A model for the design of virtual learning environments (VLE's) that considers the affordance of spatial presence.

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What is my research about?

- Exploratory model research (Richey& Klein, 2007. p.40 & p.72).
- Goals:
  - To develop a model for design of VLE's that considers the affordance of spatial presence in VLE's.
  - To develop a VLE to teach fundamentals of visual design: Unity, Contrast, Emphasis, based on the preliminary model, and compare learning outcomes with a comparable paper version

Why is it important?

- Educational use of virtual worlds is increasingly rapidly (Bainbridge, 2007; Chittaro & Ranon, 2007).
  - Contemporary VLE's are used for many types of subject matter and learning outcomes, including medicine, accounting, business, art, history, science and math, and for training of soft skills such as management and negotiation.
- Virtual worlds are primarily a visual medium (Schubert, Friedmann, & Regenbrecht, 2001), and the two most important components of presence are the visual display and the user interactivity.

Why is it important?

- Use of images to teach concepts is known to be an effective strategy for building mental models and developing creative thinking skills, because images are processed holistically (Cifuentes & Hseih, 2001; Clark & Lyons, 2004).
- The reciprocal nature of learning and doing in VLE's can build conceptual understanding (Barab, Hay, Barnett & Squire, 2001).

- Presence in virtual learning environments is important to accomplish learning goals (Jacobson, 2001) and is reported to have positive effects on students' perceptions of the course communications and relevance (Nishide, Shima, Araie, & Ueshima, 2007; Reznick & MacRae, 2006; Takatalo, Nyman, & Laaksonen, 2008).

Research questions

- How does spatial presence affect and impact learning?
- How should VLE's be designed to help learners build flexible mental models of concepts and develop problem- solving skills?
- What theoretical foundations should be considered in designing VLE's and how should they be applied to a model for design of VLE's?
- What conclusions from existing empirical studies of VLE's can be applied to the model?

Methods

Methods for exploratory model research (Richey & Klein, 2007. p.40)

- Literature review survey- accomplished
- Case Study – development and testing of Unity, Contrast, Emphasis tutorial in Second Life.
- Delphi method
- Empirical testing: Create virtual learning environment tutorial based on conclusions for literature review. Test learning outcomes, compare with outcomes from a comparable paper version.

From literature review

What is spatial presence
in virtual learning environments?

How does spatial presence
affect and impact learning?

What is spatial presence in VLE's?

"…the user's sense of *being there*, in the virtual world, accomplished through interaction with a vivid, immersive simulated environment…"

"…it affords the user a unique perception of potential interaction with a simulated environment'. (Wood, 2009)

What is spatial presence in VLE's?

- Virtual worlds are primarily a visual medium (Schubert, Friedmann, & Regenbrecht, 2001).
- The two most important components of presence are the visual display and the user interactivity. (Wood, 2009).
- The experience of spatial presence is an interactive visualization that blends the learner's internal visualization with the computer generated one.

How does spatial presence in VLE's effect and impact learning?

Spatial presence in VLE's is generally considered to benefit learning by enabling first person experiences and by manipulation of media to provide multiple points of view (Chittaro & Ranon, 2007)

How does spatial presence in VLE's effect and impact learning?

- Some of the most intriguing observations made from research into spatial presence in VLE's are its effects on higher thought processes:
  - conceptual understanding, creating mental models (Chittaro & Ranon, 2007; Kontogeorgiou, Bellou, & Mikropoulos, 2008; Limnou, Roberts, & Papadopoulos, 2008; Zacharia, 2007),
  - problem-solving (Cai, Lu, Zheng, & Li, 2006; McClean, Saini-Eidukat , Schwert, Slator, & White, 2001),
  - metacognitive and abstract thinking (Antonietti & Cantoia, 2000; Cai, et al. 2006).

Dynamics of spatial presence

- The visual display is most significant factor.
- User is aware of being in a dual environment- real and virtual
- Interruptions may not be not detrimental to experiencing presence
- Interactivity is more important than degree of immersion/ detailed realism of visualization
- Requires meta-cognitive skills to negotiate the two environments
- May enhance learning by eliminating symbols and providing a more direct experience

Theoretical Foundations

What theoretical foundations should be considered in designing VLE's

- Multimedia Learning Theory (Mayer, 2001)
- Cognitive Load Theory (Clark, Nguyen, & Sweller, 2006).
- Cognitive Flexibility Theory (Spiro, Collins, & Ramchandrian, 2007; Spiro, Feltovich, Jacobson, & Coulson, 1992).

Theoretical foundations: Multimedia learning theory (MLT)

- Students learn better when corresponding words and pictures are presented near rather than far from each other.
- Students learn better when corresponding words and pictures are presented simultaneously rather than successively.
- Design effects are stronger for low knowledge learners than for high knowledge learners, and for high spatial ability than for low spatial ability learners.
- Students learn better when extraneous material is excluded rather than included.

Theoretical Foundations: Cognitive load theory (CLT)E

- Experts have a rich repository of schema in long-term memory that allow them to use their working memory more efficiently.
- Novices need support from the instructional environment to substitute for their lack of schema.
- Instructional events rely on working memory capacity and should be supported by instructional methods that manage cognitive load.
- Display worked examples and completion problems in ways that reduce cognitive load.
- Minimize unnecessary or redundant content or presentation modes.

Theoretical Foundations: CLT cont.

- Focus its action on important content elements, avoid split attention.
- Use completion examples to promote learning.
- Transition from worked examples to problem assignments with backwards fading.
- Transition from work examples to problem assignments as learners gain expertise.
- Transition from work examples to problem assignments as learners gain expertise.
- Replace some practice problems with worked examples.

Theoretical Foundations: Cognitive flexibility theory (CFT)

- Present conceptual knowledge as knowledge in use.
- Promote flexible schema assembly through multiple representations.
- Use multiple knowledge representations and integrated multiple analogies for complex concepts.
- Avoid context dependency and promote contextual variability- by revisiting and re-arranging knowledge in the development of multiple representations.
- Present multiple interconnectedness- non compartmentalization of concepts and cases.

How should these theories be applied to the tutorial design?

- Consider aspects of divergence and confluence in the selected theories.

- Synthesize educational theories to integrate with visual design and human-computer interaction design practices grounded in physiological and psychological theory.

How should these theories be applied to the tutorial design?

- Synthesize educational theories to integrate with visual design and human-computer interaction design practices
  - Example: MLT recommendations for spatial and temporal contiguity parallel Gestalt principle of Proximity in visual design.
  - CLT recommendations for eliminating extraneous content translate into Gestalt principle of Similarity in visual design- similar content can be chunked, dissimilar or extraneous content creates extra cognitive load.
  - CFT recommendations for Multiple knowledge representations - integrated multiple analogies fit Gestalt principle of Common Fate- objects (concepts) seen moving in the same direction will be grouped together (See Appendix for a list of Gestalt principles).

Conclusions from empirical VLE research

- Give learners the structure of assigned learning (Crossier, Cobb & Wilson, 2001).
- Visual displays that lack consistent depth cues, or that are inconsistent with accepted practices of illustrating depth can disrupt the viewer's sense of spatial presence and interfere with memory of the virtual events (Riecke, Schulte-Pelkum, Avraamides, Von Der Heyde, & Balthoff , 2006).

Conclusions from empirical VLE research

- Movement will stimulate attention, abrupt changes will attract more attention than gradual transitions (Baumgartner, Valko, Esslen, & Jancke, 2006).

- Detailed architectural and landscape features can cause slower learner reaction times and reduced memory (Luo & Duh, 2009).

Conclusions from empirical VLE research

- Adult learners who started with an unguided interface and then switched to a guided one performed better than learners who started with a guided interface and then switched to an unguided one (Van Nimwegen & Van Oostendorp, 2009).

- Circular environments seem to be easier to navigate and remember than square environments (Luo & Duh, 2009; Jansen-Osmann, Wiedenbauer, Schmid & Heil, 2007).

Conclusions from empirical VLE research

- Verbal or printed text explanations can be used as advance organizers and optional 2D static views of products can provide multiple representations (Mayer, Mathias & Wetzell, 2002; Dong, Li, Yan, Wu, Yang, & Zheng, 2008).

Proposed tutorial:
Unity, Contrast, Emphasis

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- Visual Design is the deliberate arrangement of text and images to convey thoughts and ideas. The goal of visual design is to communicate one or more specific thoughts, ideas or concepts.

- Because of the intensely visual nature of contemporary instructional media, instructional designers have to make decisions regarding the visual design of a message that will impact learning outcomes.

Proposed tutorial: Unity, Contrast, Emphasis

- Graphic unity within an image can simplify a complex message making the message more accessible to the consumer. Absence of unity can make even a simple message inaccessible. Therefore, educators and instructional designers are well advised to learn design principles of unity which can be achieved through visual contrast, and hierarchical emphasis.

- In response to the need for instructional designers and educators who can generate unified instructional messages, we are designing and developing a tutorial for teaching graphic principles of unity, contrast, and emphasis for instructional message design in Second Life. We call the environment Unity, Contrast, and Emphasis.

Proposed tutorial: Unity, Contrast, Emphasis

- A graduate education class in computer graphics for learning will test the tutorial. One group will use the VLE in Second Life, the other group will use a paper version of the same tutorial. Their learning outcomes will be compared.

Proposed tutorial: Unity, Contrast, Emphasis

- Objectives:
  - The learner will be able to identify the forms and elements of design, distinguish unified messages from chaotic messages and explain how the elements of design contribute to unity or chaos.
  - The learner will also be able to identify and **explain** how contrast is or is not used to create emphasis that hierarchically directs the viewer to the important parts of the message, and **generate** an instructional message that applies principles of unity and hierarchical contrast to clarify and underscore the message.

Proposed tutorial: Unity, Contrast, Emphasis

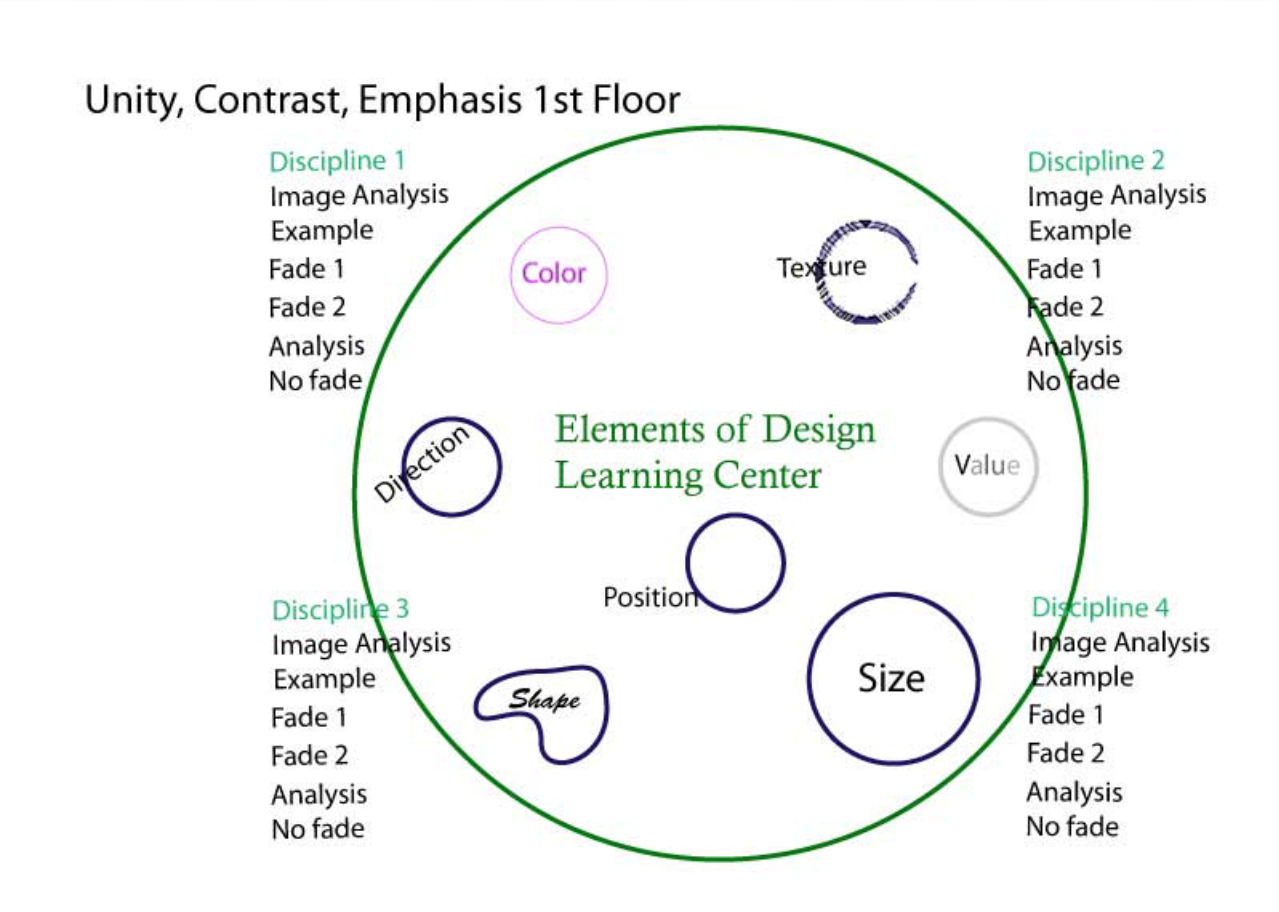
Methods

- Empirical testing of tutorial : VLE vs. Paper version
  - Presence questionnaire- Schubert, Friedman & Regenbrecht's
  - 2 raters to evaluate 15 students' 5 design tasks to yield a reliable generalizability coefficient
  - Scores can be compared using an Independent two sample T-Test assuming equal variance.
  - Qualitative interviews with participants- ongoing, for feedback as they use each method.
  - Analysis

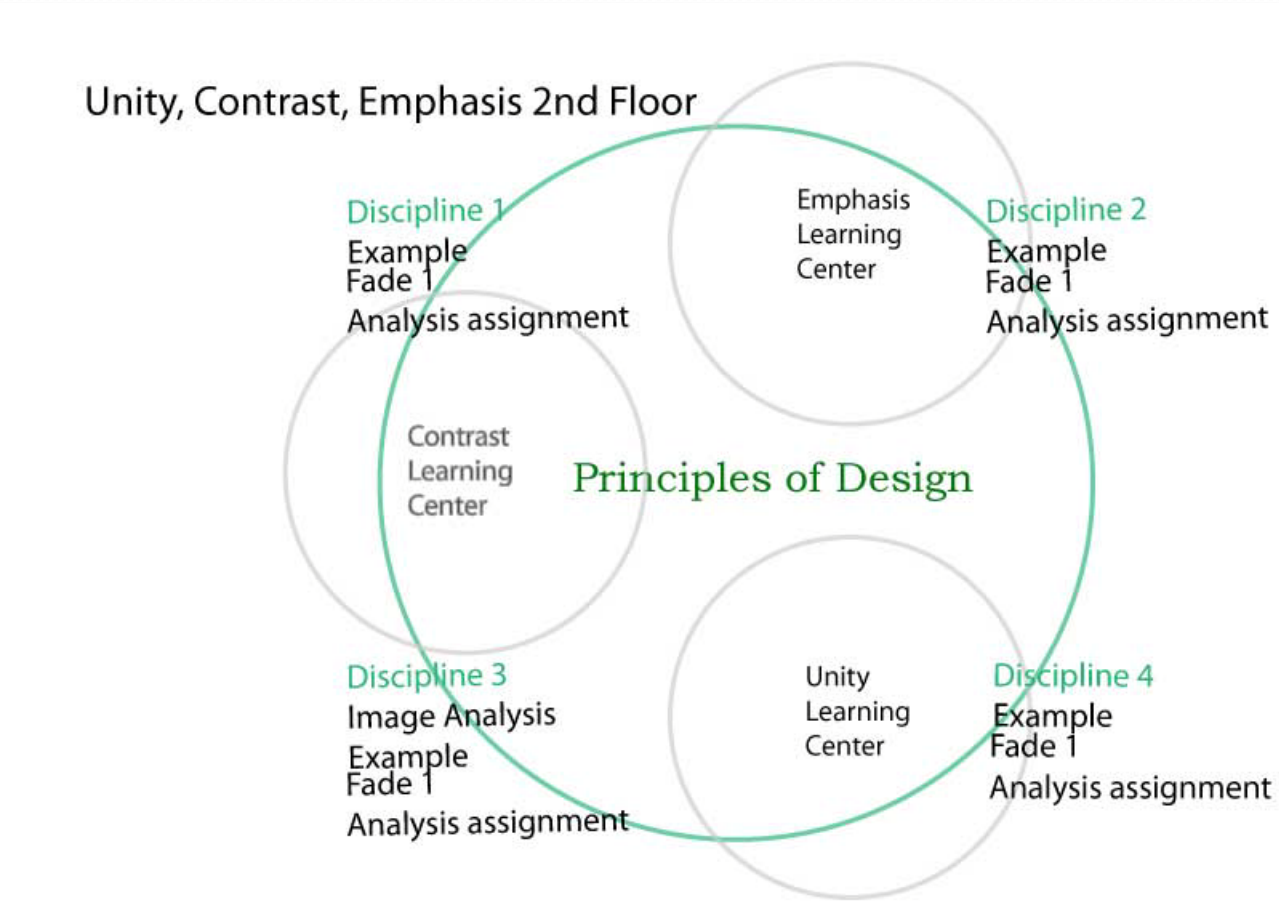
Model for design of tutorial

- A flexible, open, non-linear environment with guidance available but not restrictive. Users can explore learning centers for each topic: unity, contrast, emphasis at their own pace.
- Scaffolding will be accomplished with faded and worked examples.
- Organization will be implied by visual organization and emphasis but not program controlled.
- Assignments will be non-linear. Learners will deconstruct visual instructional messages, applying knowledge of contrast, emphasis and unity gained from visiting learning centers, then create their own messages.

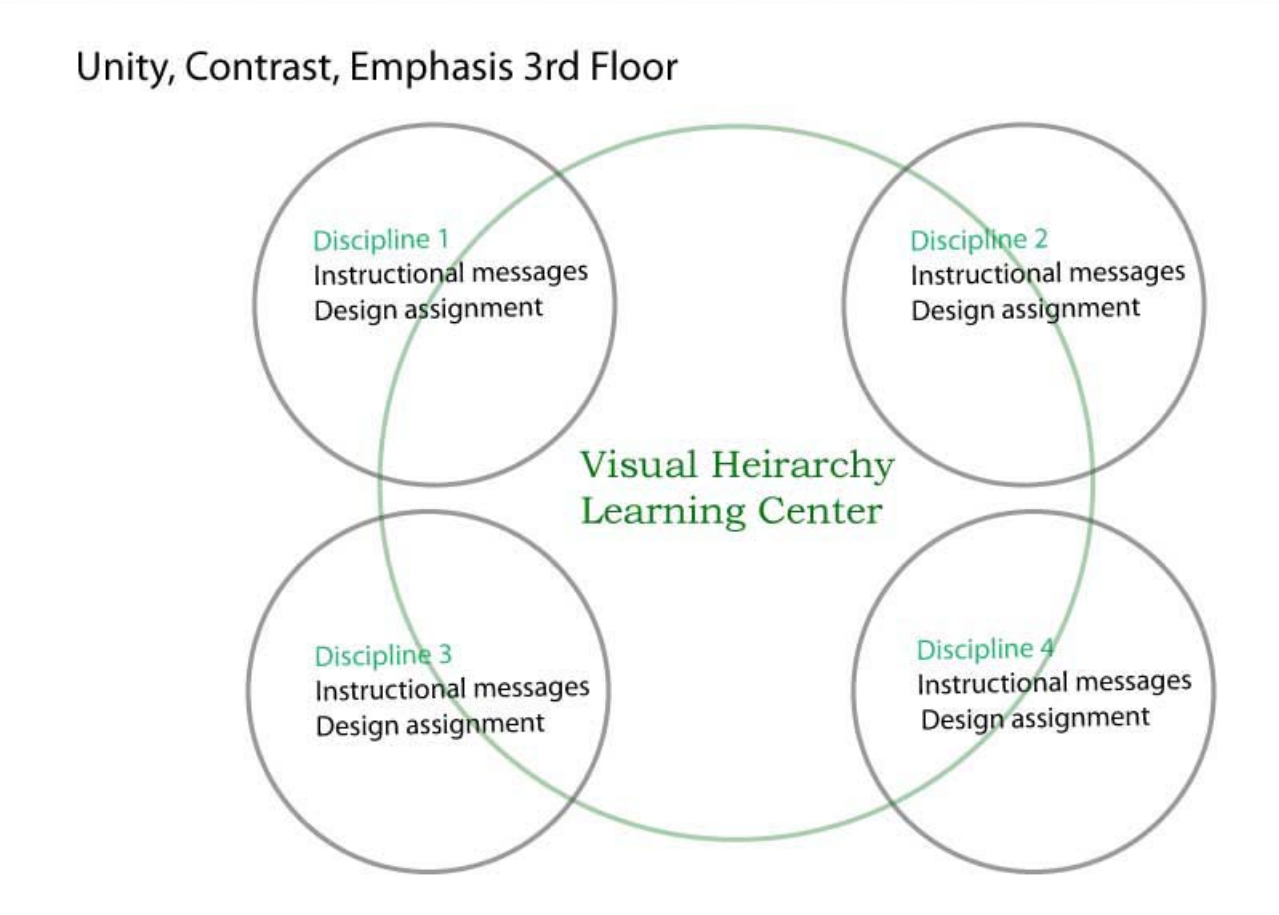
Schematic 1st floor



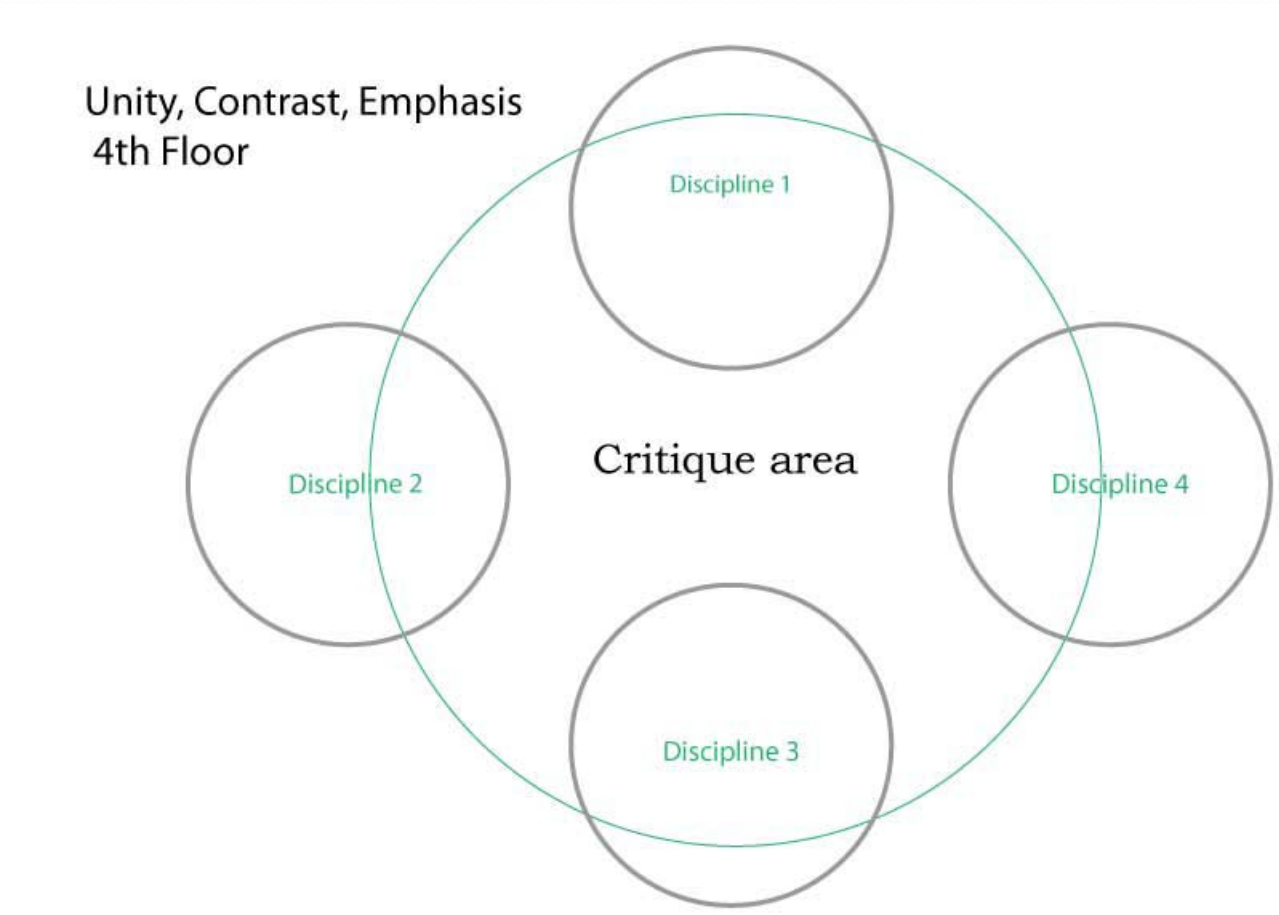
Schematic 2nd floor



Schematic 3rd floor



Schematic 4th floor



Model for assignments

- Assignments will be contextual instructional design statements that learners will deconstruct to analyze.
- Learners will identify elements of design, and analyze the effectiveness of their use, then build their own designs and reflect on the process.

Model for examples

- Instructional message examples will be presented with hyperlinks to explanations of components.
- Explanation of visual design concepts will be linked in context and available as resources, like a visual glossary.
- Examples will progress from worked through faded leading to the unworked assignment piece. Students may view worked and faded examples in any order, or proceed directly to assignment piece.

What do I want the audience to do about it?

- Play a part in the ongoing development of model(s) for design of VLE's by:
  - Providing feedback on my research proposal, methods, suggestions , questions, input from their own VLE research
  - Contribute visual instructional messages from their discipline that could be used as examples for learners to deconstruct
  - Contribute text instructional messages from their discipline that learners could develop into a visual version.

Thank you for your attention!

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Appendix

Gestalt

- Pragnanz (Good Figure)

  The law of Pragnanz or the law of good figure states that every stimulus pattern is seen in such a way that the resulting structure is as simple as possible. This means that the viewer will always try to organize the elements of a design into the simplest pattern possible. A square that is overlapping a triangle is seen as two simple overlapping shapes, rather than a single more complex polygon.
- Similarity

  The law of similarity states that similar visual elements appear to be grouped together. Elements of a design that look alike are organized into a group.
- Good Continuation

  The law of good continuation states that a series of visual elements connected in a straight or curved line is seen as belonging together. The law also states that lines tend to be seen in such a way as to follow the smoothest path
- Proximity

  The law of proximity states that visual elements which are near to each other are grouped together.
- Common Fate

  The law of common fate states that visual elements which appear to be moving in the same direction will be grouped together.