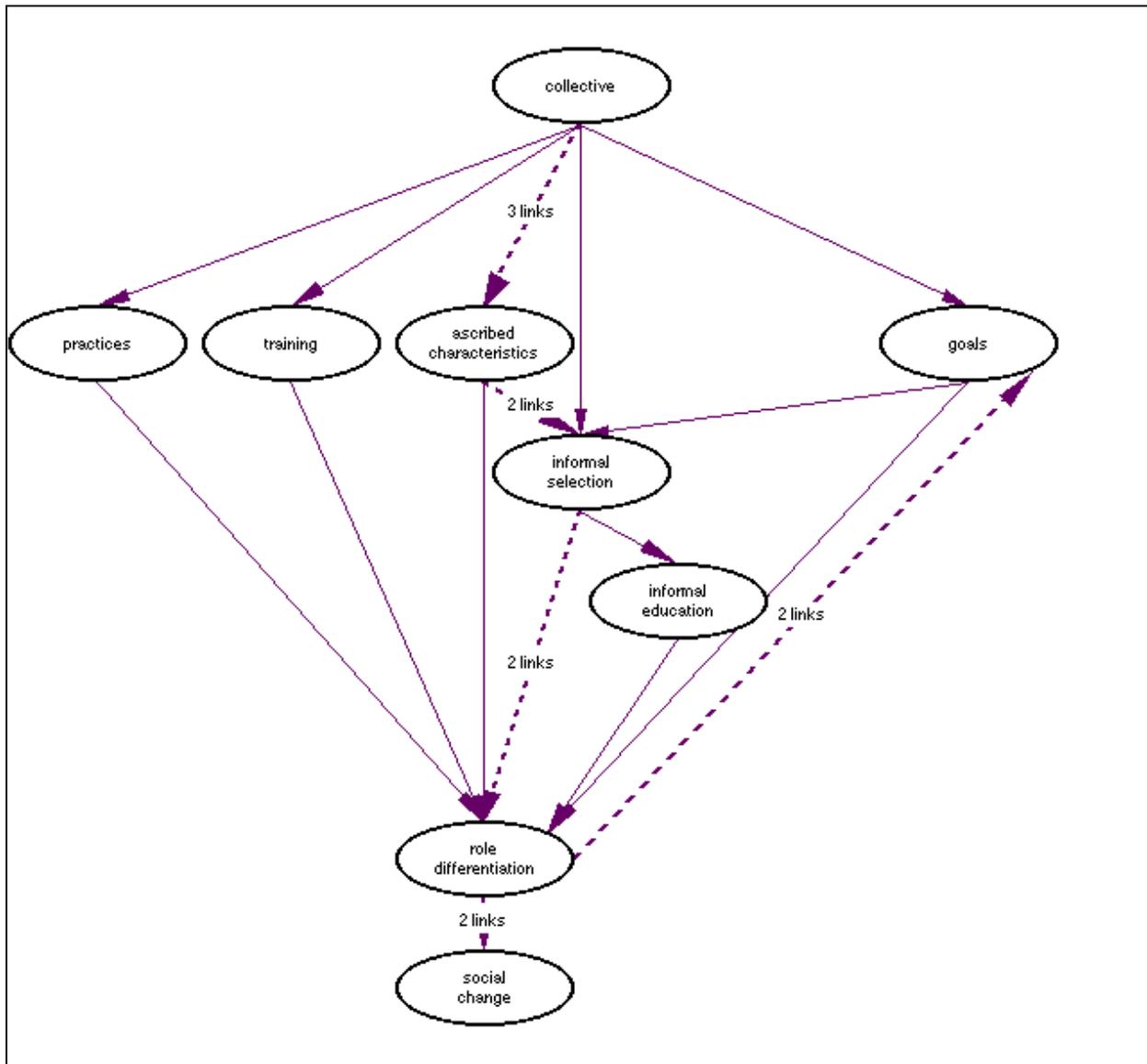
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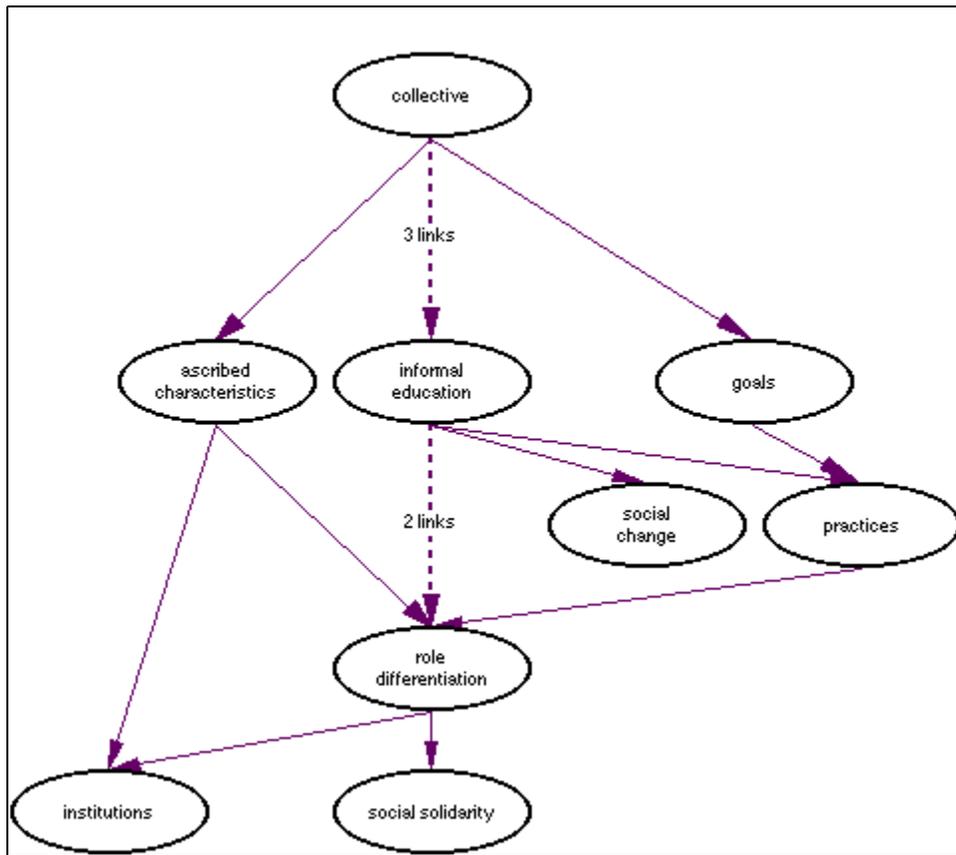
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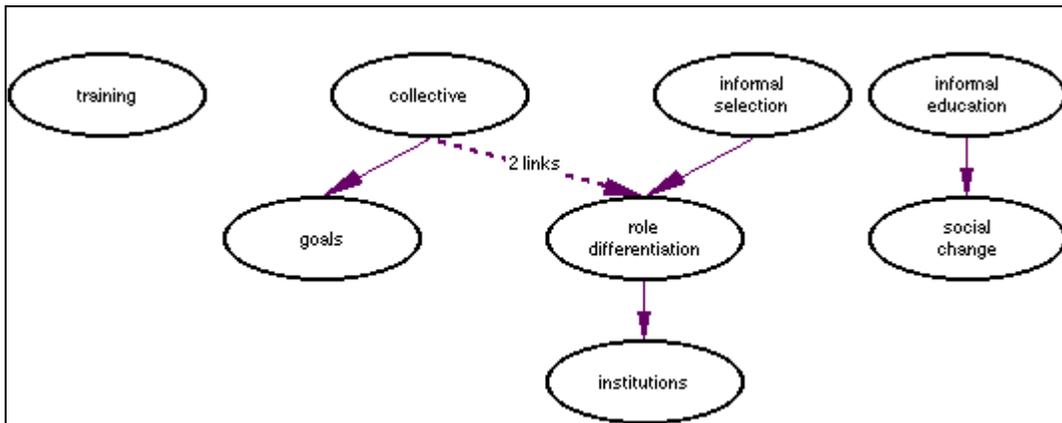
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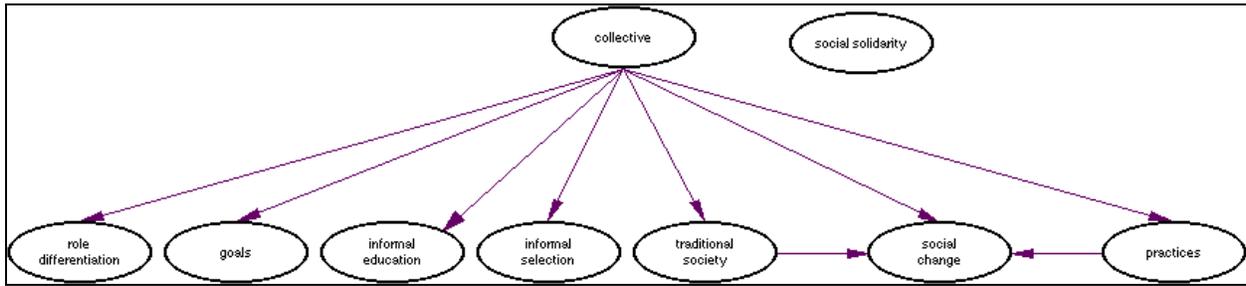
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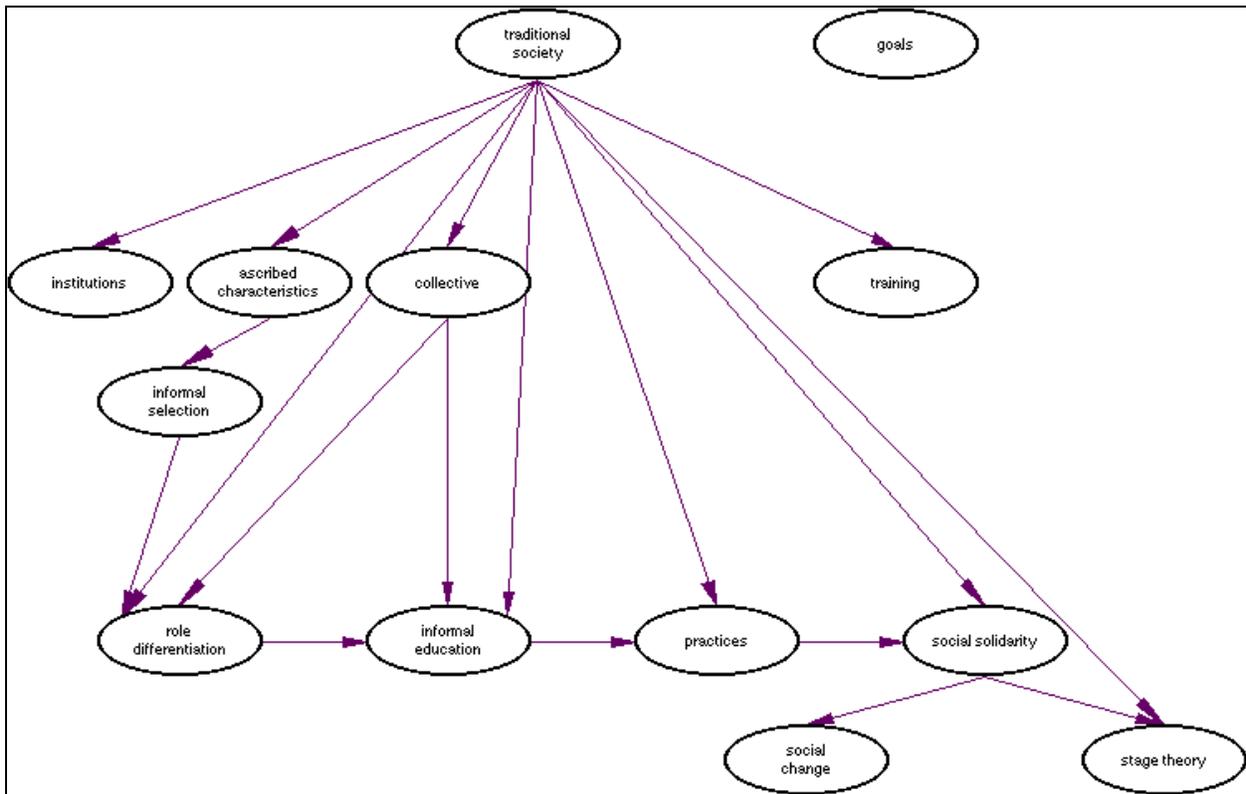
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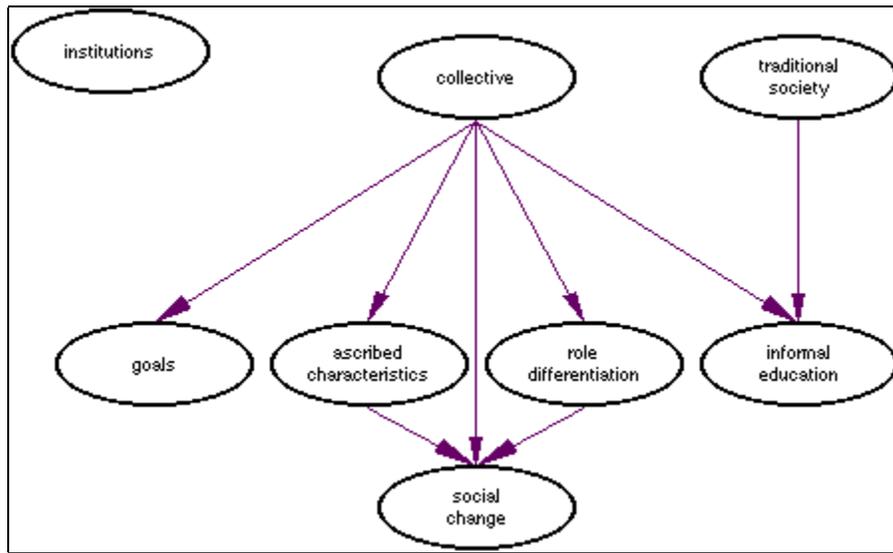
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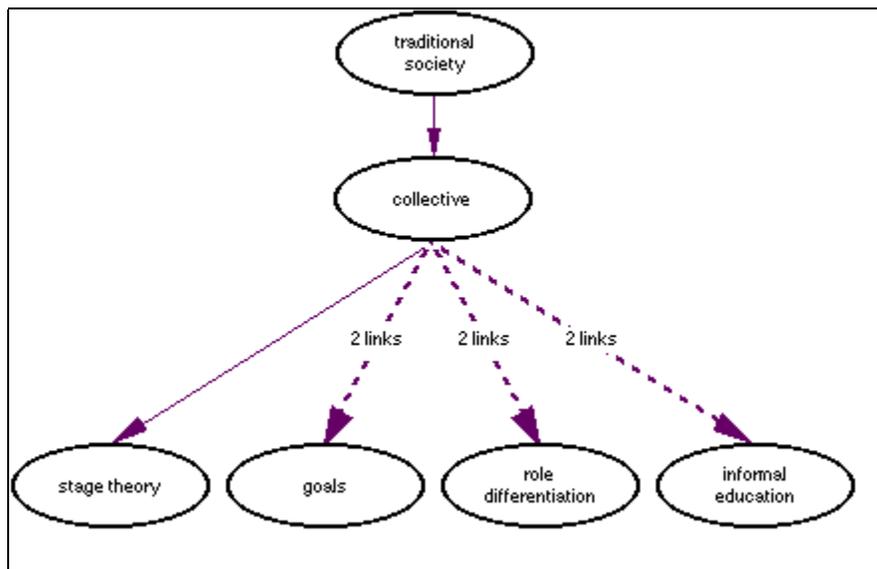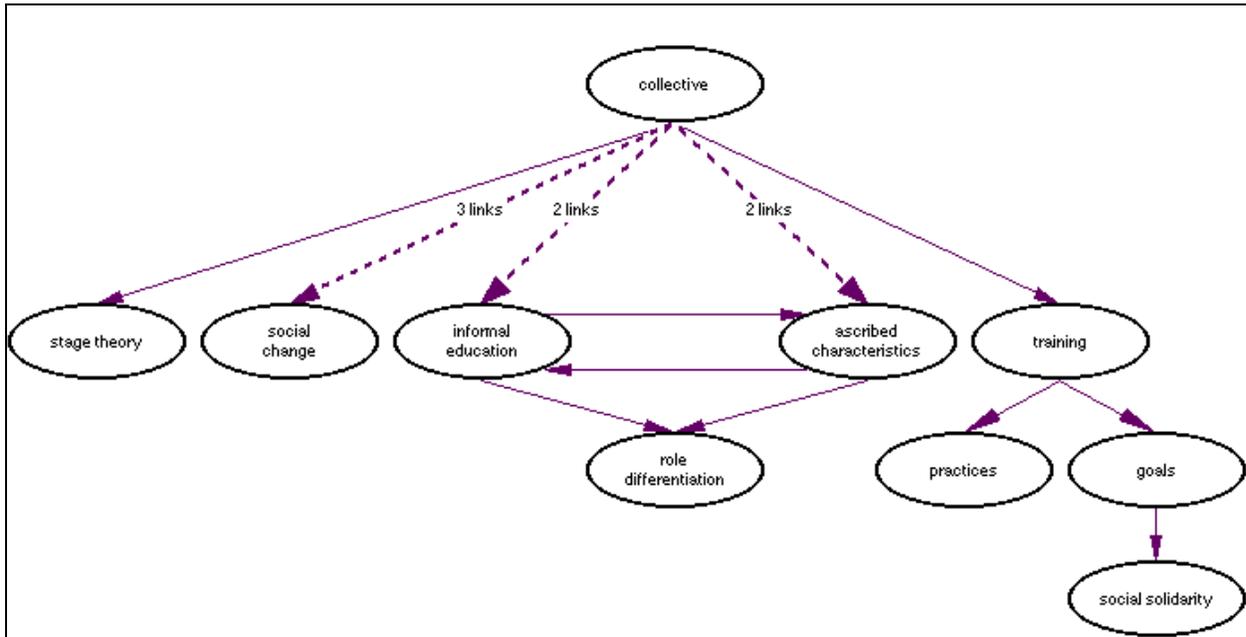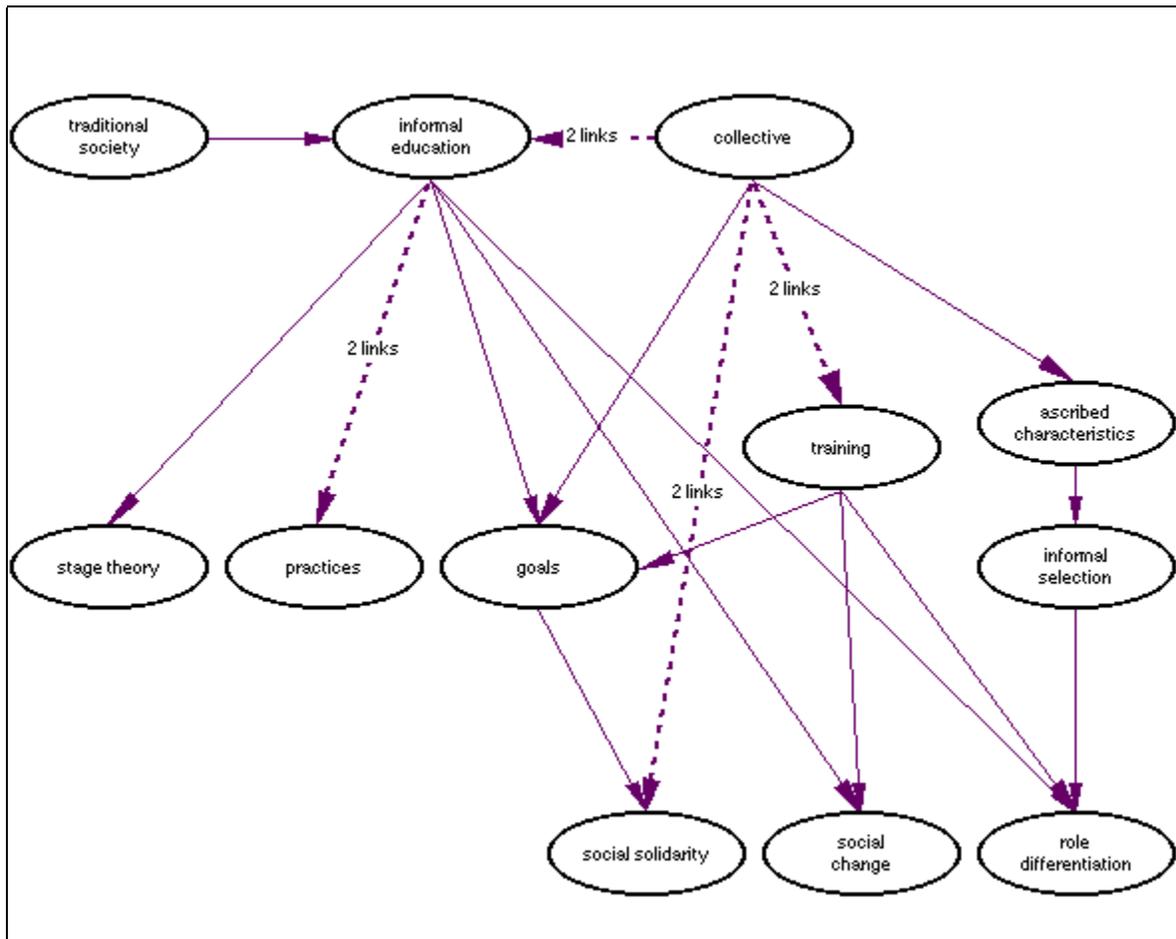
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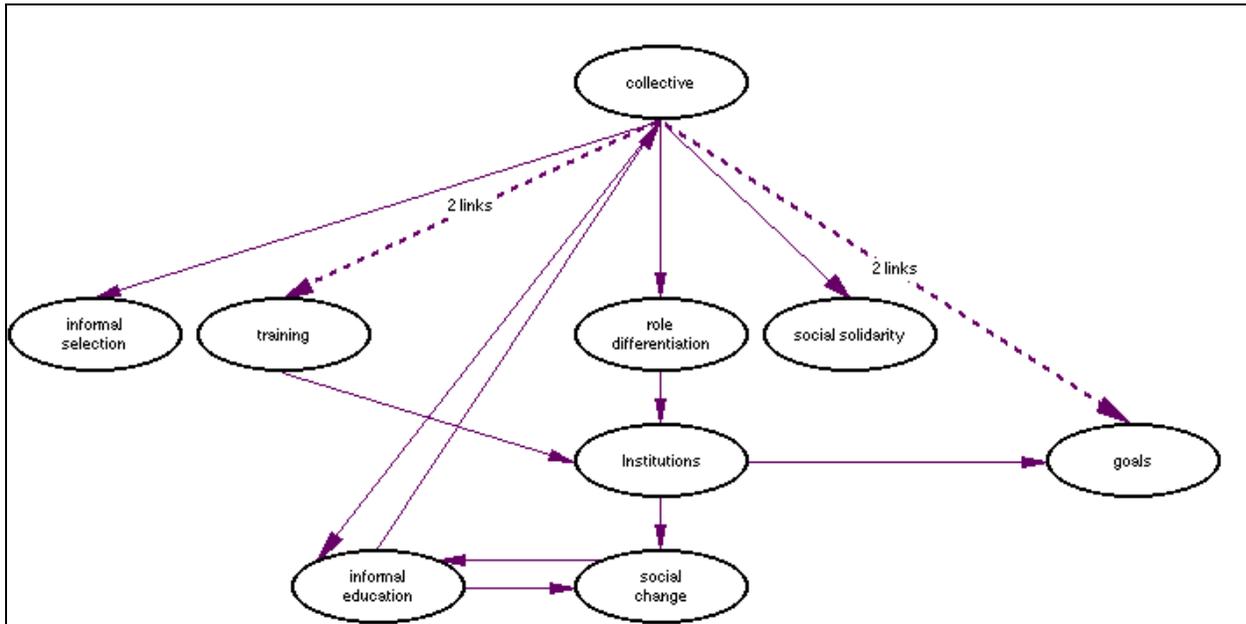
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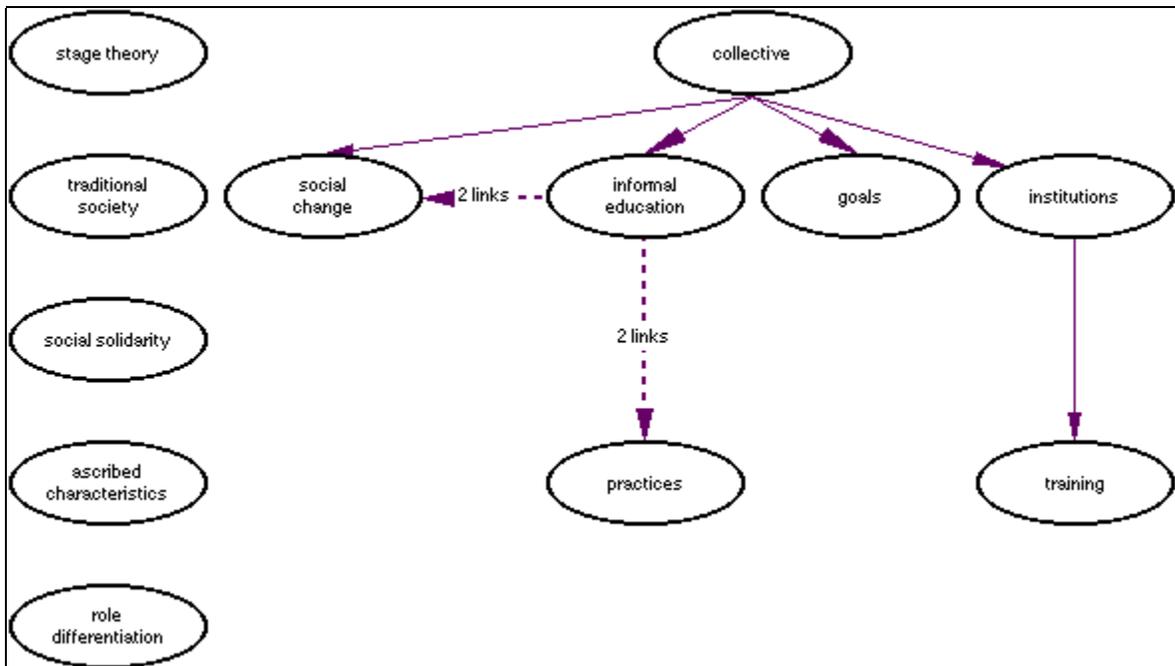
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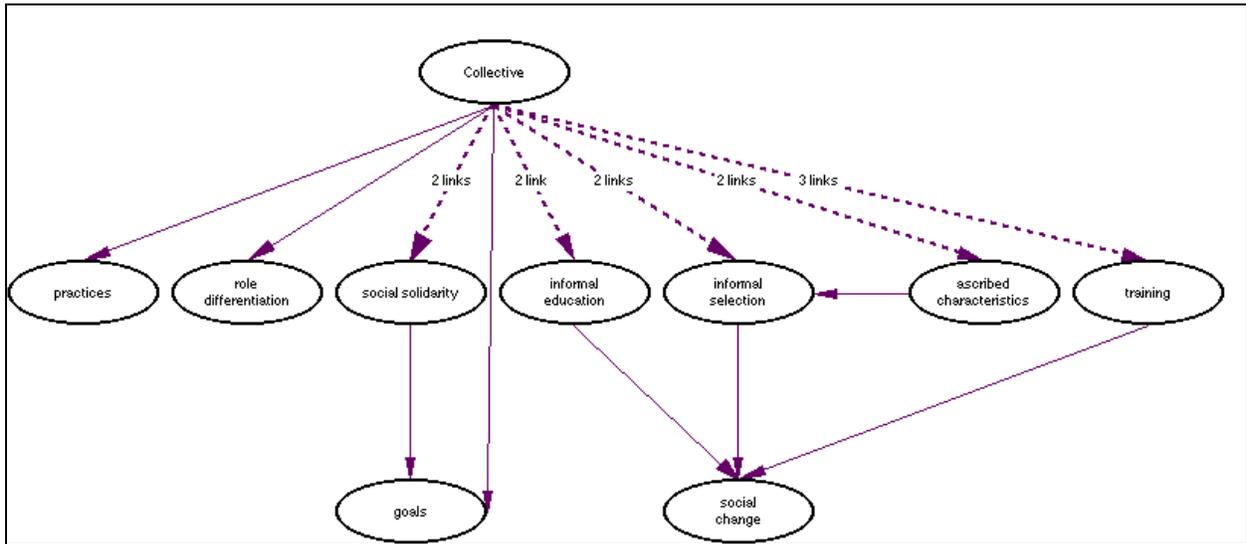
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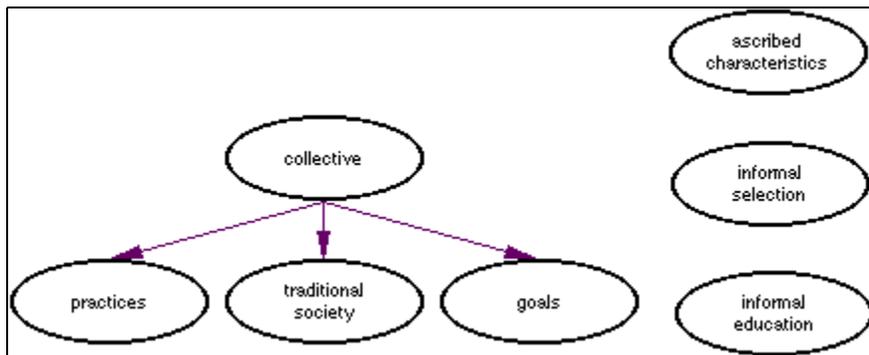
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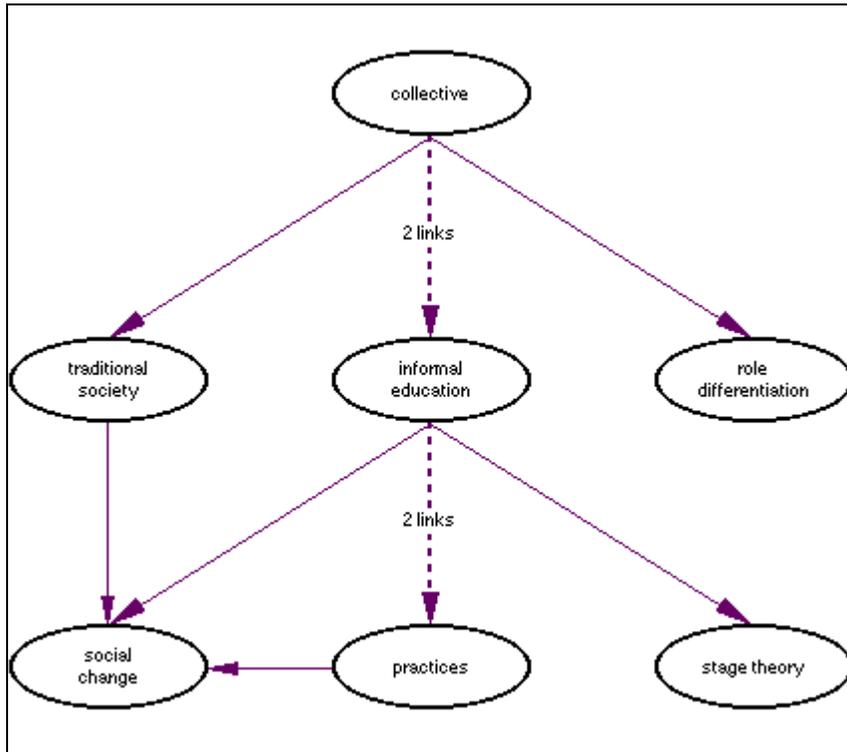
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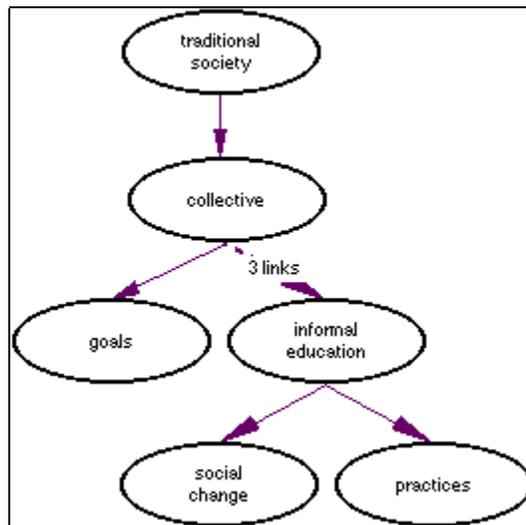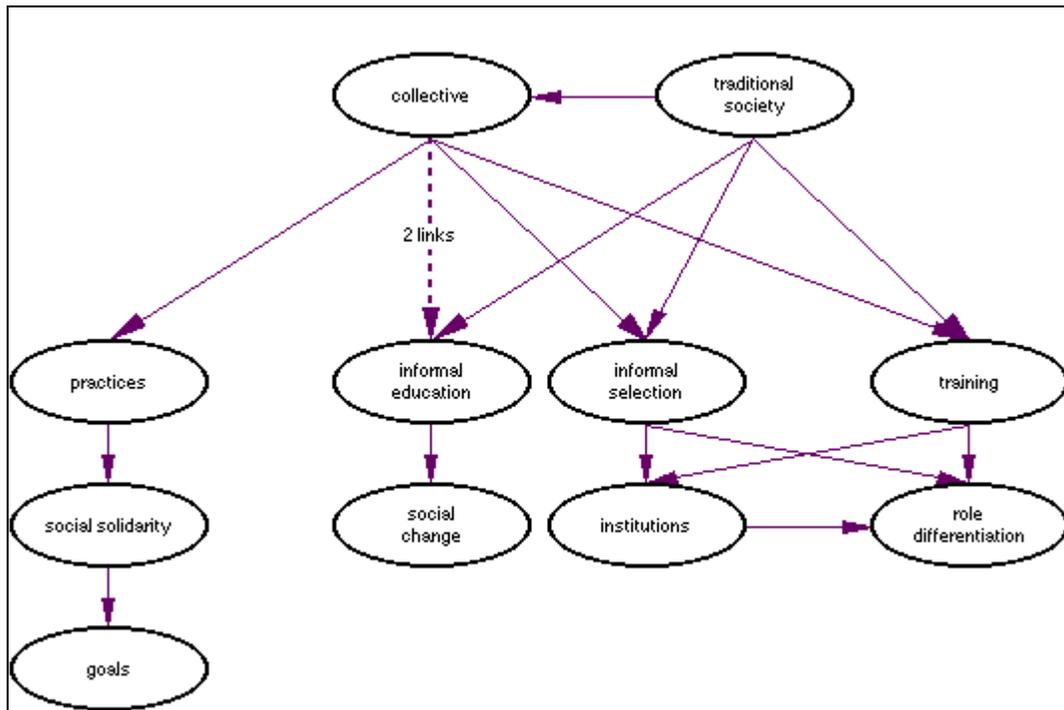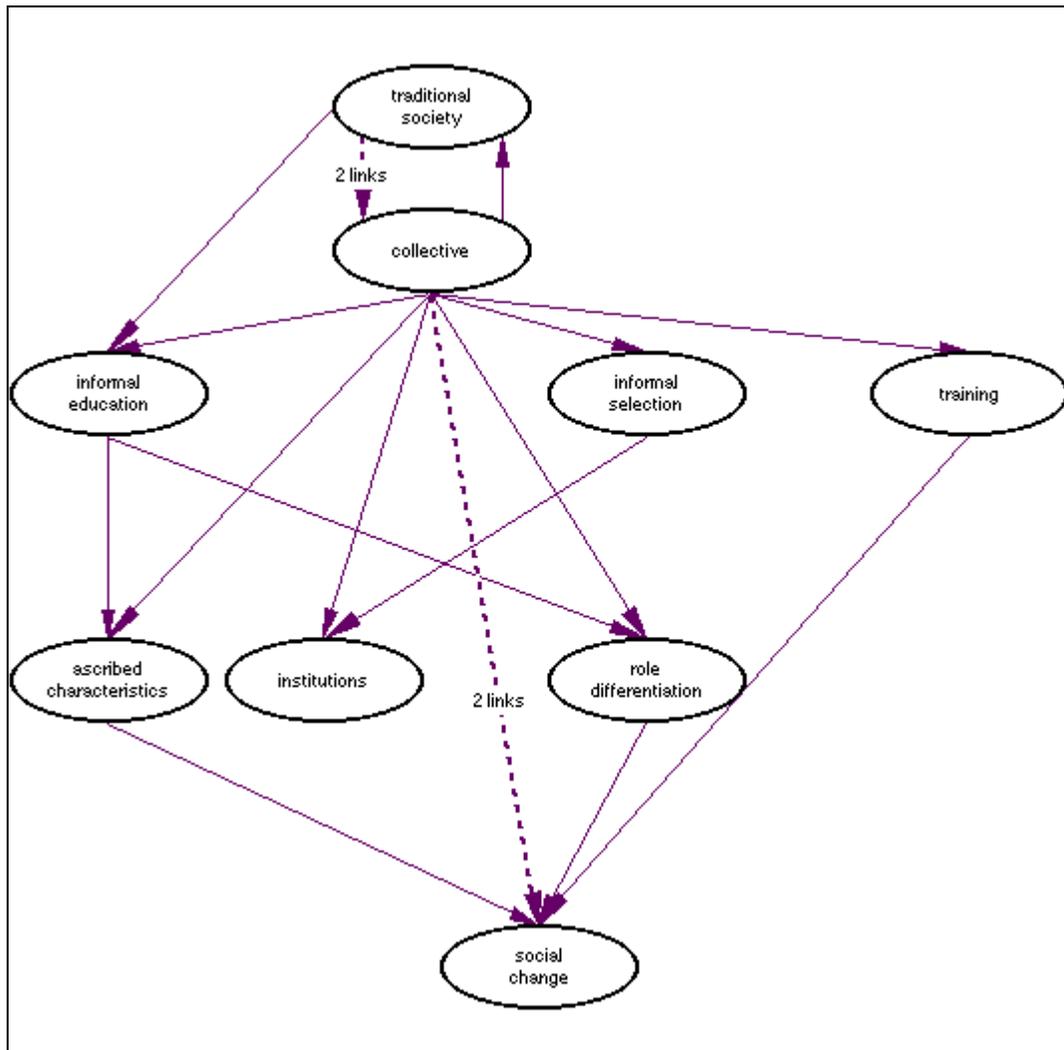
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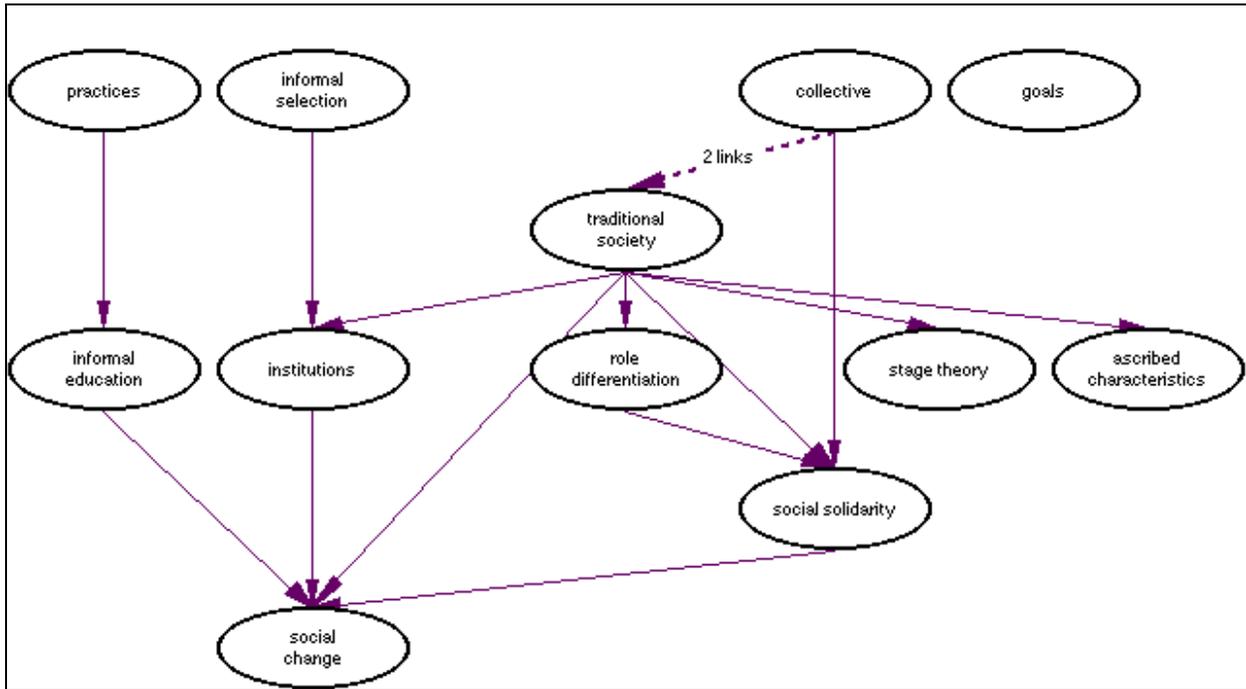
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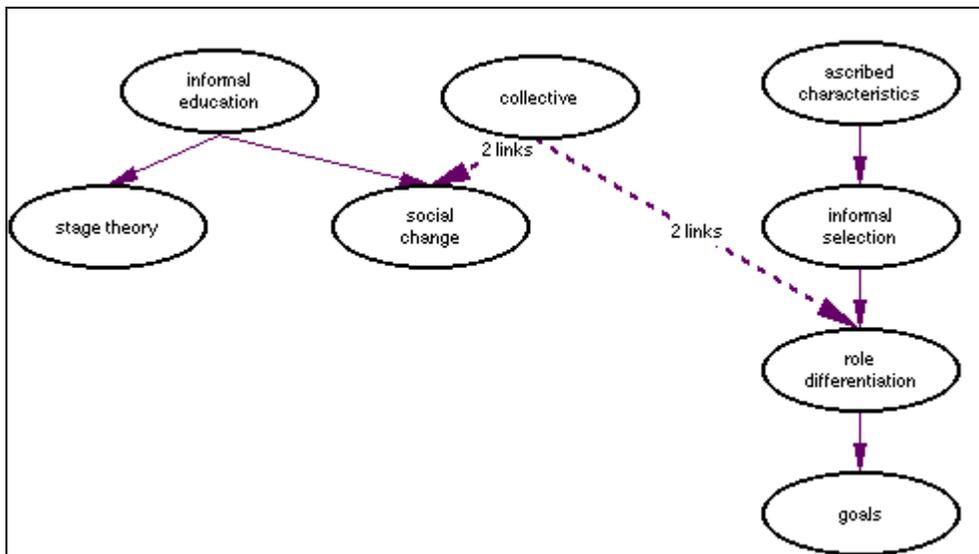
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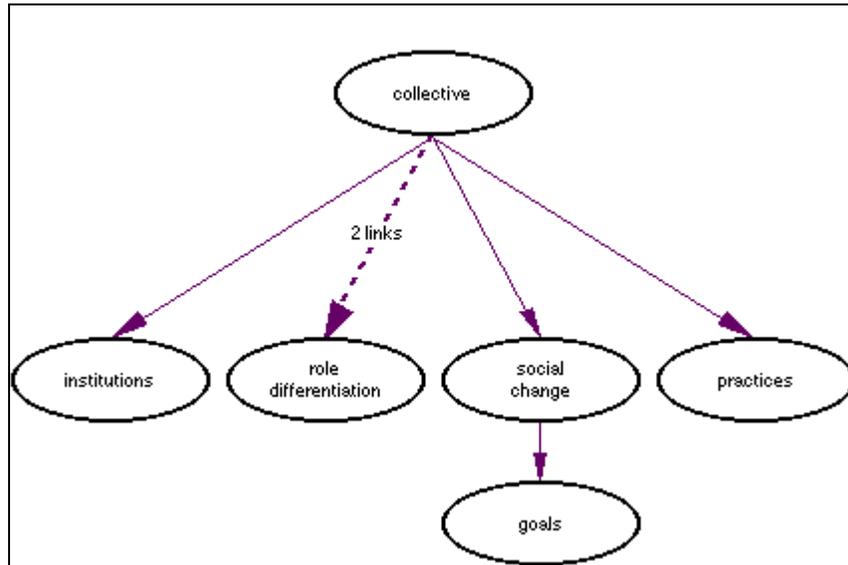
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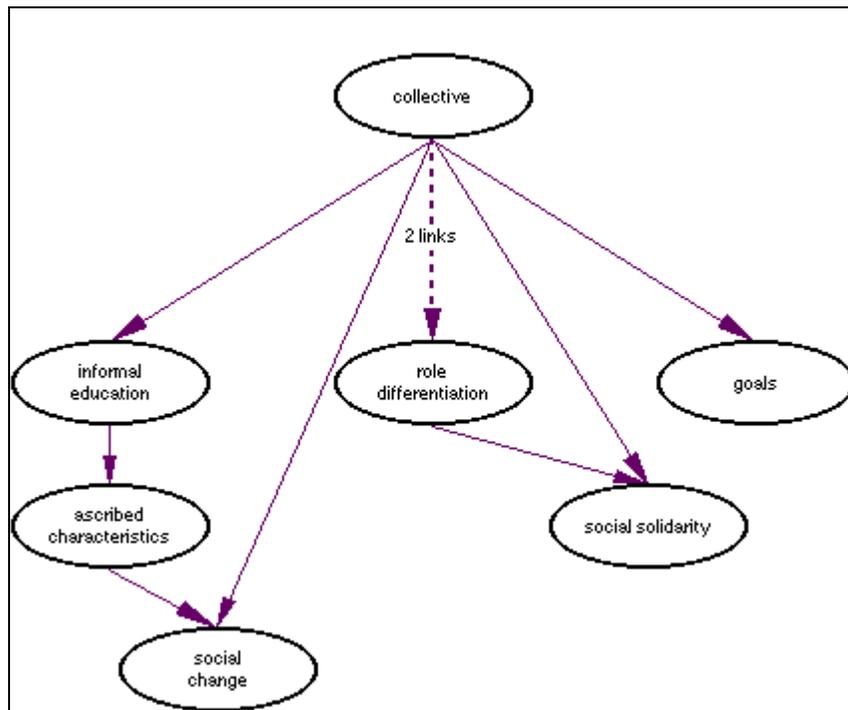
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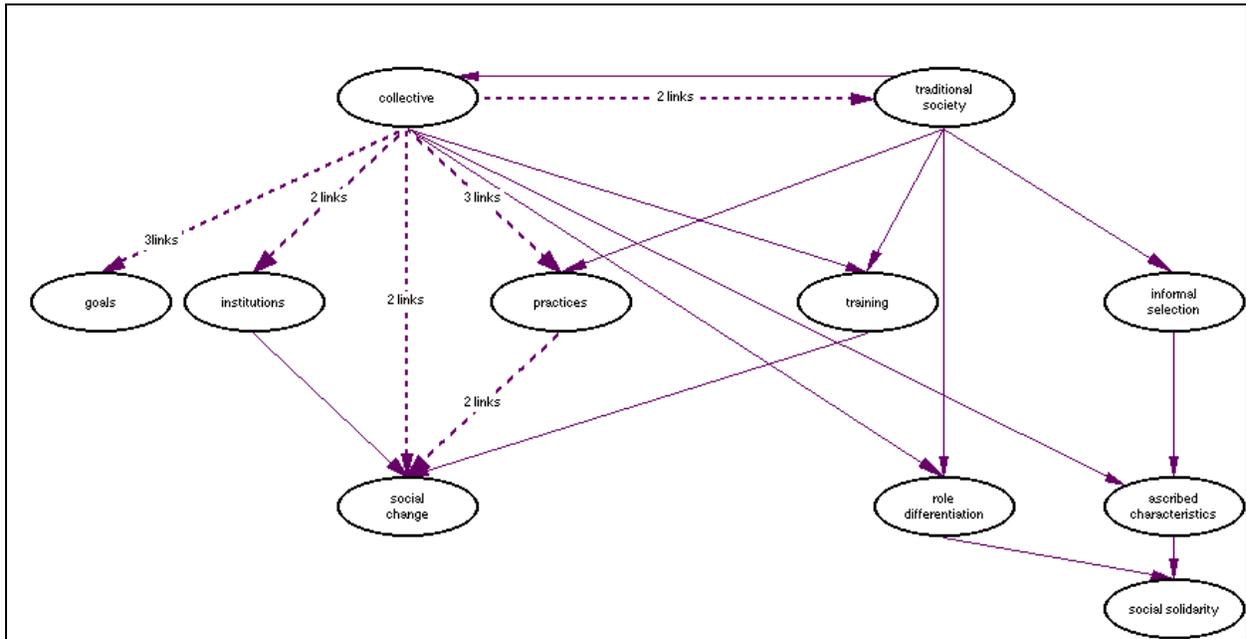
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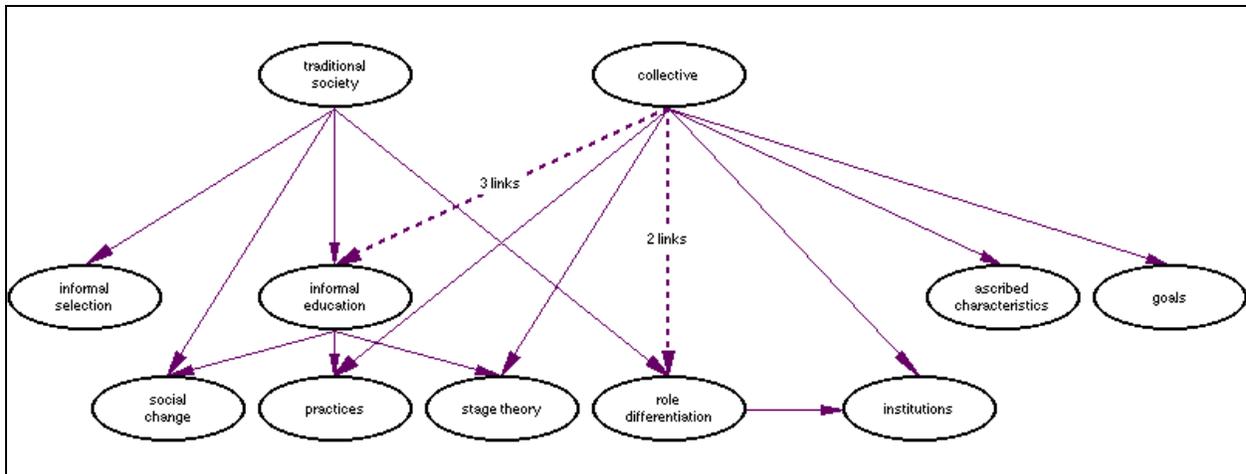
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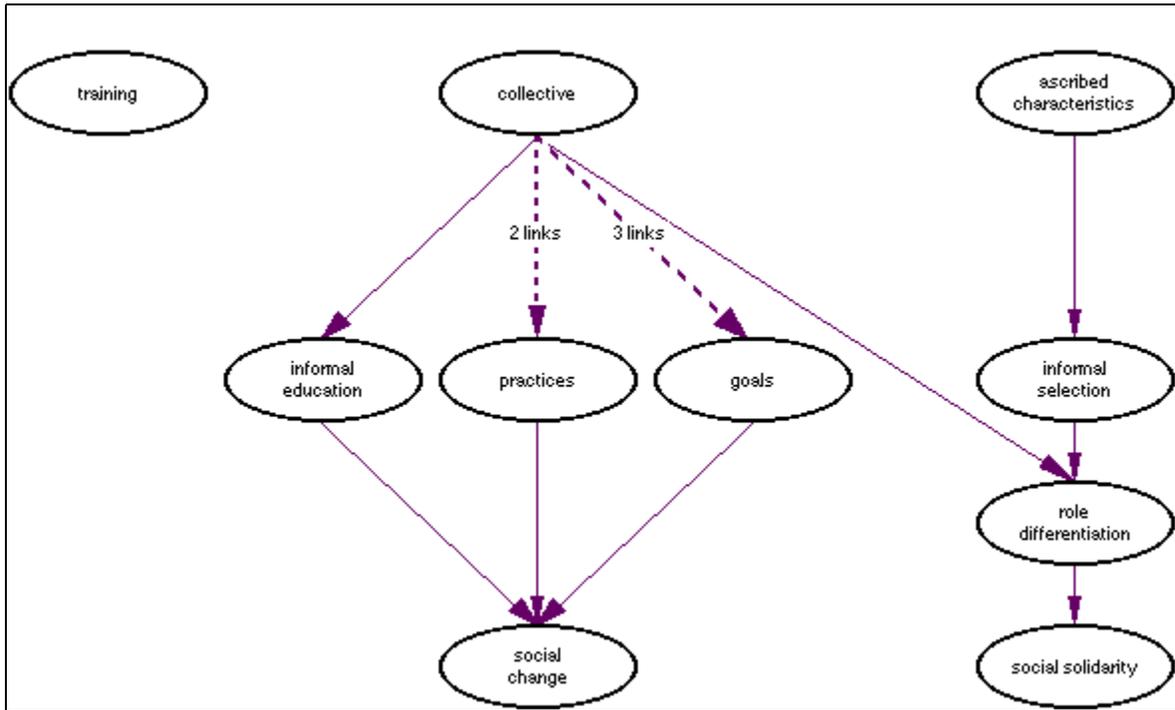
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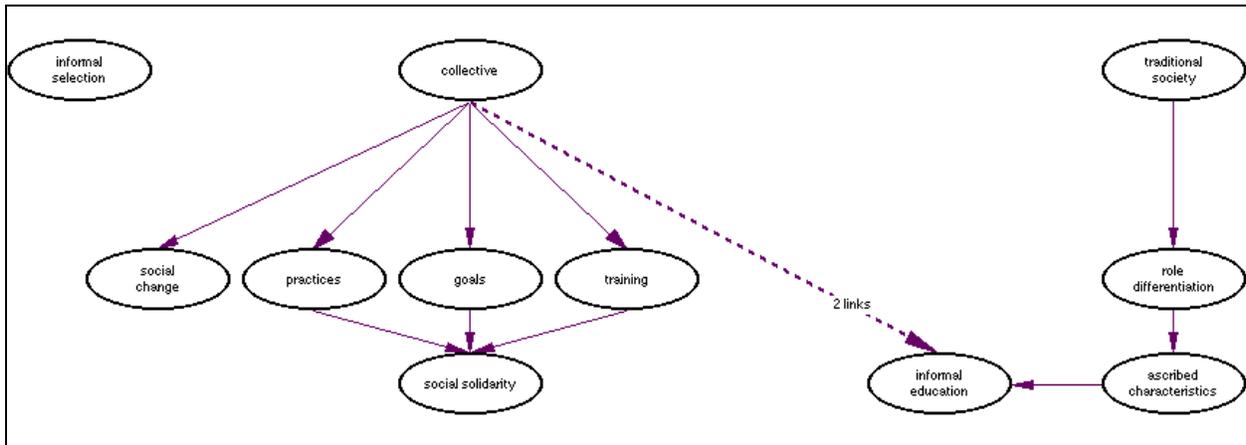
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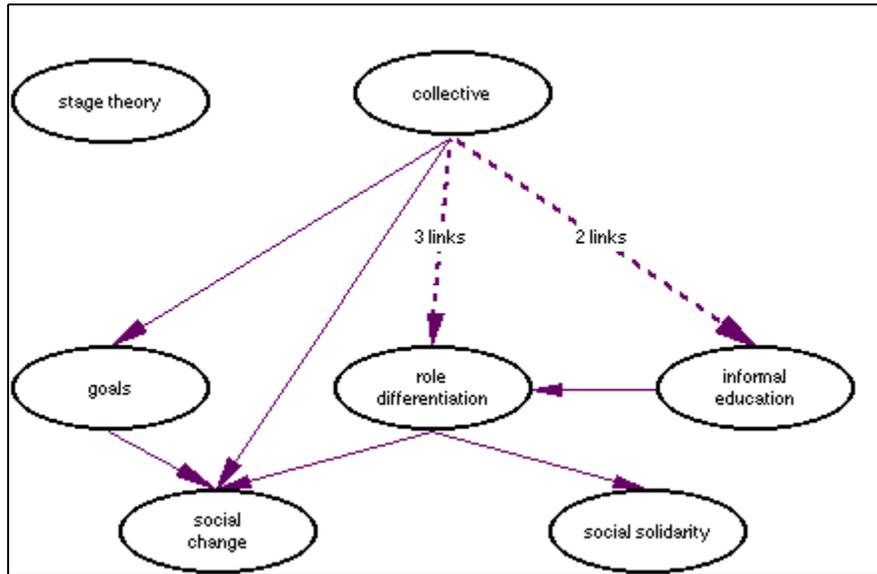
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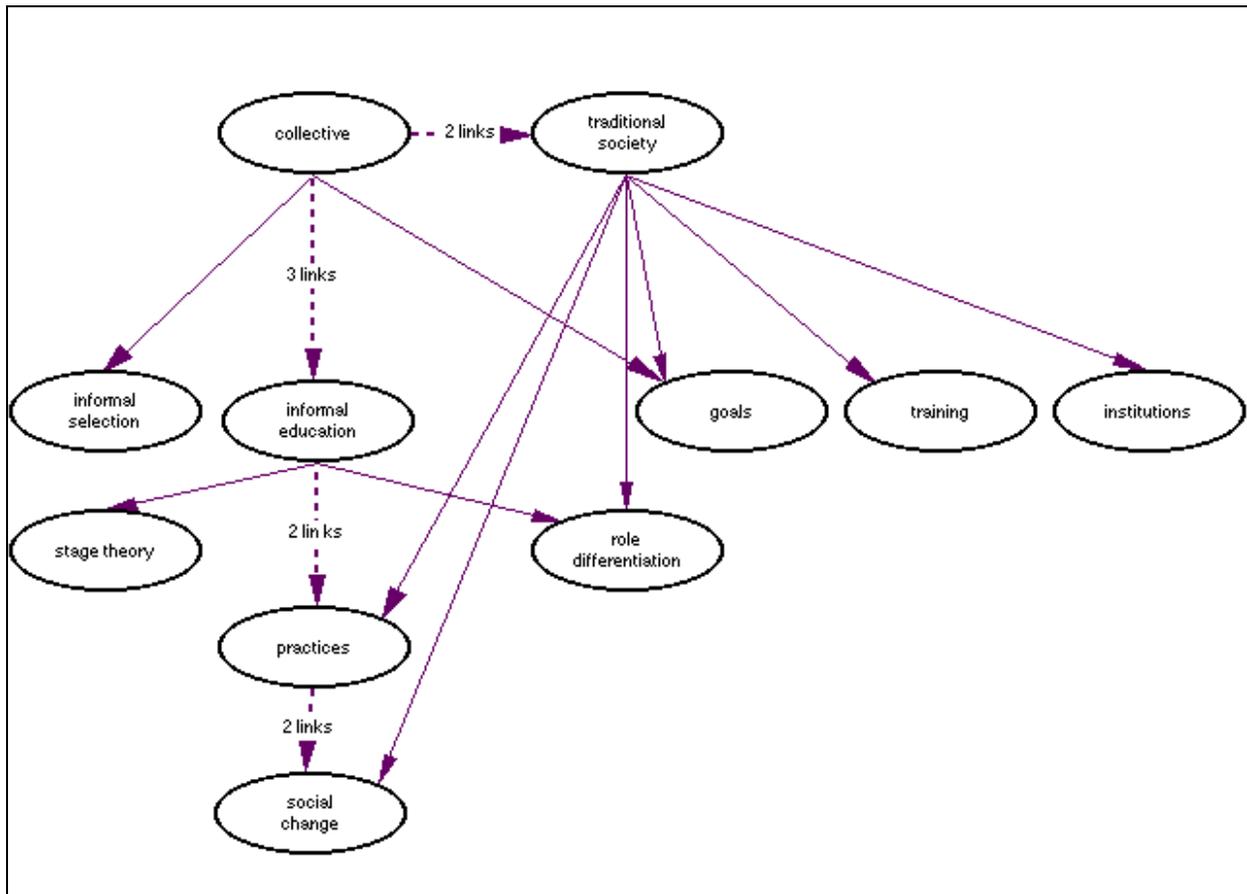
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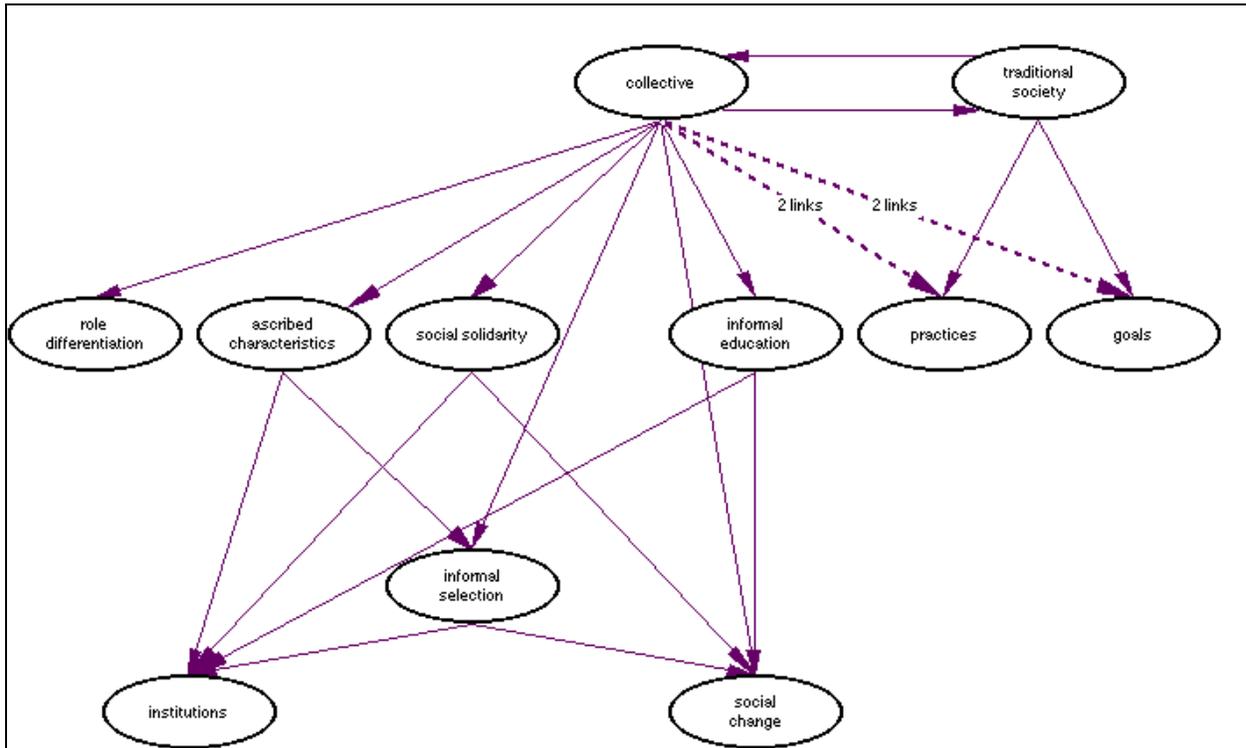
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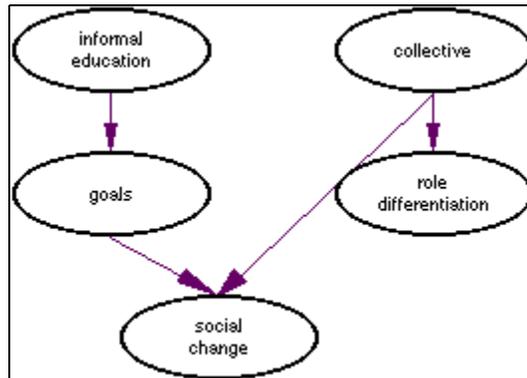
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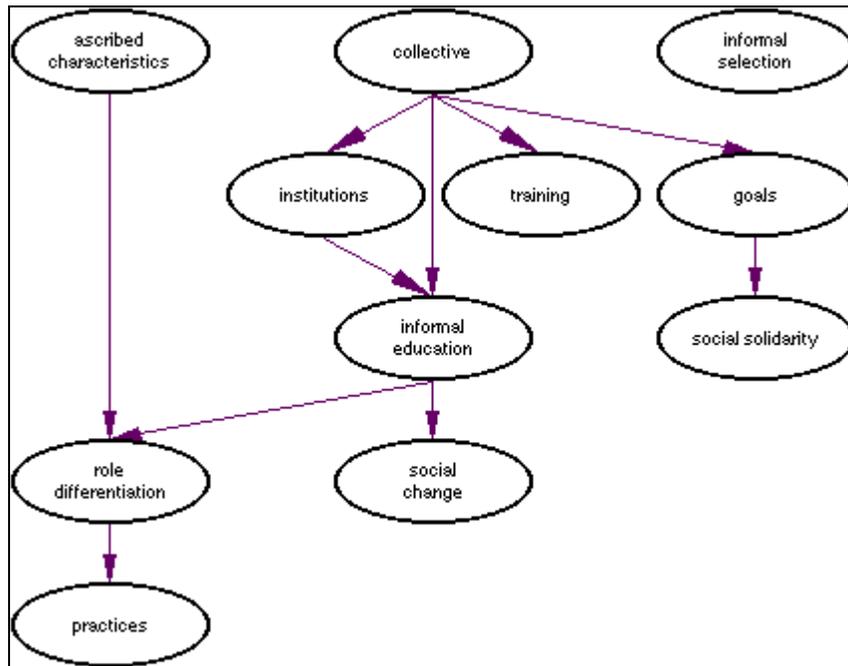
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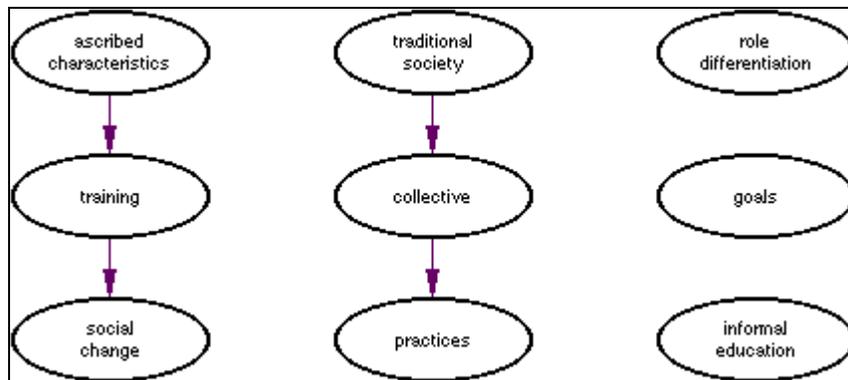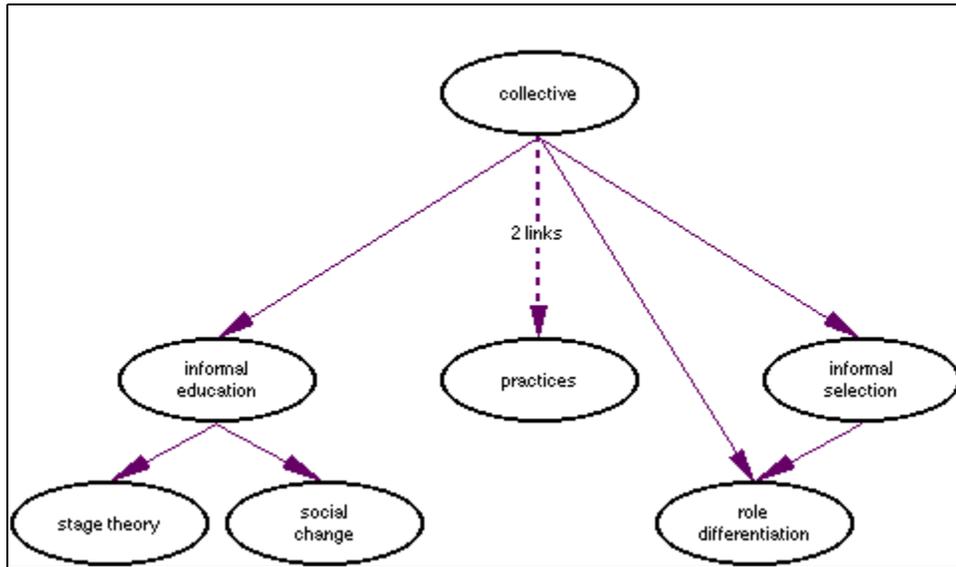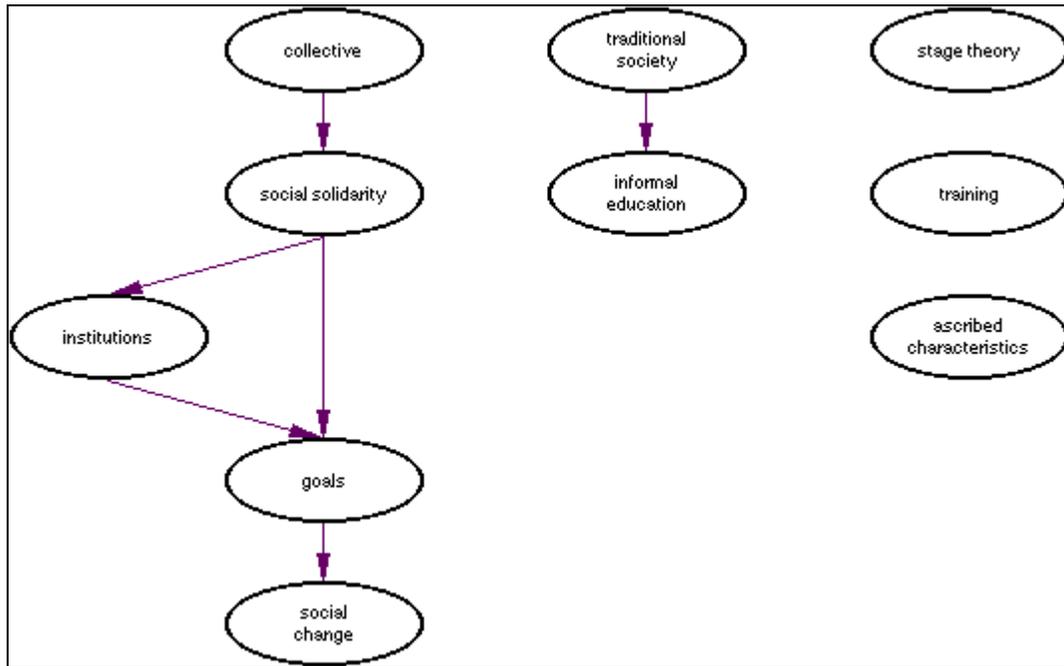
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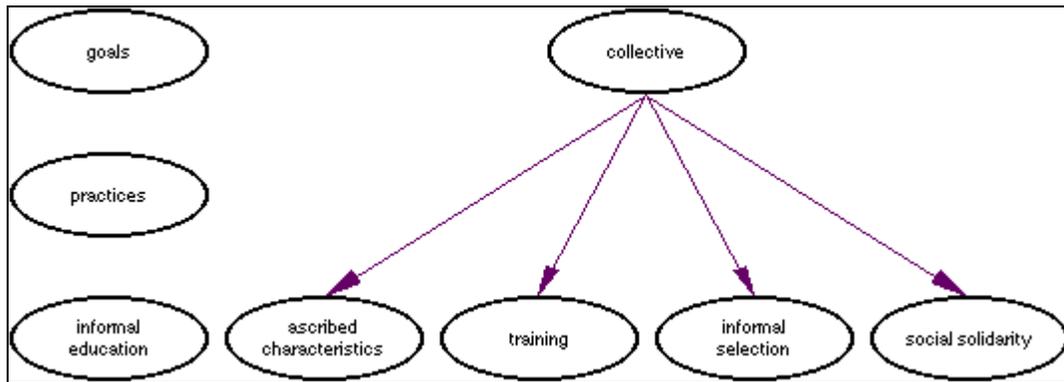

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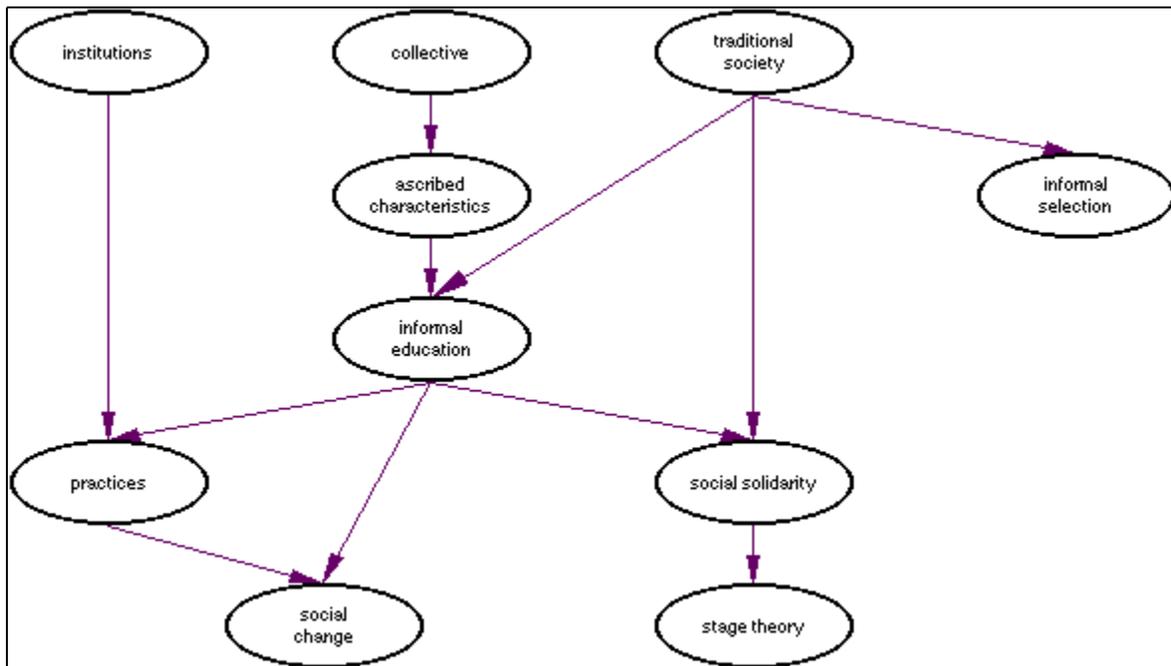
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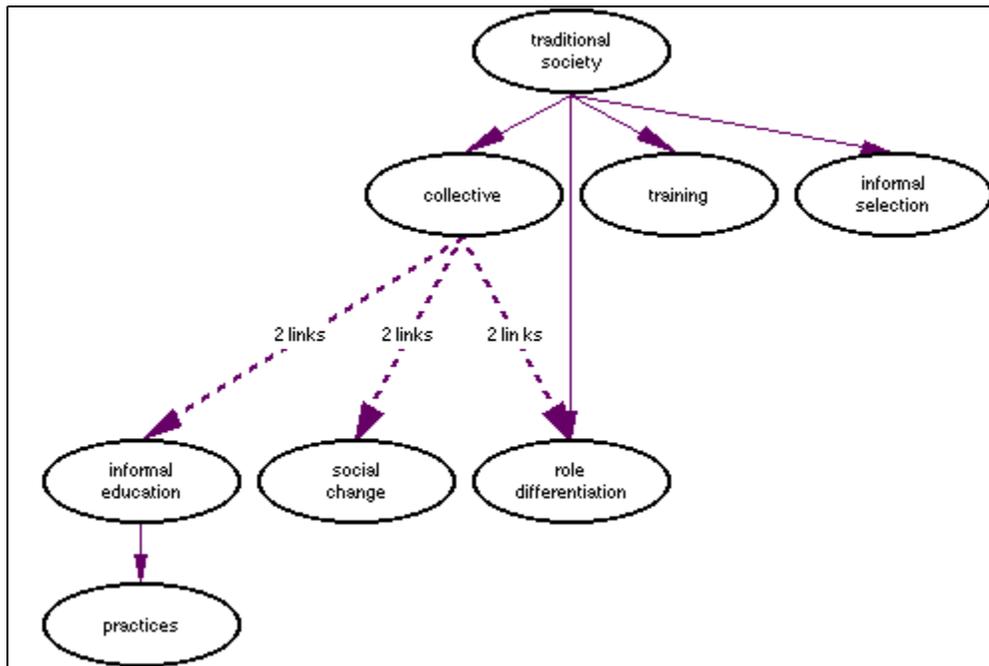


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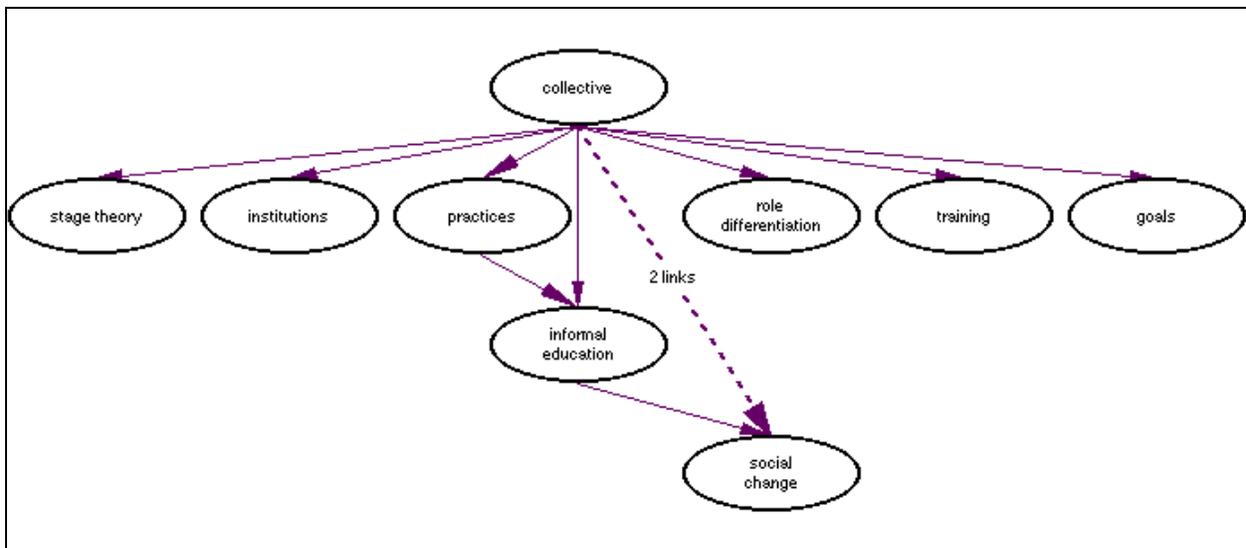
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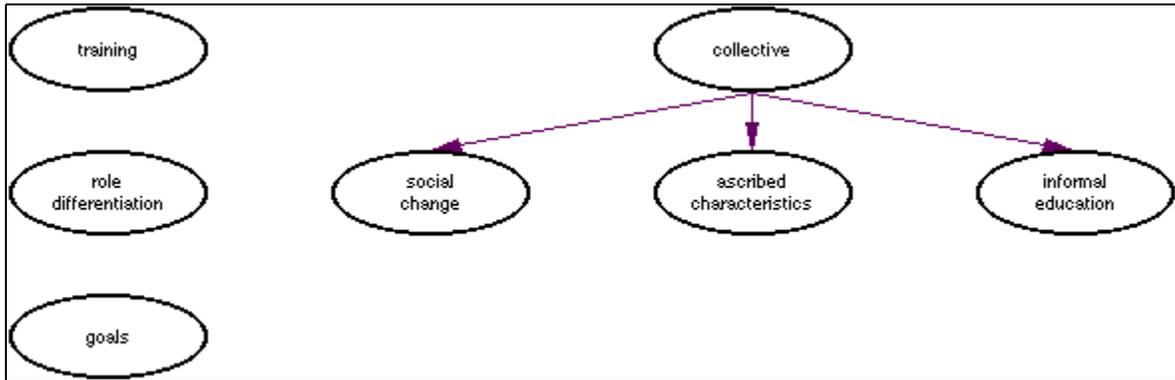
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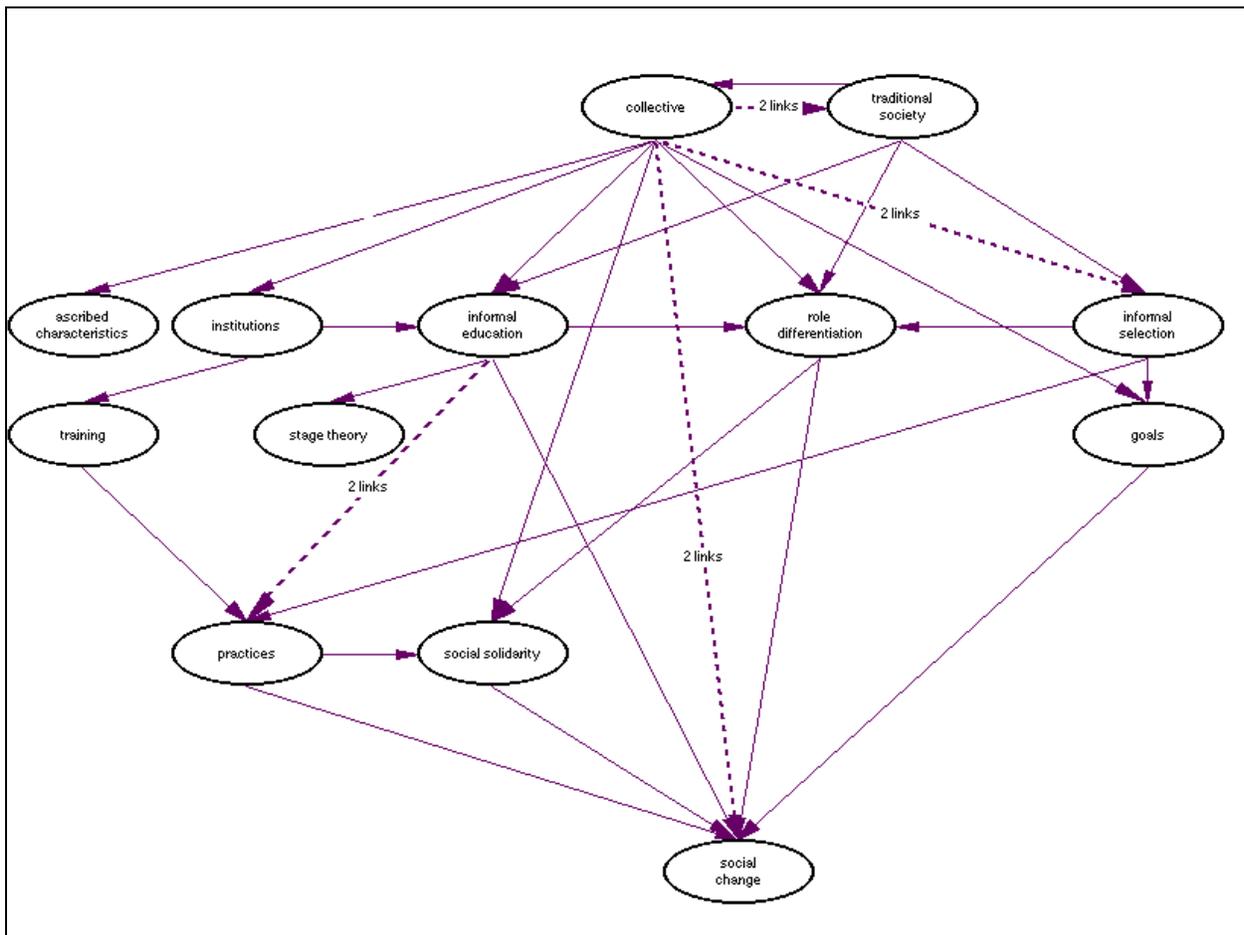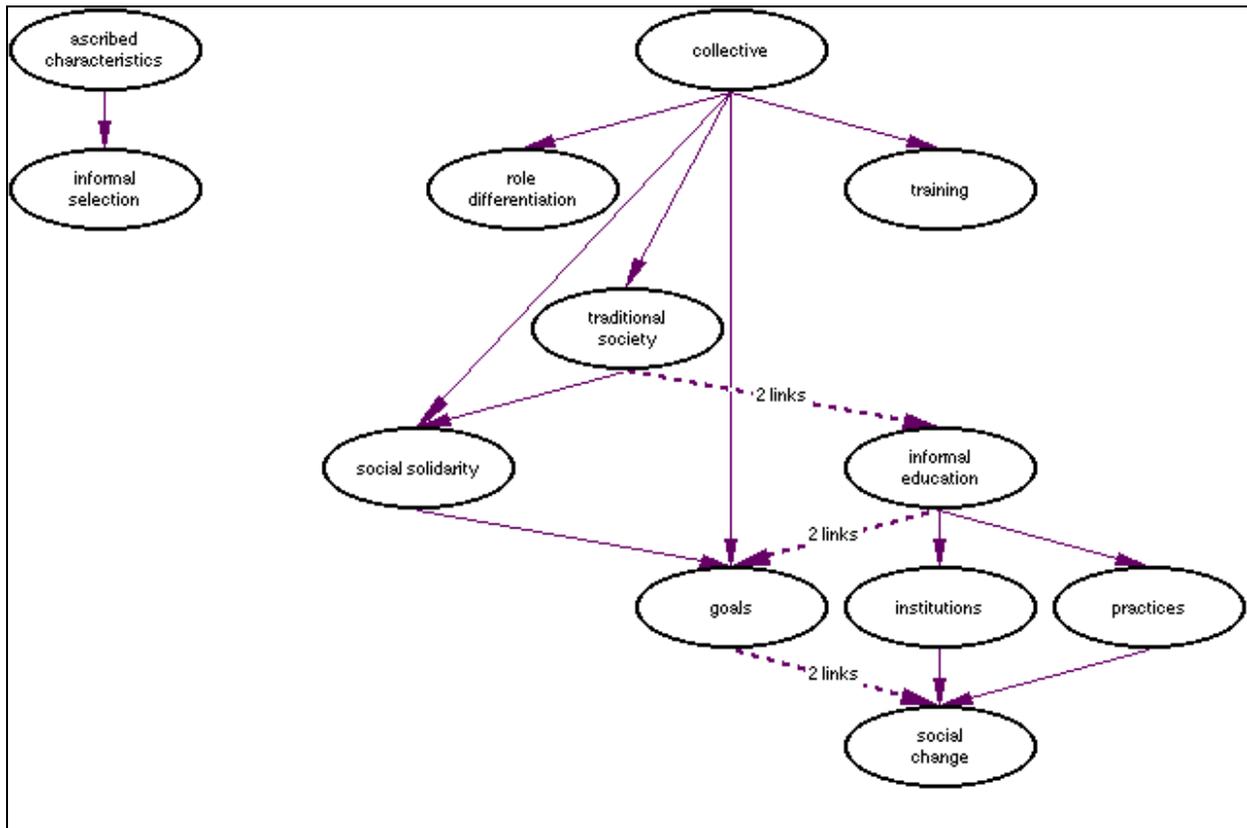
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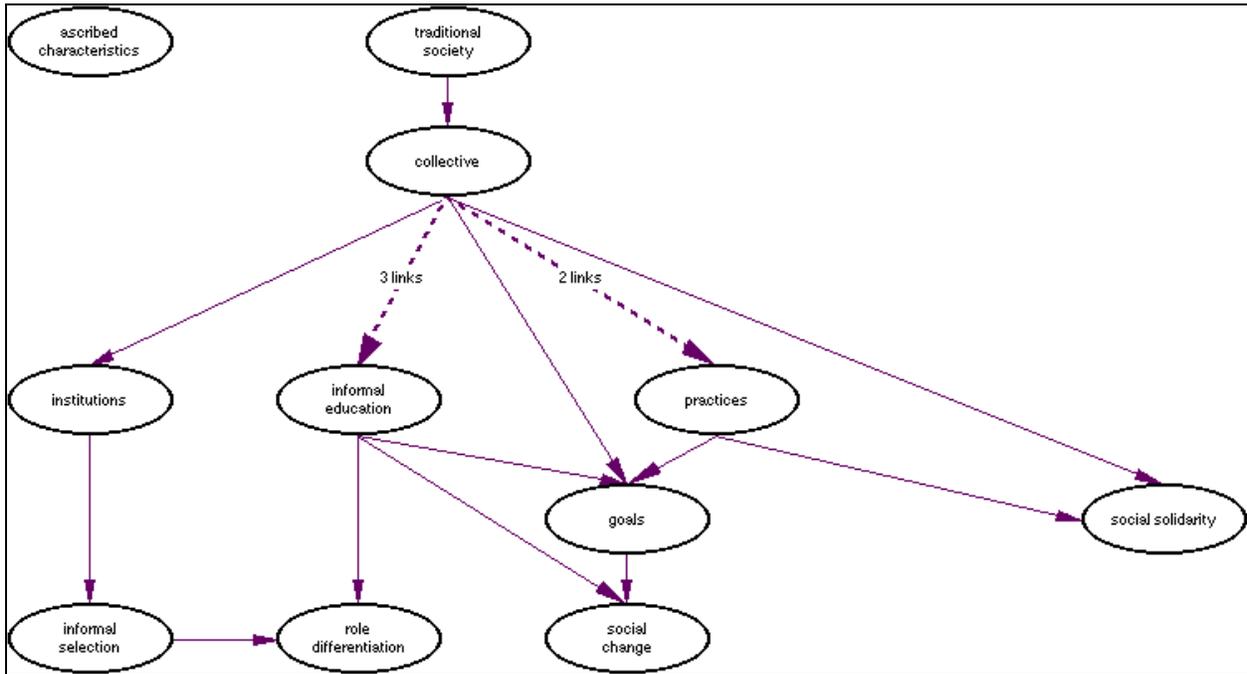
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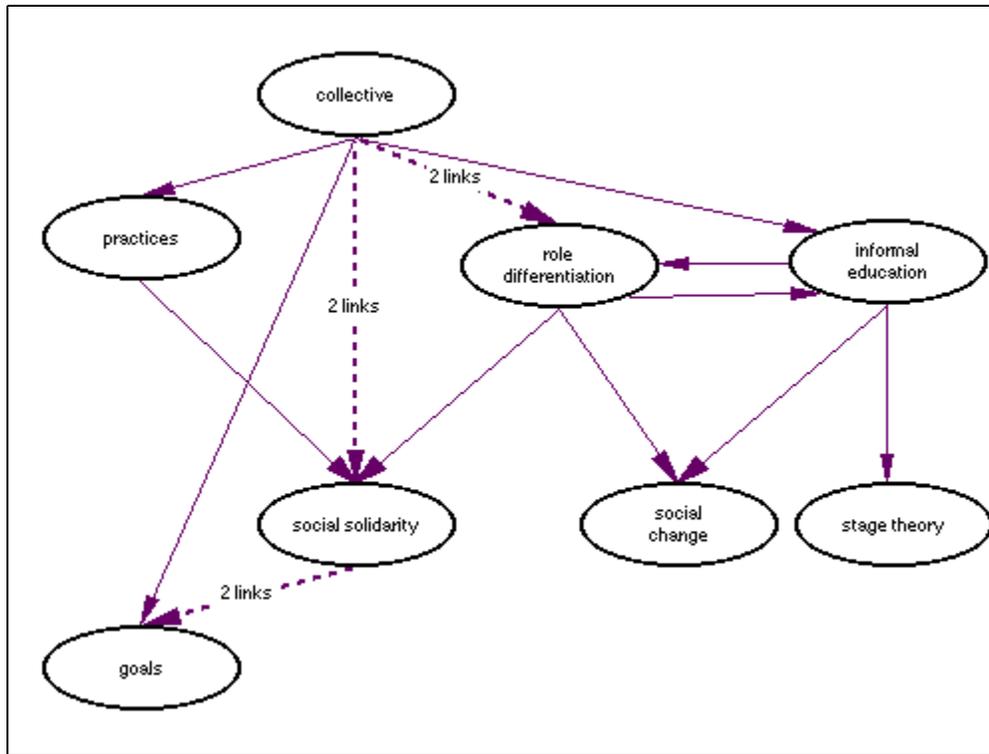
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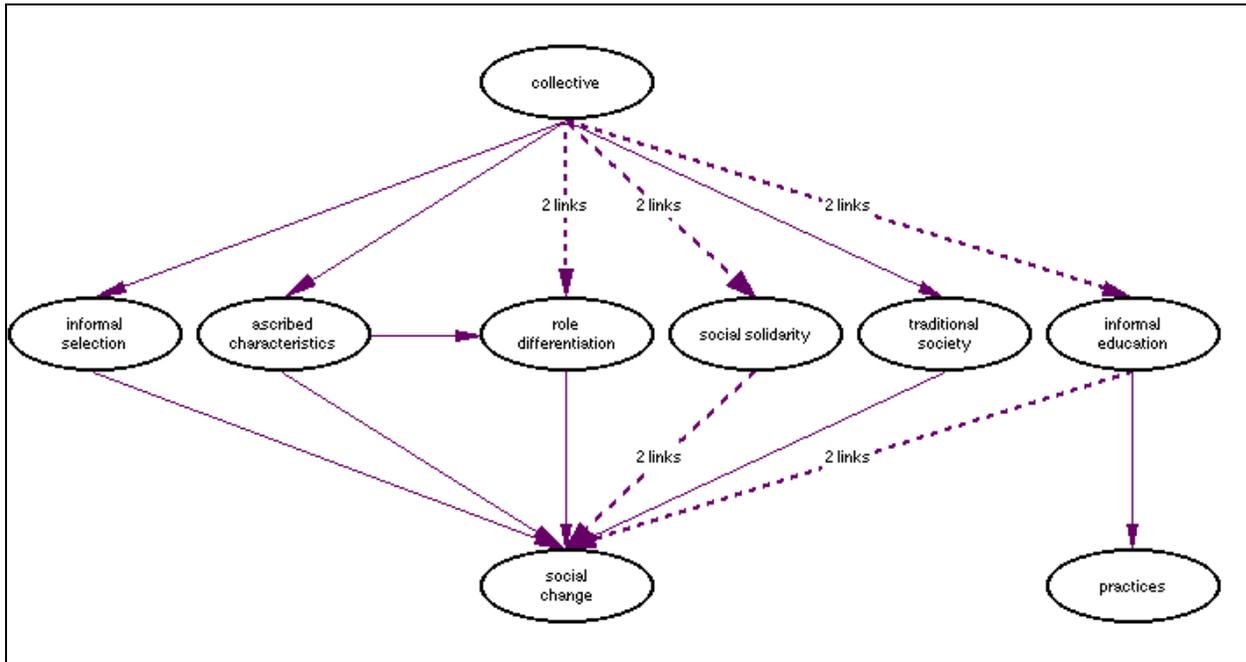
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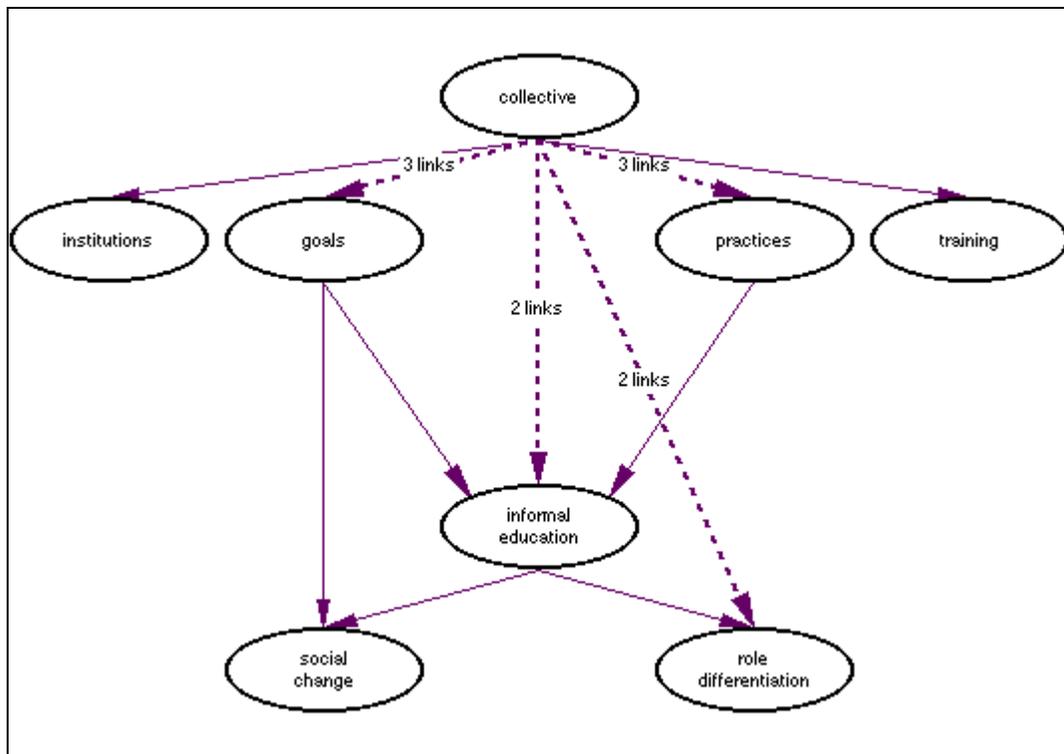
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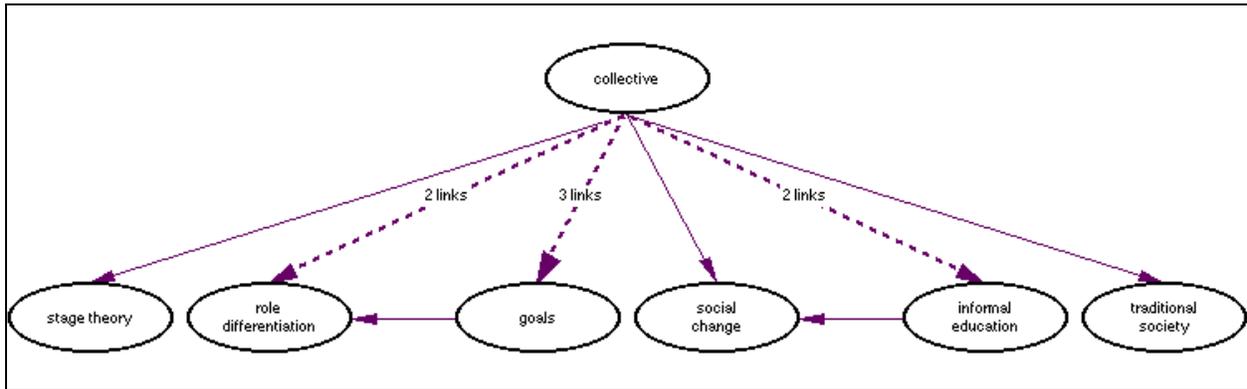
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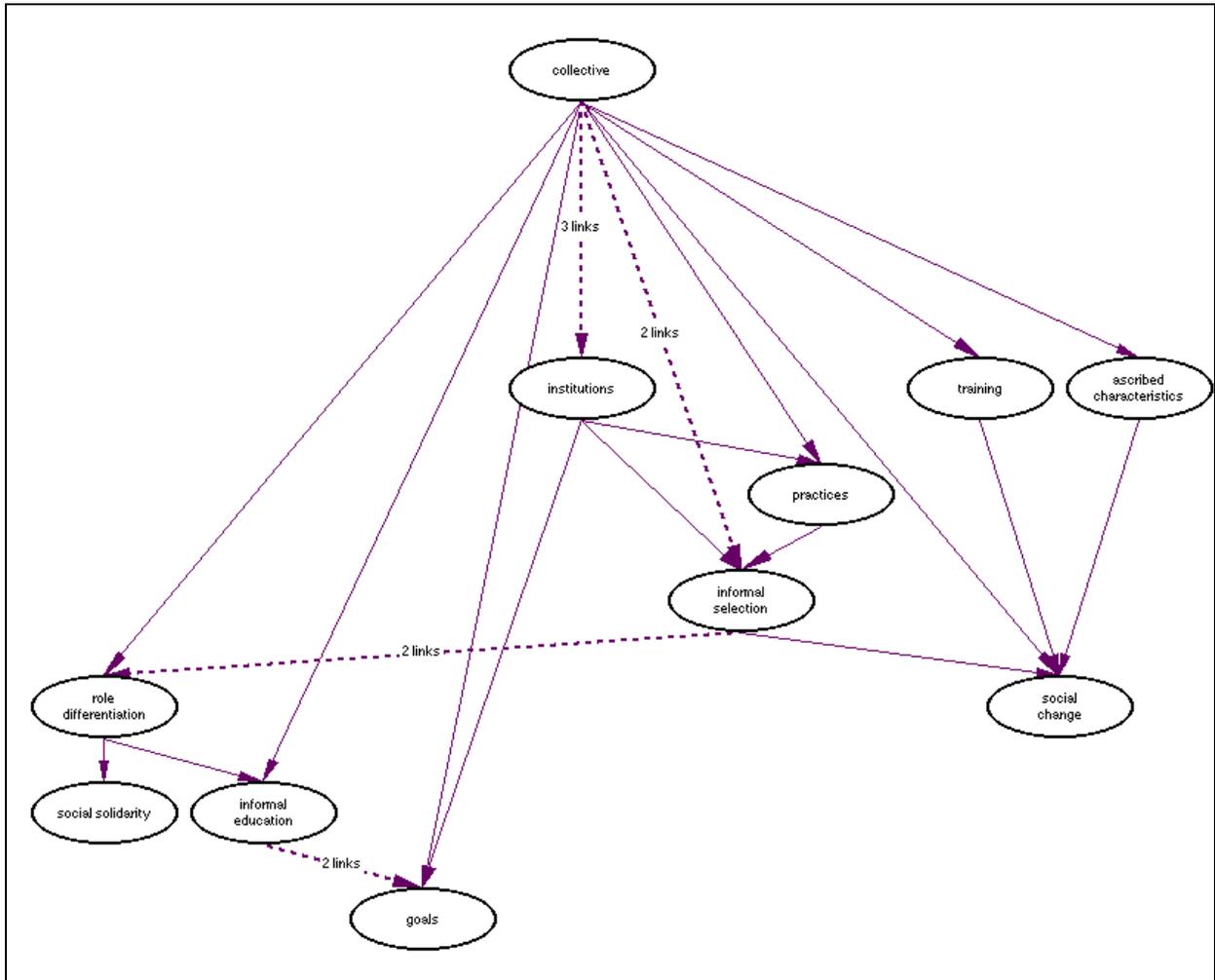
Participant 165

no data turned in

Appendix E: Table of Ordered Concept Map Scores with Participant ID Numbers

ID	Interface	Concept Map Score*	ID	Interface	Concept Map Score*
145	Metaphor-Based	14	149	Metaphor-Based	57
125	Metaphor-Based	15	138	Concept Map	64
152	Concept Map	15	163	Metaphor-Based	65
101	Metaphor-Based	16	113	Metaphor-Based	70
148	Concept Map	18	122	Concept Map	71
143	Metaphor-Based	22	120	Concept Map	72
132	Concept Map	25	154	Concept Map	75
127	Metaphor-Based	26	128	Concept Map	79
147	Metaphor-Based	27	130	Concept Map	79
106	Concept Map	29	162	Concept Map	84
114	Concept Map	31	156	Concept Map	86
110	Concept Map	41	161	Metaphor-Based	86
115	Metaphor-Based	41	116	Concept Map	88
119	Metaphor-Based	41	108	Concept Map	89
144	Concept Map	42	121	Metaphor-Based	90
146	Concept Map	42	129	Metaphor-Based	90
104	Concept Map	43	141	Metaphor-Based	93
118	Concept Map	43	137	Metaphor-Based	94
105	Metaphor-Based	44	155	Metaphor-Based	94
123	Metaphor-Based	45	124	Concept Map	95
133	Metaphor-Based	45	111	Metaphor-Based	103
103	Metaphor-Based	46	142	Concept Map	103
131	Metaphor-Based	46	112	Concept Map	107
126	Concept Map	48	102	Concept Map	108
150	Concept Map	48	109	Metaphor-Based	110
151	Metaphor-Based	49	164	Concept Map	128
139	Metaphor-Based	50	134	Concept Map	133
107	Metaphor-Based	56	153	Metaphor-Based	162
140	Concept Map	56	165	Metaphor-Based	Not submitted

Note: *Concept Map Score is the Final, weighted concept map score, the sum of the subscores: node + level + branch (X2) + cross-link (X4).

Participants were assigned to either the concept map interface or metaphor-based interface conditions. Scores in the table are arranged from lowest to highest, in two columns. The lowest score was 14 and the highest 162.

Each participant ID number is hyperlinked to that participant's protocol responses to the assessment probes. Each participant's concept map score is linked to that participant's concept map.

Appendix F: Photo Credits

1. Polycladida - Belly transparent flatworm. Bill Rudman.

http://www.rzuser.uni-heidelberg.de/~bu6/f_parapl.jpg

2. Blue faced angel fish. Animal World.

http://exotictropicals.com/encyclo/marine/angels/blue.htm

3. Dragonfly, coral, jelly fish, fern pine tree, velociraptor, pond turtle, diatom, protozoa,

sponge. Encarta Online. ©2002 Microsoft Corporation.

4. Ciona intestinalis - Flatworm food. Frank Emil Moen.

http://www.marinbi.com/ascidiacea/ciona_intestinalis1.jpg

5. Polycladida - Flesh colored flatworm. Peter Wirtz.

http://www.rzuser.uni-heidelberg.de/~bu6/index.html

6. Nine planets. NASA. http://www.nineplanets.org/gif/Nineplanets460.jpg

7. Polycladida - Orange and blue flatworm. Wolfgang Seifarth.

http://www.rzuser.uni-heidelberg.de/~bu6/index.html

8. Polycladida - Transparently skinned planarian (back). Mike Miller.

http://www.rzuser.uni-heidelberg.de/~bu6/index.html

9. Polycladida - White ribbon flatworm. Wolfgang Seifarth.

http://www.rzuser.uni-heidelberg.de/~bu6/index.html

10. Polycladida - White ribbon flatworm. Wolfgang Seifarth.

http://www.rzuser.uni-heidelberg.de/~bu6/index.html

DEBBIE DENISE REESE

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Riner, VA 24149
Voice: 540-381-5188 Email: debbie@vt.edu

CAREER OBJECTIVE

Faculty/research tenure track position in Learning Sciences combining cognition, sociology, instructional design, interface design, educational systems development, educational reform and structural equation modeling. Research concentrations center about performance improvement through (a) computer-mediated delivery of complex conceptual content, (b) education reform using Internet technologies to enhance awareness and quality of collective norms and informal social control at the neighborhood and community level, and (c) mental modeling as a computer-mediated methodology for assessment, reflection and self-regulation.

EDUCATION

- **Virginia Polytechnic Institute and State University (1998-2003: defended March 21, 2003)**
  Ph. D. in Education, Curriculum, and Instruction: Instructional Technology
  Cognates in Educational Research and Cognition
  Dissertation: *Metaphor and Content: An Embodied Paradigm for Learning*
  Committee members: John K. Burton (Chair), John M. Carroll, Peter Doolittle, Glen Holmes, Kusum Singh
  GPA 4.0
- **Western Illinois University (1996-1998)**
  Master of Science - Instructional Technology and Telecommunications.
  Thesis: *Interdisciplinary, Cognitive and Affective Connections through Visual Tools Adapted to Interactive Multimedia*
  Additional concentration of coursework in cognition and statistics. GPA 4.0
- **University of Iowa (1993, 1994)**
  coursework at the Blank/Belin Center for Talented and Gifted Children
- **Drake University (1992, 1993)**
  coursework in meeting the needs of special populations
- **Iowa State University (1981-1988)**
  128 semester credit hours in physics, mathematics, creative writing, music, and modern dance
- **University of Nevada at Las Vegas (1972-1975)**
  B.S. Education, with Distinction
- **State University of New York at Stony Brook (1971-1972)**

EXPERIENCE

- **2002 - present** – Graduate Research Assistant, Center for Human-Computer Interaction, Virginia Polytechnic Institute and State University. Statistical analysis of EPIC study longitudinal survey data.

- **2001 - 2002** – Instructor (as graduate assistant), Instructional Technology Department of Teaching and Learning, Virginia Polytechnic Institute and State University: three sections of two graduate level, year-long, instructional technology courses for preservice teachers; designed and delivered courses.
- **2001 - 2001** – Research Assistant – Educational Policy and Leadership Studies, Virginia Polytechnic Institute and State University: analysis of the TIMSS data, the effect of student characteristics on science achievement; create database of relevant literature; co-author literature review; prepare and clean data; perform statistical adjustments to account for complex sampling design; hypothesize and validate LISREL structural equation model.
- **1999 - 2001** – Program Coordinator (graduate assistantship) for Instructional Technology master's degree program, Department of Teaching and Learning, Virginia Polytechnic Institute and State University: design and deliver web-based instruction; design and conduct on-campus educational technology classes; conduct program and course evaluation for research and publication; design, develop, and process web-based forms for data collection; provide electronic support for students; schedule classrooms, cohort site meeting rooms and sessions, and training sessions; liaison between students, faculty, staff, and administration; maintain records of payroll and program development; assist with on-campus technology production classes (digital audio, multimedia authoring and scripting).
- **1998 - 1999** – Graduate Assistantship - HouseCalls, Department of Teaching and Learning, Virginia Polytechnic Institute and State University: computer tech support for faculty
- **1998 - 1999** – Design and Develop Software for Dr. Bem Allen, Professor, psychology Department, Western Illinois University
- **1997 - 1998** – Part-time Instructor, Carl Sandburg College, Center for Agriculture, Business, and Industry, Illinois.
- **1997 - 1998** – Design and Develop Software for Virginia Diehl, Professor, Psychology Department, Western Illinois University
- **1997 - 1998** – Graduate and Teaching Assistantship, Western Illinois University, Department of Instructional Technology and Telecommunications
- **1992-1996** – Teacher: calculus readiness; modern dance; ballet; piano; creative writing; creative dramatics; singing; fitness-Ames, Iowa; Keokuk, Iowa; Summer Program for Talented and Gifted Children, grades 4 - 8, Keokuk and Burlington, Iowa
- **1990 - 1996** – Teacher: 6, 7, 8 Talented and Gifted; Music; Language Arts; Reading-Keokuk Community Schools, Keokuk, Iowa
- **1991 - 1996** – Director, Tri-State Dance Theater, Keokuk, Iowa: budget; director of school and camp programs; fund-raising; graphic design; grant writing; hire and pay talent and technical staff; liaison between local and arts

councils, public, and schools; production manager; publicity; scheduling; student recruitment
- **1990** – Two performances aired on Iowa Public Television: "The Samuel Barber Song Project"
- **1988 - 1990** – Instructor, Octagon Center for the Arts, Ames, Iowa
- **1988 - 1990** – Manager, CoMotion Dance Theater (modern dance company) Ames, Iowa: community and state representative for company within local and state arts organizations; director of volunteer programs; director of scholarship program; director of fund raising, director of grant writing; graphic design; director of marketing; newsletter editor; public appearances (group presentations, radio, television); director of publicity; scheduling
- **1989 - 1990** – Poetry commissions: Iowa State Dance Department; South Dakota State University Dance Department
- **1988 - 1991** – Performance Artist - singer, poet, dance educator - Iowa Arts Council, Arts and Recreation Council of Greater Des Moines; Des Moines Art Center; University of Northern Iowa; CoMotion Dance Theater; Central Iowa Symphony; Jazz in July
- **1982 - 1988** – stay-at-home mom and student at Iowa State
- **1981 - 1982** – Dispatcher - Green County Sheriff's Department, Jefferson, IA
- **1975 - 1981** – stay-at-home mom
- **1975** – Teacher - 6th Grade Core and Music, Las Vegas, Nevada

GRANTS AND RESEARCH PROJECTS
- **2002 - present** – EPIC (Exploring People, Internet, and Communities): Interdisciplinary Views of the Blacksburg Electronic Village, Virginia Polytechnic Institute and State University. John M. Carroll, PI. NSF-ITR sponsored project, quantitative and qualitative data analysis (graduate research assistant).
- **2001 - present** – *Interface metaphors and content: An embodied paradigm for computer-mediated learning,* Virginia Polytechnic Institute and State University. J. M. Carroll, PI. Debbie Denise Reese, Co-PI. NSF ROLE proposal currently under revision for re-submission June 1, 2003. Pre-proposal was one of 15 selected from 85 national applications, received highest rating in all categories.
- **2001** – PT3 Grant, Virginia Polytechnic Institute and State University. Served as technology teacher (graduate assistantship).
- **2001** – Students' Cognitive, Affective, Socio-demographic characteristics and school/classroom instructional contexts as factors in mathematics and science achievement: Analysis of TIMSS, Virginia Polytechnic Institute and State University. Kusum Singh, PI. NSF ROLE sponsored project, (graduate research assistantship).
- **1999 - 2001** – ITMA grant (Instructional Technology Master's Program), Virginia Polytechnic Institute and State University. Served as program administrator (graduate assistantship).

AWARDS
- **2003** – Certificate of Recognition from the International Visual Literacy Association's book of *Selected Readings* editors for paper (Trees of Knowledge: Changing Mental Models through Metaphorical Episodes and Concept Maps) nominated for the Editors' Choice award.
- **2002** – Our review of the book *The child and the machine: How computers put our children's education at risk* (Reese and Burton, 2002) was recognized by Teacher's College Record as one of the ten most popular book reviews of the year.
- **1998** – initiation into the National Honor Society of Phi Kappa Phi
- **1997 - 1998** – Graduate and Teaching Assistantship, Western Illinois University, Department of Instructional Technology and Telecommunications
- **1997** – Winner, J. W. Stein Creative Young Scholar Award, Western Illinois University
- **1996** – Winners of the Family Practice Doctors of Iowa Issues Video Competition, 2nd place, Keokuk Talented and Gifted Program, 8th grade.
- **1988** – Winner Iowa State University Simon Estes Master Class Competition - Singer, soprano
- **1988** – Winner, Iowa State University Concerto Competition - Singer, Soprano
- **1987 (spring) 1987 (fall) 1988 (spring) 1988 (fall)** – Iowa State University - leading roles in Lyric Opera Productions - Iowa State University

PAPERS, PUBLICATIONS, AND INVITED TALKS
- Reese, D. D. (October, 2003). *PFNET translations: A tool for concept map quantification.* Paper to be presented at the Association for Educational Communications and Technology, Anaheim, CA.
- Reese, D. D. (April, 2003). *Mapping structure: Testing the relational assumption in metaphor-based, computer-mediated instruction.* Paper to be presented at the American Educational Research Association, Chicago, IL.
- Carroll, J. M., & Reese, D. D. (January, 2003). Community collective efficacy: Structure and consequences of perceived capacities in the Blacksburg Electronic Village, *Proceedings of the Thirty-Sixth Annual Hawaii International Conference on System Sciences (CD/ROM).* Hawaii: Computer Society Press, in press. Ten pages.
- Dunlap, D., Schafer, W., Carroll, J. M., & Reese, D. D. (in press). *Delving Deeper into Access: Marginal Internet Usage in a Local Community.* Paper presented at the HOIT (Home Oriented Informatics and Telematics) 2003 Conference, Irvine, CA.
- Reese, D. D. (November, 2002). *Collective efficacy: Building informal social controls through virtual communities.* Invited talk for Digital Cities and Internet Communities graduate HCI/Computer Science course at Virginia Polytechnic Institute and State University, Blacksburg, VA.
- Reese, D. D. (2003). Trees of knowledge: Changing mental models through metaphorical episodes and concept maps. In R. E. Griffin & V. S. Williams &

J. Lee (Eds.), *Turning trees: Selected readings*: International Visual Literacy Association.
- Reese, D. D. (2002, June). *Trees of knowledge: Cultivation through metaphorically engineered hypertext learning environments.* Paper presented at the HyperText 2002 Doctoral Consortium, College Park, MD.
- Reese, D. D. (2002). *Learner characteristics, behavior, and achievement within web-based distance education: A learner-centered model.* Paper presented at the annual meeting of the American Educational Research Association, New Orleans, LA.
- Reese, D. D., & Burton, J. K. (2002). [Review of the book *The child and the machine: How computers put our children's education at risk*][electronic version]. *Teachers College Record, 104*(1).
- Singh, K., Fikretoglu, Deniz, & Reese, D. D. (2002). *Students' Sociodemographic and Affective Characteristics, and Science Achievement.* Paper presented at the annual meeting of the American Educational Research Association, New Orleans, LA.
- Reese, D. D. (2001, February). *The ITMA model: A preliminary exploration of the relationship between learner characteristics, attitudes, and academic achievement in web-based distance education.* Paper presented at the annual meeting of the Eastern Educational Research Association, Hilton Head, SC.
- Reese, D. D. (2000, February). *Learning environments which effect higher-order processing: Metaphor in action.* Paper presented at the annual meeting of the Eastern Educational Research Association, Clearwater, FL.
- Reese, D. D. (1999). *Meeting goals 2000 through visual tools adapted to interactive multimedia.* Paper presented at the annual meeting of the Illinois Education and Technology Conference, Springfield, IL.

SERVICE:
- **2002** – Appointed president – Instructional Technology Student Organization (ISTA), Virginia Polytechnic Institute and State University
- **2000 – 2001** – Committee member - Professional Development Portfolio standards and prototype committee, Instructional Technology Program, Teaching and Learning, Virginia Polytechnic Institute and State University.
- **1996** – Committee member - Platform Committee, Democratic Party--county and district
- **1994 - 1996** – Tree plantings - Lee Country Conservation Board; KMS TAG
- **1991 - 1996** – Prairie plantings - Lee County Conservation Board; KMS TAG
- **1995** – Established Keokuk Middle School Cultural Diversity Student advisory Board, assembly and field trips
- **1995** – Established Keokuk Middle School Cultural Diversity Student advisory Board, assembly and field trips
- **1994 - 1995** – Executive committee, secretary, family advocate - Habitat for Humanity
- **1994** – Keokuk Business and Professional Woman of the Year nominee
- **1991 - 1996** – Council member - Keokuk Fine Arts Council

- **1991- 1992** – Project Wood Duck - Lee County Conservation Board and KMS TAG (Keokuk Middle School Talented and Gifted) -- received national recognition
- **1990 - 1996** – Director - Tri-State Children's Dance Theater (six years of annual summer dance camps, school residencies, performances and workshops)
- **1988 - 1990** – Council member - Ames Community Arts Council
- **1987 - 1989** – Council member, treasurer - Ames Community Youth Orchestra
- **1985** – Soccer coach, Ames Arts and Recreation

SPECIAL SKILLS:
- **Technology software**: Adobe PhotoShop, Macromedia Director, FrontPage, HyperStudio, HyperCard, Microsoft Office Suite, Adobe Illustrator, Adobe Acrobat, Adobe Premier, Netscape Composer, Inspiration, AppleWorks
- **Statistical and data analysis software:** SPSS, LISREL, EQS, NVivo, PCKNOT

PROFESSIONAL ORGANIZATION MEMBERSHIPS:
- **2003 - present** – AECT (Association for Educational Communications and Technology)
- **2002 - present** – IVLA (International Visual Literacy Organization)
- **1999 - present** – AERA (American Educational Research Association)