# PowerPoint and Learning Theories: Reaching Out to the Millennials

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## Abstract:

*Our research exercise consisted of a survey conducted on 52 second year dental students to consider approaches for measuring the effectiveness of applying cognitive learning theories for teaching using technology. We did this in an effort to enhance the learning of millennial students' using their modes of communication preferences. The Cognitive Load, Multimedia and Visual Learning Theories were employed, and student preference was tested to determine the importance of the three theories in PowerPoint presentations (PPP) with respect to millennial student preference. Results, as expected, revealed students did not value PPP slides containing text without images. Given the relatively small sample size and the selected group of students in the present study, future studies should consider students from other disciplines and from different generations before generalizations can be made.*

### *Key Words:*

Millennials, PowerPoint, Cognitive Learning Theories, Cognitive Load Theory, Multi-Media Learning Theory.

## Introduction

As millennials, today's students are independent, inclusive (move between global and virtual communities), opinionated and aware, investigative (use technology), and expect immediacy (information at light speed) (Lippincott, 2010). Librarians are addressing these issues through redevelopment of their Information Commons to accommodate millennials' preferences and "their tendency to express themselves and relate to one another in ways mediated by digital technologies, and their patterns of using the technologies to access and use information and create knowledge and art forms" (Palfrey & Gasser, 2008, p.4). Clearly, librarians have recognized that a new approach is required with this generation but with respect to PowerPoint presentations, this may seem redundant as a simple Google search locates a multitude of sites that list "rules" for PowerPoint use. However, despite this readily available information, we have sat through enough ineffective presentations to wonder why we all aren't using them. The purpose of our research exercise was to apply cognitive learning theories to a digital technology used throughout higher education to test a contextual framework for future studies assessing teaching and learning effectiveness with respect to the millennials' communication preferences. We hope this exercise will reach out to educators not currently using the available guidelines. Beyond this exercise, future studies would benefit from a larger sample of millennials and not be limited to our selected group to achieve a representation across the disciplines and generations. Three cognitive learning theories, cognitive load theory, multi-media learning theory and visual spatial learning theory, were applied to PowerPoint slide design and 52 second year dental students were surveyed to determine if this could form a contextual framework for future studies considering effective methods of teaching and learning using any visual technology. Millennial dental students were the subjects, but it is hoped that this framework could be applied to different disciplines and other generations as well to determine commonalities and differences.

## An Understanding of Knowledge Acquisition: Educational Psychology Learning Theories

The acquisition of knowledge has and continues to be a focus of educational psychologists and educators. Current work on multimedia learning took hold in 1969 (Reed, 2005), when Clark and Pavio (1991) argued that information is elaborated through either visual or auditory associations and demonstrated that pictures provide better memory than words. Following this, Baddeley (2001) proposed a working memory model consisting of phonological, visual-spatial, and central information integration demonstrating that visual-spatial and central integration were more important for memory. In the 1980's Sweller's Cognitive Load Theory (CLT) was developed. Essentially Sweller (Van Merrinboer & Sweller , 2005) hypothesized information must be processed in working memory before it can be stored in long term memory and that an overloaded working memory will be less effective for long term processing. That is, learning decreases with working memory overload.

Using these theories, Mayer (2001) developed the Multimedia Learning Theory (MMLT), which consists of seven multimedia instruction principles based on his studies (see Table 1).

**Table 1**

Mayer's Multimedia Learning Theory Principles

1. **multimedia principle**: students learn better from words and pictures than words alone.
2. **spatial contiguity principle**: students learn better when corresponding words and pictures are presented near, rather than far from each other on the page or screen
3. **temporal continuity principle**: students learn better when corresponding words and pictures are presented simultaneously rather than successively
4. **coherence principle**: students learn better when extraneous words, pictures, and sounds are excluded
5. **modality principle**: students lean better from animation and narration than from animation and on-screen text
6. **redundancy principle**: students learn better from animation and narration than from animation, narration, and on-screen text
7. **individual differences principle**: design effects are stronger for low-learners than for high-learners and for high spatial learners than for low spatial learners (Reed, 2006, p. 91-92).

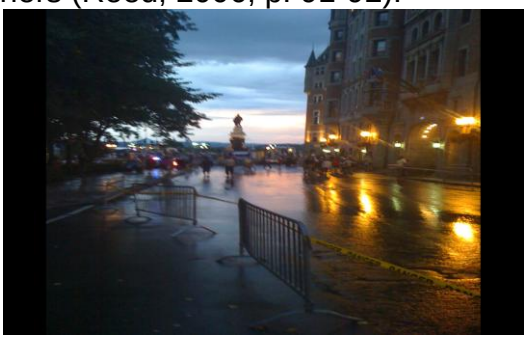


**Figure 1 Satisfies multimedia principle 1 when presenter explains the image**

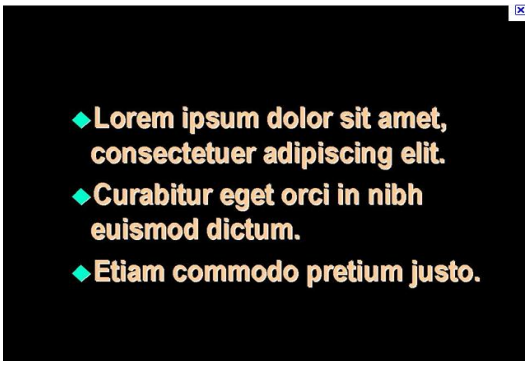



**Figure 2 violates multimedia principle 1**

Reviewing these principles, it becomes evident why PowerPoint might be criticized when it is comprised of slide after slide full of text lacking images. PowerPoint can be an artistic canvas on which the educator creates his/her multimedia learning experience,

but if it contains only text, working memory will be overloaded resulting in less effective communication, slower processing, and slower learning. As Clark (2008) in her article *PowerPoint and Pedagogy: Maintaining Student Interest in University Lectures* states, "lecturers must use their PowerPoint with design, flair, and skill" (p.42). We felt one way to increase our skill may be the incorporation of the aforementioned principles to PowerPoint slides. Support for this approach was also established by Leutner, Leopold and Sumfleth (2008), who considered the CLT and were able to demonstrate science students' increased comprehension and learning outcomes through mental image construction, and Van Merriboerne and Sweller (2008) who are now studying the incorporation of CLT in health profession education to optimize learning.

## Material and methods

A 15 question survey based on the three learning theories was administered to 52 second year UBC dental students in a WebCT format to gain insight into their preferences in PowerPoint slide design as a mode of communication to enhance learning. The survey is presented in Table 2.

**Table 2. Statements Indicators of Learning Theories in PowerPoint presentations**

| Statement (indicator) | Theory # |
|---|---|
| St.1 For me, images are effective for learning during a Power Point presentation if the instructor talks about the image while it is still on the screen. | CLT |
| St.2. I think images are effective for learning during a Power Point presentation if the professor uses a tablet to identify the areas as he/she talks about them. | CLT |
| St.3. I think images are more effective in a Power Point presentation if everything is labeled and the professor reads the labels. | CLT |
| St.4. I believe Power Point presentations are more effective if there is text without images. | MMT |
| St.5. I think in Power Point presentations the text should be on the same slide as the image. | MMT |
| St.6. I think in Power Point presentations text is more effective than a professor explaining an image. | VLT |
| St.7. Watching the virtual tooth in a Power Point presentation helps me to understand the preparation. | VLT |
| St.8. For me the virtual tooth is more effective when I can manipulate it. | VLT |
| St.9. I think images on the Power Point slides are important for teaching. | VLT |
| St.10. I think video clips are an effective learning tool. | CLT& MMT |

| | |
|---|---|
| St.11. I think video clips require narration to be effective. | MMT |
| St.12. I do not think Power Point with images is an effective teaching tool. | CLT& MMT |
| St.13. I think in a Power Point presentation the text should be on a separate slide from the image. | MMT |
| St.14. I think it is effective when the professor reads the text on Power Point slide. | CLT |
| St.15. I think Power Point can be an effective format for teaching. | VLT& CLT |

# CLT- Cognitive Load Theory, MMT-Multimedia Theory, VLT- Visual Learning Theory

SPSS program (version 18.0) was used for all statistical analyses and the threshold for the statistical significance was set at P value $<0.05$. The internal consistency of stated preferences was assessed by Cronbach's alpha method. This method tests the internal consistency referring to the degree to which similar statements measure the same dimension. In the present context, similar statements were expected to be internally consistent. The higher the Cronbach's alpha score, the more reliable indicators are. The Cronbach's alpha 0.7 or higher is usually considered as an acceptable level of reliability but lower thresholds are also sometimes used in the literature (Nunnaly, 1978). In the present research exercise, given that statements were similar but not identical; an acceptable level of internal consistency was lowered and measurements (statements) were considered reliable when Cronbach's alpha exceeded 0.60.

Univariate statistics was used to describe frequency distributions in regards to different statements. In the multivariate testing, the present research exercise examined modes of communication in PowerPoint slide design based on 3 learning theories: cognitive load theory, multimedia theory and visual learning theory. A total of fifteen indicators were chosen to represent these three theories and certain indicators (statements) were chosen to represent each of the theories (Table 2). As some of the statements were phrased in a reversed order, their contributions to a dimension were expected to be negatively related to a dimension as compared to other indicators of the same dimension. The agreement with each statement was measured on a visual analog scale from a minimum of 0 (complete disagreement) to 10 (complete agreement).

Confirmatory Factor Analysis (CFA) was chosen to test three dimensions, each structured for each theory. The CFA statistical method seeks to determine if the number of dimensions and the loadings of their indicators conform to what is expected on the basis of pre-established hypotheses.

The Principal Component Analysis was chosen as a method and the Eigen value beyond unity was set as a threshold for extracting a factor i.e. confirming a theory. The level of statistical significance was set at $P<0.05$.

## Results

The reliability statistics revealed an acceptable level of agreement for interrelated statements with a Cronbach's alpha beyond 0.77. Student agreement in regards to

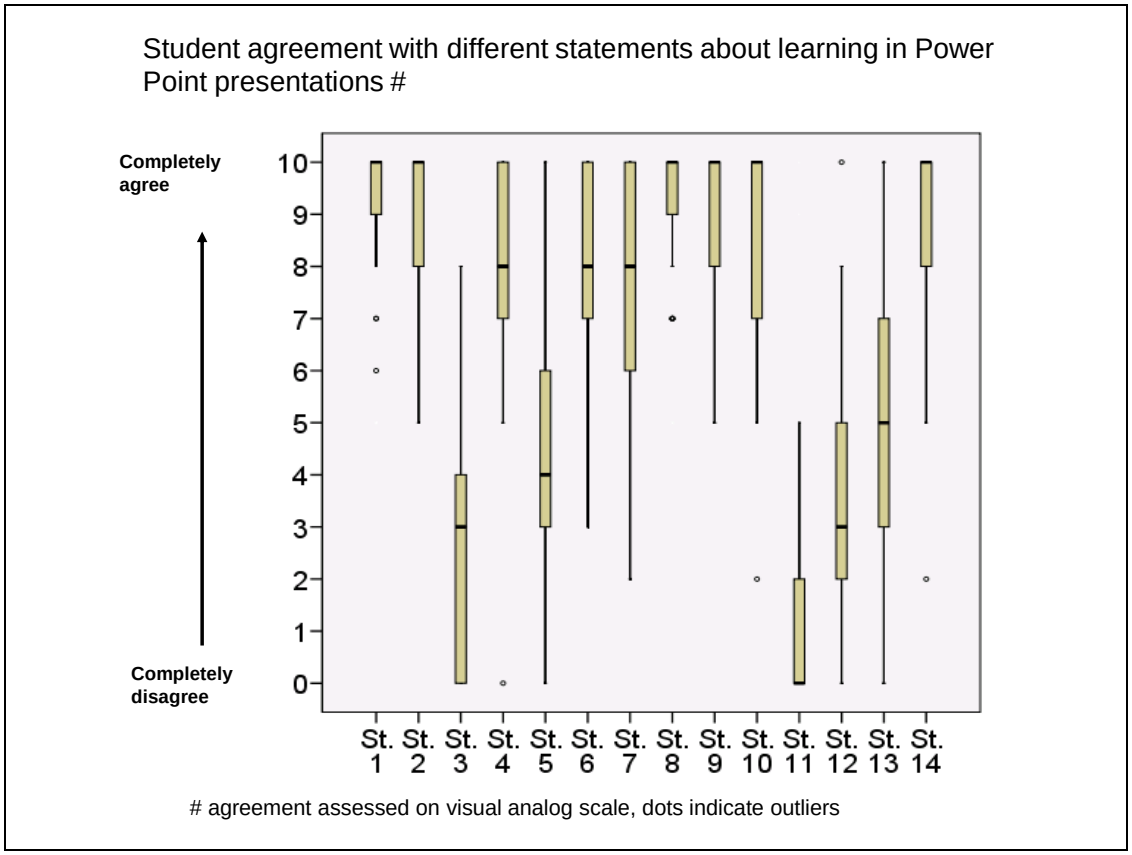
different aspects of learning in PowerPoint presentations is presented in Table 3 and Figure 3.

**Table 3. Student preferences in PowerPoint presentations**

| Statement indicator (St.1-St.15) | Agreement score # | | |
|---|---|---|---|
| | min | max | mean±SD |
| St.1 For me, images are effective for learning during a Power Point presentation if the instructor talks about the image while it is still on the screen. | 5 | 10 | 9.3 ±1.2 |
| St.2. I think images are effective for learning during a Power Point presentation if the professor uses a tablet to identify the areas as he/she talks about them. | 5 | 10 | 9.4 ±1.3 |
| St.3. I think images are more effective in a Power Point presentation if everything is labeled and the professor reads the labels. | 5 | 10 | 9.1 ±1.5 |
| St.4. I believe Power Point presentations are more effective if there is text without images. | 0 | 8 | 2.8±2.1 |
| St.5. I think in Power Point presentations the text should be on the same slide as the image. | 0 | 10 | 8.0±2.2 |
| St.6. I think in Power Point presentations text is more effective than a professor explaining an image. | 0 | 10 | 4.5±2.6 |
| St.7. Watching the virtual tooth in a Power Point presentation helps me to understand the preparation. | 3 | 10 | 8.1±2.1 |
| St.8. For me the virtual tooth is more effective when I can manipulate it. | 2 | 10 | 7.7±2.1 |
| St.9. I think images on the Power Point slides are important for teaching. | 5 | 10 | 9.4±1.2 |
| St.10. I think video clips are an effective learning tool. | 5 | 10 | 9.2±1.3 |
| St.11. I think video clips require narration to be effective. | 2 | 10 | 8.4±2.1 |
| St.12. I do not think Power Point with images is an effective teaching tool. | 0 | 10 | 1.3±2.2 |
| St.13. I think in a Power Point presentation the text should be on a separate slide from the image. | 0 | 10 | 3.1±2.2 |
| St.14. I think it is effective when the professor reads the text on Power Point slide. | 0 | 10 | 5.2±3.0 |
| St.15. I think Power Point can be an effective format for teaching. | 2 | 10 | 8.9±1.6 |

# agreement scores from 0 completely disagree to 10 completely agree

**Figure 3**




Overall, students considered PowerPoint presentations to be effective modes of communication (Table 3, St.12), particularly if the educator talks about the image while it is still on the screen (Table 3, St.1) and if the educator uses a tablet to identify the areas as he/she talks about them (Table 3, St.2). Students agreed that video clips are also an effective mode of communication (Table 3, St.10). As expected, PowerPoint presentations were not considered as effective modes of communication if there were text without images (Table 3, St.4).

Multivariate testing of a number of indicators to represent theories of learning showed that not all indicators were equally contributing to their corresponding theory. Final results of this analysis are presented in Table 3. We thought there were seven related indicators for the Cognitive Learning Theory (Table 2), but testing confirmed substantial commonality only among five out of seven indicators considered (Table 4).

**Table 4. Dimensions of Student learning in PowerPoint Presentations #**

| LEARNING THEORIES AND THEIR INDICATORS (ST.1-ST.15) | INDICATOR LOADING |
|---|---|
| **Dimension of Cognitive Loading Theory** | |
| St.1 For me, images are effective for learning during a Power Point presentation if the instructor talks about the image while it is still on the screen. | .825 |

| | |
|---|---|
| St.2. I think images are effective for learning during a Power Point presentation if the professor uses a tablet to identify the areas as he/she talks about them. | .770 |
| St.3. I think images are more effective in a Power Point presentation if everything is labeled and the professor reads the labels. | .528 |
| St.12. I do not think Power Point with images is an effective teaching tool. | -.710 |
| St.15. I think Power Point can be an effective format for teaching. | .672 |
| **Dimension of Multimedia Theory** | |
| St.5. I think in Power Point presentations the text should be on the same slide as the image. | .910 |
| St.13. I think in a Power Point presentation the text should be on a separate slide from the image. | -.910 |
| **Dimension of Visual Learning Theory** | |
| St.7. Watching the virtual tooth in a Power Point presentation helps me to understand the preparation. | .831 |
| St.9. I think images on the Power Point slides are important for teaching. | .634 |
| St.14. I think it is effective when the professor reads the text on Power Point slide. | .642 |
| St.15. I think Power Point can be an effective format for teaching. | .467 |

# Confirmatory Factor Analysis; * Indicator loadings relate to the relative contribution to a dimension (max=1.0), higher loadings indicate higher contributions to a common dimension.

## Discussion

The application of Cognitive Load Theory, Multi-media Learning Theory, and Visual Spatial Theory shows that this mode of communication appeals to our dental students' preferences. The survey revealed that 95% of the participants preferred a multimedia mode of communication in a large group learning setting because it allowed them to make connections and have a better grasp of clinically relevant dentistry. In addition, 85% said multimedia modes of communication in a large group setting made the clinical simulation exercises easier for them to study at home. This could have implications as we evolve into a more digitally oriented educational setting. For example, concepts such as distance education, podcasting, the virtual classroom and self-directed learning (Barbour & Reeves, 2009) (Clark, R. & Mayer, 2008) may be more useful to students and perhaps more effective as educational tools if cognitive learning theories are applied to them.

Indeed, in an interview in the *Sydney Morning Herald* (2007), Sweller is quoted as saying PowerPoint "is effective to speak to a diagram, because it presents information in a different form. But it is not effective to speak the words that are written, because it is too much load on the mind and decreases your ability to understand what is presented" (p.2). Sweller (2005) is, in effect, stating that Mayer's multimedia principles in

PowerPoint are effective only when there are images with accompanying explanations, not simply text. Our students also supported this throughout the survey.

In our survey, 96% of the dental students stated they were visual learners. This does not surprise dentists as dental admissions have visual and spatial components to their selection process. Dentists must be able to visualize to practice clinical dentistry; in fact, they tend to be high spatial learners. When considering Mayer's individual differences principle that design effects are important for high spatial learners, the psychological literature would suggest that to maximize their students' preference for multimedia communication dental educators might consider using images in PowerPoint with narration (i.e.: avoid slides with all text) if they opt for PowerPoint in their presentations. In addition, as our dental students are required to complete several upper level science courses, this would appear to support Leutner et al (2008) study determining science students' learning outcomes improved with mental imagery.

Other disciplines in higher education may wish to consider their students' preferences enabling the educator to tailor their PowerPoint presentations possibly by introducing the cognitive learning theories to them. Examples that come-to-mind are art, history, biology, chemistry, physics, and anthropology, all visually and conceptually rich disciplines where images are easily introduced to enable, according to CLT and MMLT, more efficient learning. . It is our suggestion that in areas where images are not suitable for the subject or if the educator is not comfortable teaching with images, he/she may consider another presentation format. One of us recently sat-in-on a presentation in a science related field where the educator did not use PowerPoint at all. The presentation was very well done as the educator drew images of the chemical structures on overhead transparencies and then went on to verbally explain how these structures related to the field of discussion. It was a very informative and entertaining session for the students, and we believe the educator's objective for the session was met.

PowerPoint may not be an effective communication mode for millennials if educators are not cognizant of CLT and MMT and use PowerPoint slides more like cue cards for themselves instead of learning tools for the students. Educators may wish to consider that

1. their students may have a preference for visual, auditory learning or, more commonly, a combination of learning modes, and expect technology as a mode of communication with these preferences
2. CLT states that the working memory consists of visual and auditory tracts and is most efficient when both tracts are employed in the learner simultaneously
3. MMLT states PowerPoint should consist of images with auditory explanation (not written)
4. if an educator cannot use PowerPoint in an image format with voice accompaniment, then another presentation format could be employed for maximum effectiveness

One of the obstacles to progress in this area is the acceptance of technology in education. Teo (2009) describes the Technology Acceptance Model (TAM), which is used extensively in the business community but is slow to take hold in academia. TAM "specifies the causal relationships between perceived usefulness, perceived ease of

use, attitudes toward computer use, and behavioral intention to use technology" (Teo 2009, p.303). In studying 475 pre-service teachers, Teo (2009) was able to demonstrate "perceived usefulness, attitudes towards computer use, and computer self-efficacy have direct effect on behavioral intention to use technology, while perceived ease of use, technological complexity, and facilitating conditions affect behavioral intention use indirectly" (p.309). However, as illustrated by Liu, Liao, and Pratt (2008) using TAM alone is not sufficient in e-learning; a combination of learning theories must be employed. It is our aim to continue educational research based on this exercise to benefit both the educator and the learner. To proceed, we will require a larger sample size. In addition, it would be useful to determine if these results are skewed (due to the specificity of dental student selection) by expanding the study into other faculties and disciplines. In addition, we would like to assess learning outcomes by comparing the effectiveness of an image based PowerPoint presentation and a text based PowerPoint presentation through a randomized double blind approach and consider a qualitative method to deepen our understanding, leading to a more complicated hypothesis and more meaningful results.

## Conclusion

There is a developing awareness that millennial students consider technology central to communication. As we continue to introduce technology into our teaching and learning, it behooves us to make this form of communication as effective as possible. We have demonstrated dental students prefer PowerPoint presentations that incorporate cognitive learning theories such as Cognitive Load, Multi-media Learning and Visual Spatial Learning Theories in their slide design. New research is now assessing the effectiveness of CLT on learning modes such as self-directed learning (Van Merrinboer and Sweller, 2010) to make learning more comfortable and efficient for our millennial students and we hope to continue investigation into these modes of technological communication.

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