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Abstract

Purpose: The educational psychology practice domain is strengthened by exploring how motivational principles informed the design and delivery of online higher education, and by examining which theoretical factors professionals perceived as significant.

Approach: A *professional learning goal model* was applied for designing and delivering Internet-based learning. Courses were delivered to 47 international MBA students using the *Lansbridge University New Brunswick* Learning management System along with the *ElluminateLive*™ virtual classroom. The hypothesis was that participants would identify and appreciate the learning context informed by the key principles underlying the model (andragogy, motivation, self-regulation, self-efficacy, self-schema).

Method: Online eBusiness management courses were examined using *non-parametric* methods to assess participants' perception of instruction and learning context quality, using survey and interview methods. Various statistical algorithms were applied while qualitative analysis of participant feedback was performed using theoretically-coded factors and distribution-free tests.

Findings: The hypothesis was proven at a statistically significant level ($n=41$, $p<0.0001$). Learning delivery *presented* as the highest component impacting the performance outcomes (exam scores), with an overall regression result that online course delivery theoretical factors explained 33% of the variance in the student performance outcome ($p<0.001$). Qualitative analysis on feedback ranked motivation as the strongest element.

Originality: A three-dimensional model was created to harness the *Chi-Square* conditional probabilities.

Article type: Quasi-experiment research paper supplemented with an online conference presentation.

Keywords: educational psychology, professional learning, andragogy, self-regulation, online education.

Introduction

This research paper is a quasi-experiment that replicates (and supports) earlier published findings that adult-centered motivation, course design, and interactive delivery techniques improve student outcomes such as satisfaction and grades (reported in: Strang 2004a; Strang 2006). In this study, Executive MBA student perceptions of theoretical elements underpinning a *professional learning model* (Strang 2004a) are quantitatively and qualitatively assessed through surveys, interviews, and exam scores to determine if they are statistically significant. The rationale is discussed next, then the learning factors (literature review), followed by the methodology, results, and implications.

Research Rationale

Many studies have identified course completion, participant satisfaction, and student motivation, as challenges in online/distance education, for example: (Lawrence 2003; Owen 2003; Deberard *et al.* 2004; Deshields *et al.* 2005). Another article argues that professionals and managers need more "holistic …client-centered, learning-based values and principles" (Briggs 2004, p. 9).

The importance of applying contemporary principles such as andragogy, self-efficacy, self-regulation, social learning, and critical thinking to improve the professional learning context is substantiated in literature. Intentional learning theory for example, advocates learning as a deliberate activity, and research confirms success by emphasizing that students need to be engaged in self-monitoring, self-regulation and goal directed learning (Choi and Hannafin 1995). This has also been successful in several universities for promoting a process-based model of learning (Jarvela 1995). Current research advocates this importance of applying andragogy and social learning principles as a strategic organizational method to improve the professional learning environment (Kessels and Poell 2004). Social development learning emphasizes the role of the learner and peers, as well as flexibility, in the learning process (Reeves 1994). Other writers have noted the increased emphasis on learning outcomes for on-line learning emphasize the importance of self-regulated learning and goal directed behavior where professional learners take an intentional orientation towards cognition, become aware of their own learning processes and engage in self-directed learning (Scardamalia and Bereiter 1992).

Theoretical Alignment with Literature

The professional learning goal concept axiomatically integrates principles from the social sciences (mainly educational psychology) such as constructivism, social learning, and contextual development. It

is driven by several principles, namely: andragogical motivation, self-regulation, self-efficacy, and self-schema. Figure 1 highlights how these facets relate to the educational psychology domain of knowledge.

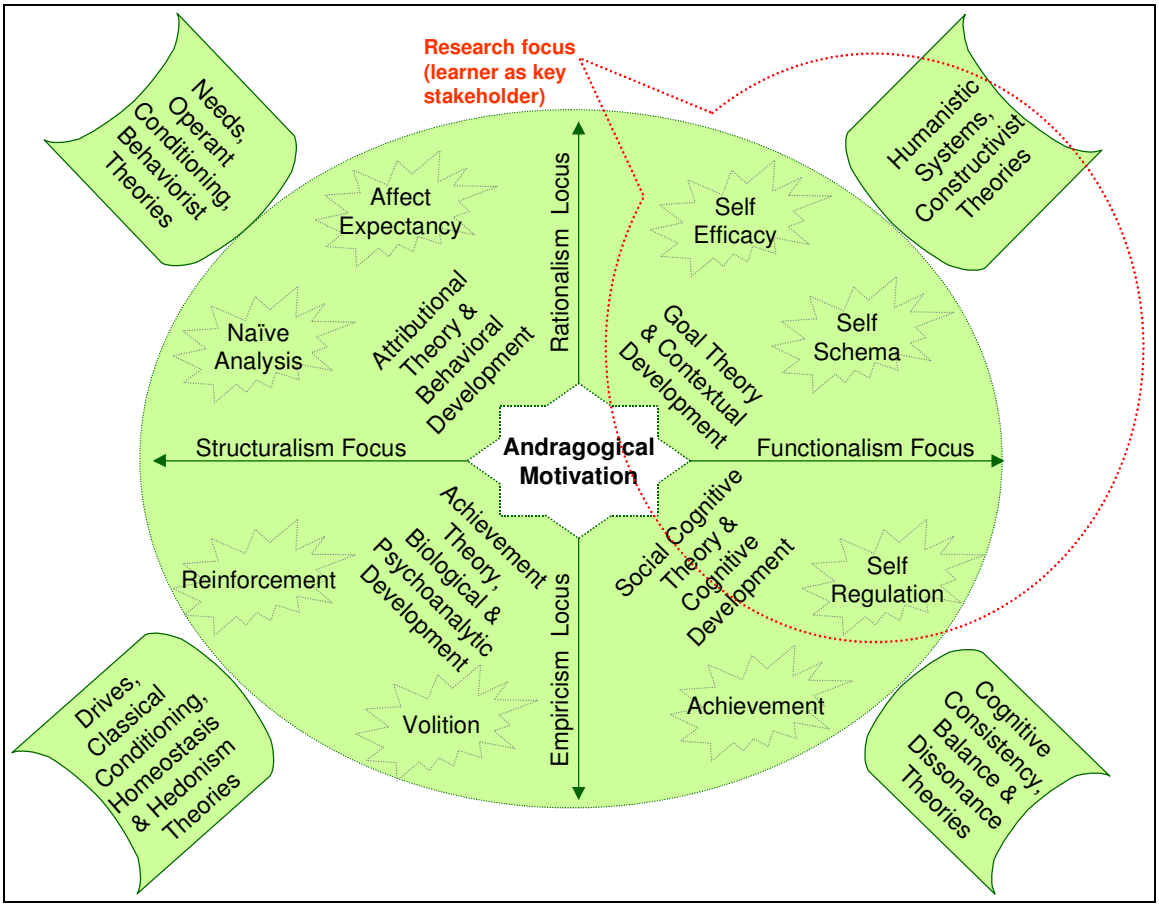

Figure 1: Meta-Theoretical Educational Psychology Domain of Knowledge (Strang 2004a)

Figure 1 positions relevant theories into four quadrants demarcated by two axis suggesting an evolutionary alignment toward structuralism or functionalism (horizontal) along with an empiricism versus rationalism developmental origin (vertical). There was inadequate space to list all principles (e.g. psycholinguistics, cognitive learning, knowledge creation, perception, personality and learning styles), and some elements subscribe to multiple schools of thought (across quadrants).

Literature Underlying Professional Learning Goal Model

The principles of interest are briefly discussed next, namely: andragogical motivation, self-regulation self-efficacy, and self-schema/cognitive development. These are the factors later tested in the experiment.

Andragogical Motivation

Andragogy is the most significant adult learning theory influencing this research. It refers to an adult learner-focused approach in education to differentiate it from *pedagogy*, which is an instructor-led content-focused style. This theory emphasizes that adults are self-directed and should take responsibility for decisions. Instructors applying andragogy adopt a role of facilitator or resource rather than lecturer or grader (Knowles 1984a,1984b). Pedagogy (teacher focused methodology) is seen here as less effective for adult learners, such as eBusiness managers, because as theorized in educational psychology it is aimed at child and adolescent students, with the teacher primarily controlling the what, where, when, why, and how. As applied here, andragogy involved strategies such as case studies, role-playing, simulations, and self-evaluation. A contemporary andragogy application from current literature illustrating how this works, emphasizes five requirements for adult professional learning:

1) Learners need to know why something is important to learn;
2) Learners need to be shown how to direct themselves through information;
3) Topics should be related to the learners experiences;
4) People will must be ready and motivated to learn;
5) Learners need help to establish positive beliefs, overcome inhibitions, and improve behaviors; (adapted from: Peckham and Fallon 2004, pp. 4-6).

Alternative adult learning theories are available in the educational psychology literature, such as *Experiential Learning* (Rogers and Freiberg 1994) and the *Characteristics of Adults as Learners* (Cross 1981). These were analyzed and tested in a separate research effort, but andragogy was found to better promote the cognitive development, motivation, and self-regulation in the distributed online learning context (Strang 2004a, 2006). For example, *CAL* emphasizes adapting to the age of participants, specifically that they may have less ability as they grow older (may require less cognitively complex content), which did not correlate with findings that andragogy was statistically significant (Strang 2006).

Self-Regulation

In brief, *self-regulation* is a key principle associated with cognitive learning, which could be viewed as including volition (act of using willpower), and as a variant of equilibration in which the learner monitors and adapts using planning, forethought, and self-reflection as a constructive feedback mechanism. Self-regulation borrows ideas from the self-leadership principles, in that individuals create strategies to help them achieve their objectives, in conjunction with goal setting and monitoring their progress. Self-regulation is related to social learning theory in that people have beliefs (conditioned by the context and prior learning), they monitor their behavior and the environmental outcomes, and this may lead to subsequent adjustment of behavior or beliefs (Zimmerman and Risemberg 1997). People are guided in

their behavioral choices by predetermined goals, an assessment of contextual conditions, along with their own capabilities required in order to achieve them (Bandura 1977, 1997). Progress towards the goal is monitored and adjustments are made to behaviors, while focusing on a goal (or other self-beliefs) – it is this monitoring of progress that is the key underlying functional in self-regulation, in the light of self-regulatory processes (Strang 2006). Self-regulation includes monitoring one's own behavior, monitoring the environmental outcomes, and the results generated from it through a series of sub-functions, during which comparisons are made with original goals and other belief constructs (Zimmerman *et al.* 1992).

Self-Efficacy

Self-efficacy is defined as "an individual's judgments of his or her capabilities to perform given actions" (Schunk, 1991; Schunk, 1999, p. 220), and "people's judgments of their capabilities to organize and execute courses of action required to attain designated types of performance" (Bandura, 1986, pp. 18-19). Self-efficacy is differentiated from self-concept (self-confidence) in that the former is a specific view of one's capabilities in a single context rather than a general capability across functional domains (Marsh & Shavelson, 1985), and it advocates that a learner's self-feelings affect their behavior, choice of activities, goal setting, effort, value expectancy, persistence, determination, and ultimately their conceptual learning achievement. Self-efficacy, motivation, and self-regulation are interrelated and interact in the individual. Self-efficacy influences the activities chosen, the goals and difficulty level set, effort and enthusiasm applied, level of persistence in the face of difficulty, and affective self-reactions - therefore these play a pivotal role in determining behavioral choices (Bandura 1977), and improving motivation (Strang 2006).

Self-Schema

Self-schema originated in cognitive psychology because behaviorism was seen as inadequate for explaining feelings, mental imagery, introspection and other phenomena that could not be directly linked to specific stimuli and responses, or even unrelated to behavior (Winn and Snyder 1996). Schemata are cognitive development, mental structures and processes (Miller 1956; Miller *et al.* 1960), and complex cognitive processing borrows on the related concept of 'chunking' large amounts of information into smaller manageable quantities for learning. Constructivism is associated with self-schema development in the professional learning goal approach since perception and rationalism is "the justified truth of what individuals believe at a point in time, which can change over time and from one context to another" (Strang 2003, p. 3), which impacts learning. The constructivist ideology argues knowledge is subjective and personal, mentally constructed in many different ways, as a working hypothesis (Simpson 2002), people are active learners and therefore construct meaning for themselves (Geary 1995). This relates to the above factors since cognition is influenced by interaction with social environments (Bandura 1986,

1997). In this research, self-schema development broadly refers to constructivist knowledge creation, critical thinking, and self-reflection.

Professional Learning Course Design and Instruction

The course content and delivery approach is borrowed from constructivist and social development ideologies. For these courses, the overall course design and delivery approach involved an integration of three theoretical methodologies, customized for the professional learning approach, as illustrated and briefly summarized in Figure 2. This integrated model leverages the behavioral aspects of the *ARCS* methodology, the motivational *Nine Event Instructional Approach*, as well as the contextual development *Anchored Instructional Theory*, to emphasize professional learning goal theories (concepts adapted from: Keller 1983; Gagné 1985; Bransford 1990). The model transforms contemporary instructional design from a sequencing pedagogy towards an adult need-based andragogy through learning motivation, critical thinking/schema development, confidence, and self-management.

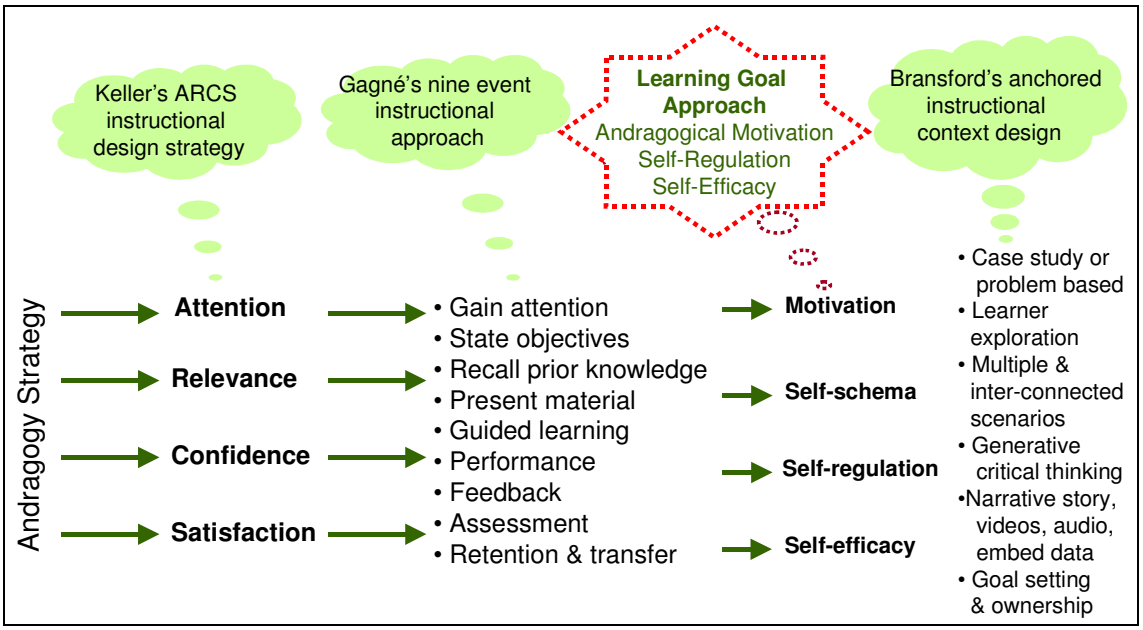

Figure 2: Course & Instructional Design Integrated with Goal Approach (Strang 2006)

The content design was also influenced by the *cognitive apprenticeship learning model* (Brown *et al.* 1989; Collins *et al.* 1989) which integrates situated learning and the expert-novice learning principles holistically apply many of the humanistic, behavioral, constructivist, and cognitive development theories discussed earlier. One challenge experienced in applying the cognitive apprenticeship idea for social learning and goal-setting was the lack of experts available and willing to participate. *Reciprocal learning*

activities (adapted from: Laurillard 1995) offered a work-around for the lack of experts, which was accomplished here by using peers and instructors as the experts for online reflective dialogue.

Research Methodology

Several online courses were designed and delivered to international Executive MBA students. This quasi-experiment is a replication earlier work, and thus re-uses the same proven instruments and techniques. In this replication, more nonparametric statistical measures we well as qualitative coding-analysis procedures are emphasized in this replication. Rigorous standardized procedures are applied to confirm the sample normality as well as to triangulate evidence (theoretical factors, data sources, and methods).

Hypothesis

The research hypothesis (H_1) is that participants will identify and appreciate the improved learning context informed by the key theories underlying the professional learning goal model (in particular: andragogical motivation, self-regulation, self-efficacy, self-schema), as measured by their perceptions from survey/interview questions and tests/final exam results. A positivist and empirical approach is taken in this paper to test this hypothesis. All ordinal responses are grouped into frequency matrices whereupon statistical formulas are applied to quantitatively test the above hypothesis. First of all, quantitatively, this is measured by direct responses from survey questions having discrete response options. An interview with predetermined questions of interest having an ordinal response scale, is applied to gather ancillary data. Secondly, from a qualitative standpoint, participant's written feedback is analyzed using a theoretically coded taxonomy (explained below) to measure perceptions of the applied professional learning goal model factors.

Experimental Scope and Subjects

An online course was designed by applying the professional learning goal approach and delivered online via the *Lansbridge University New Brunswick* Learning Management System (LMS), plus leveraging *ElluminateLive*™ for synchronous lectures, interactions, as well as student guidance. The 14-week course entitled "Information Technology Management for eBusiness" was given to Executive MBA students, in two enrollments managed through the LMS, the first having 26 participants, and the second having 21. The courses ran consecutively and were taught by the author using identical materials and approaches. The participants were split only due to the enrollment size and participant availability, and as such (with an 'almost natural' random selection) it is considered a quasi-experiment. All students were surveyed through the LMS tool, and independently interviewed, with a useable response rate of 87% (41 out of 47),

so there was no self-selection or preferential bias. The two enrollments were treated as a single aggregated experiment frame, with an assumption of a normal distribution. As explained later, sample data aggregation was necessary to meet the prerequisites of the statistical analysis algorithms due to the low frequency counts at some levels of the survey response scales. Demographically speaking, multiple cultures were observed (UAE, United Kingdom, Canada, United States, India, China, Australia, Denmark, Ireland, Malaysia, Signapore, Japan, Fuji, and New Zealand); 59% were male, 41% female, with ages ranging 24-53, and all reported to be employed full-time while taking the course.

Instruments and Data Management Techniques

In recognition that accepting an in-place evaluation framework leaves the survey analysis subject to statistically unknown construct and content validity (Zechmeister *et al.* 2001, pp 238-244), the LMS survey had been modeled after a proven andragogical assessment instrument – the *Self-Efficacy for Self-Regulated Learning Scale* (Gredler and Scwartz 1997). For additional construct reliability, the course delivery assessment codings were adapted from the 'Domains of Performance Indicators' framework (Reeders and Marshall 1996), and Robson's Web-based course evaluation themes (Robson 2002).

In addition to the survey, participants were interviewed for feedback after the MBA was completed, to determine if they had maintained their perceptions. The relevant survey items, interview questions, and response formats used for this analysis are listed in Table 1. All results were captured in the LMS.

Table 1: Course Survey Items and Interview Questions

Instrument Items	Response Format
Survey question 21: The professor used effective instructional techniques (organizing content and lectures, explaining processes, interacting with students, applying useful learning methodology, motivating students).	Agree/Disagree? Likert 0-5 scale.
Survey question 22: The course was clearly designed, with relevant and easy to follow materials, with clear links between content and goals.	Agree/Disagree? Likert 0-5 scale.
Survey question 23: The scheduled student activities and interactions were relevant to theory, and they supported the learning goals, negotiated between student and professor during course.	Agree/Disagree? Likert 0-5 scale.
Survey question 24: The delivery and assessments (tests and assignments) were relevant to theory & learning goals, throughout the course.	Agree/Disagree? Likert 0-5 scale.
Survey question 25: Do you have any additional constructive comments or improvement suggestions about the course design, content, delivery method, or professor's teaching style?	Written comments.
Interview question 9: Do you have any additional comments, reflections, or updates since last taking the course?	Verbal/chat.

The response scales used for the survey and exam, in terms of what results were coded into the analysis result tables and statistical software import files, are shown below in Table 2.

Table 2: Survey Response and Performance Coding Scales

Survey Response Scale:	Performance "*Tests & Final Exam*" Scale:
0 = Not Applicable	1 = Did not write (withdraw or incomplete)
1 = Strongly Disagree	2 = Wrote but failed
2 = Disagree	5 = Passed
3 = Neutral	
4 = Agree	
5 = Strongly Agree	

The survey was administered online at the end of the course (as the last step in the e-syllabus). Course participants were interviewed by online chat and/or telephone approximately 6 months after completing the course. The main purpose of the interview was to determine if the student had maintained their perceptions originally given in the course survey, as well as to capture additional reflections. For the tests and final exam, the defined course weightings were applied. Rather than report the final percentage or GPA, each participant's final mark was recorded as a "1", "2", or "5" in a new row in the LMS database.

The data analysis framework consists of columns representing response level by rows of factors (Table 3).

Table 3: Survey & Interview Response Raw Data Organization Framework

	Response Levels … across all samples			
Factors:	Participant #1	Participant #2	Participant #4	Participant #N
Course Survey Question #21	1/strong disagree	4/agree	5/strong agree	5/strong agree
Course Survey Question #22	4/agree	1/strong disagree	1/strong disagree	5/strong agree
Course Survey Question #23	1/strong disagree	2/disagree	5/strong agree	5/strong agree
Course Survey Question #24	3/neutral	4/agree	5/strong agree	3/neutral
Course Survey Question #25	Comments…	Comments…	Comments…	Comments…
Performance: Pass Exam?	1/No write	1/No write	2/Failed	5/Yes

There were no responses with "not applicable" (0) answers so this interval level was dropped from analysis. The raw data was summarized into frequency columns grouped by theoretical factor (Table 4).

Table 4: Summarized Survey & Interview Response Contingency Matrix

	Frequency Counts Grouped by each Response Level Class				
Factors:	1/Strong disagree	2/Disagree	3/Neutral	4/Agree	5/Strong agree
Q#21: Andragogy (Instruction)	Count	Count	Count	Count	Count
Q#22: Course Design	Count	Count	Count	Count	Count
Q#23: Learning Goals/Motivation	Count	Count	Count	Count	Count
Q#24: Delivery (Interaction)	Count	Count	Count	Count	Count
Q#25: Comments	(coded separately using theoretical tags explained below)				
Performance: Pass Exam?	Count	Count	Not used	Not used	Count

The survey comment responses are analyzed and coded using a theoretical-tagging methodology that has worked well with previous qualitative leadership case studies (Strang 2004b, 2005). The theoretical codes were developed partly from the professional learning goal model (and are almost identical to the root factors tested in the survey questions #21-24), and also partly from reviewing the responses to derive

common educational psychology related elements. A confirmatory factor analysis was not performed on this construct. Each participant response was read several times using the five factors listed in Table 5. Negative or positive dimensions (theoretical tags) were tallied based on the author's subjective interpretation of the comment (and with knowledge of the participant's personality and situation). As an example, if the response mentioned anything referring to how the course objectives or goal-setting improved their learning experience, a positive tally was made, and vice-versa for a negative articulated perception. Examples of each qualitative theoretical tag are shown in Table 5. If a phrase in a survey comment was judged by the author to directly support more than one theoretical tag, then the 'best fit' theoretical code was selected (only one theoretical tag-coding was permitted from a comment phrase).

Table 5: Example Application of Theoretically-Coded Tags

Theoretical Factors:	**Random Comments (From Participant Responses)**	
	-1/Negative Observation	+1/Positive Observation
Goal Choices	"feeling the usual student stress of getting assignment 3 done on time."	"enjoyed the essays…forces you to think about the theory."
Social Learning	"Exchanging the essays/ papers with your peers is a very a good idea …[but] raises the bar, as we are all a little bit competitive."	"particularly enjoyed the interactive nature of the course, which helped me learn a lot from both my instructor and peers."
Motivation	"challenges with posting responses [online]… found it too repetitive."	"pleased with steady feedback", "vClasses help keep on track"
Critical Thinking	"A suggestion …post discussion points on the actuality… theoretical point of views on the actuality/ the news around …world."	"after studying …. this course [helps] to link all my international hands on working experience to science and theory."
Administration & Information Technology (IT)	"find it difficult with all the logins and passwords to keep track of …"	"friendly open working environment [online] …"

Process triangulation was applied during quality assurance to achieve experiment reliability and validity. This was accomplished by having a research colleague (familiar with theory, and the context) review the survey responses as well as the authors theoretical coding. A consensus was reached on any different perceptions (of which there were only two variances and these were unaminously resolved).

The coded survey comments were summarized and stored into a contingency matrix as shown in Table 6. Since several of the statistical computations require positive numbers, the negative integer tallies are later converted to positives by multiplying each count class by "-1", with all results put into another similar table so as to preserve all intermediate data and computational steps (for quality assurance). The rows and columns will be transposed where necessary (as copies of the data) within the contingency matrices used for the Chi-Square and Kruskal-Wallas calculations to make it more convenient to prcess with the MiniTab and Excel software. From a mathematical basis, this will not change the results of the statistical algebraic formula (you can transpose the rows and columns but the χ^2 result will be identical).

Table 6: Summarized "Comment" Analysis Coding Contingency Matrix

Factors:	Frequency Counts Grouped by each Theoretically-Coded Tag	
	-1/Negative Observation	+1/Positive Observation
Goal Choices	-Count	+Count
Social Learning	-Count	+Count
Motivation	-Count	+Count
Critical Thinking	-Count	+Count
Administration & Technology (IT)	-Count	+Count

Software

The two online courses were designed and delivered using the Lansbridge University LMS, with the ElluminateLive™ facility for the online classes. TestGen™ software was used for some online tests. Statistical analysis was done in MiniTab™ and MS Excel™. MS Access™ database was used during course design to inter-relate theory topics to goals and produce an entity relationship model of subjects.

Statistical Procedures

All tests are conducted at the 95% confidence level while the actual probabilities are reported since they are available from the software. A *Chi-Square* statistical analysis was chosen as the main procedure to explore the hypothesis that participants of the online MBA courses will rate their satisfaction high when the professional learning goal approach has been applied. The relative benchmark in this case (null hypothesis) would be a normal Chi-Square distribution consisting of the expected conditional and marginal probabilities associated with a comparable sample size. If the Chi-Square test indicates a statistical dependence between the factors, the *Marascuilo test* is then applied to isolate which factors are significant, using formulas from (Marascuilo and Mcsweeney 1977). *Pearson's Product Movement* and *Spearman's Rank Correlation Coefficient* will be leveraged to order the results and calculate the sample correlation coefficient between two and multiple factors respectively. *Spearman's* formula is adjusted to allow for no-tied ranks as applied from (Carlson and Thorne 1997, p. 295; Minitab 2004). *Multiple regression*, *two-way factor ANOVA*, and *Correlation Coefficient* algorithms are applied to the raw data (not frequency counts), to analyze each factor's impact on the tests and final exam outcome, using formulas documented by (Carlson and Thorne 1997, p. 698; Aliaga and Gunderson 2003, pp. 778-780; Keppel and Wickens 2004, p.156; Minitab 2004). Multiple regression procedures will be applied to the survey responses (but not to the coded feedback taxonomy), only if the Chi-Square tests prove significant.

The *Kruskal-Wallis Rank Test* is applied to analyze the theoretically coded-comment data (to locate the medians of each factor category), as a strategy to determine if particular factors have a significant and different effect on the overall results. The formula was applied from (Aliaga and Gunderson 2003, pp. 923-924; Keppel and Wickens 2004, p. 146; Minitab 2004). It is a nonparametric procedure based the Chi-Square distribution as the benchmark of what a normal expected population probability distribution would be. This technique is conceptually similar to ANOVA and Marascuilo processes for evaluating groups. The *Chi-Square test for independence* algorithm is applied (in software), using the formula abbreviated and briefly explained by (Carlson and Thorne 1997, pp. 576-578; Minitab 2004). Three key assumptions necessary for applying this test are (besides applying rigorous control procedures):

1. All "Expected" cell frequencies should be >= 0.5 recommended >= 1 (Dixon and Massey 1983);
2. 20% of "Expected" cell frequencies should be >= 5 (Marascuilo and Mcsweeney 1977; Daniel 1990);
3. Variables are ordinal or nominal such as Likert scales and counts (Carlson and Thorne 1997, p. 568).

Statistical risk mitigation was achieved in two ways. The first was the application of the two software products (MiniTab and Excel) to verify critical test statistics (such as standard deviations, F-tests, correlations). Secondly, distribution-free tests (e.g. Kruskal-Wallis) were used to corroborate the Chi-Square and regression coefficient findings, for data integrity assurance and sample normality violations. Indirectly this also applied method triangulation (different quantitative and qualitative constructs used). Additional normality estimates are calculated, such as VIF and Durbin-Watson. The articulation of research validity and reliability discussed above is abbreviated as a trade-off in favor of result details, but rigorous standards are applied (Snee 1973; Marascuilo and Mcsweeney 1977; Cohen 1988; Tamhane and Dunlop 2000; Zechmeister *et al.* 2001; Aliaga and Gunderson 2003; Keppel and Wickens 2004).

Results and Discussion

The survey and interview results of the two courses were treated as an aggregate having a total sample size of 47. However, not all responses were received and/or valid, and thus the experimental sample frame size became n=41. The gender ratio remained practically unchanged. The hypothesis tested is: the professional learning goal approach applied during course design and online instruction will result in participants' perceiving a recognition of better learning methods and context, improved satisfaction, and motivation, plus improve the performance outcome (pass the tests and final exam).

The analysis in the following sub-sections is divided into two parts. The first part, which is most significant to exploring the hypothesis, applies various statistical algorithms on the frequency counts from

survey questions #21-24 plus analysis of the performance outcome. The second part investigates the survey question #25 responses that were comments about the course design, instructional approach, and learning context. This latter section is more subjective and uses theoretically-coded tags to quantify the qualitative comments into positive or negative frequency counts, to facilitate statistical analysis.

Analysis of Course Survey and Interview Responses

This section analyzes the survey and interview responses, which were summarized into matrices as frequency counts. The survey response details are too voluminous to list and rather than show the frequency counts separate from the histogram graphs, instead the survey response counts by Likert scale category are portrayed below their x-axis in the Figure 3 plot.

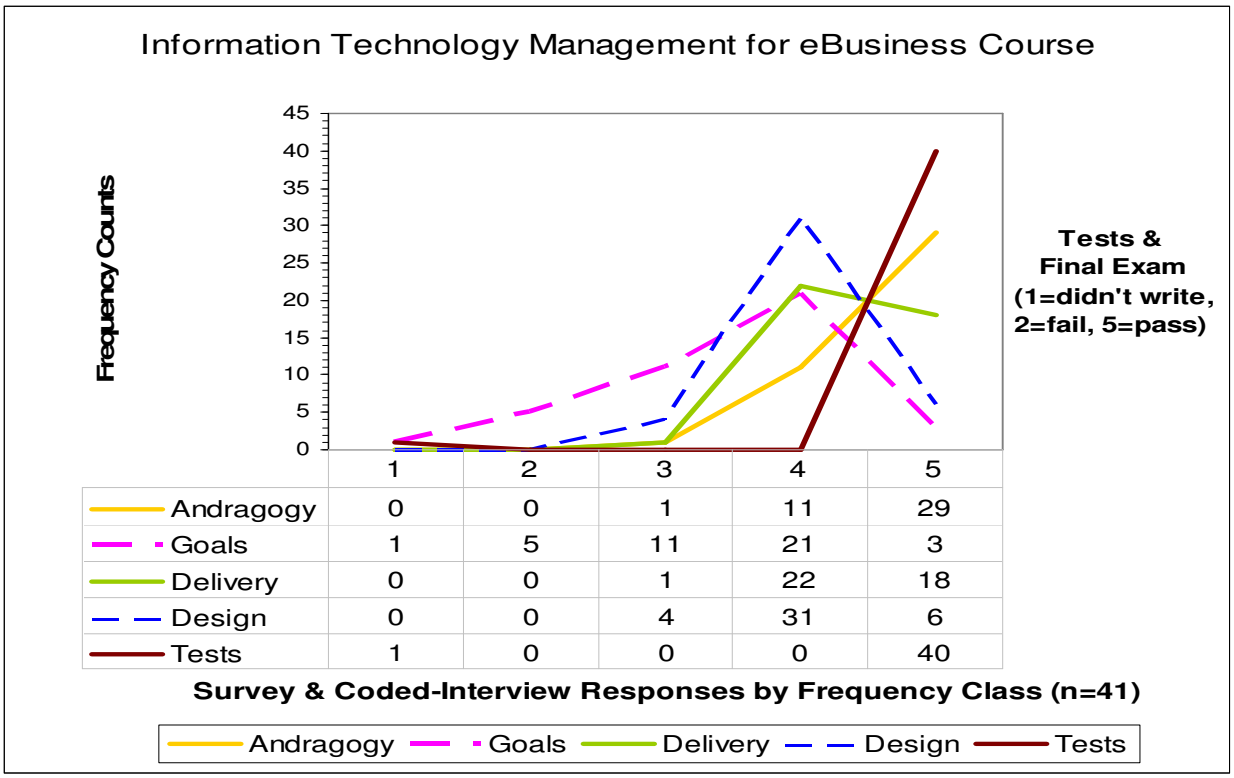

Figure 3: Plot of Course Survey & Interview Response Frequencies by Grouped by Category

The four survey questions (#21-24) are described by a theoretical category title as shown in the plot. The survey question #25 comment result is not included in this plot but is analyzed separately in the following subsection. The performance outcome (tests and final exam score) is also included in this histogram analysis, but since only three response scales were used in the coding, levels 3-4 are not used. Note that in this plot, the actual frequency counts are listed, such as the zero counts for the "andragogy" category at levels 1 and 2. As described earlier, it was necessary to aggregate levels 1-3 together for later statistical analysis (an acceptable technique) because the contingency matrix cells did not contain sufficient

frequencies to fulfill the Chi-Square prerequisites. Theoretically, it is a desired result to have no results in the lower response scales 1-2.

All categories in Figure 3 show an increasing left to right, higher response count, toward the "agree" or "strongly agree" (4 and 5) scale, with the "*final exam pass outcome*" being a desired result at level 5. These results indicate support for the hypothesis that participants identified with the instructional approach, course design, goal focus, and assessment methods, and furthermore they were moderate to highly satisfied with the overall learning experience. Two critical interpretations are firstly that andragogy (learner-centered instructional approach) stood out as a highly perceived learning factor, and secondly, the applied delivery approach was very significant at the response scale 4.

Table 7 summarizes the key elements of the Chi-Square analysis on the survey questions #21-24, plus the interview responses to the *Final exam* question. The results are statistically significant with a large Chi-Square value indicating support for the hypothesis that these factors were perceived by participants as improving their learning experience (χ^2 = 123.5797, p-value = 6.04E-23, α = .05, H_0 rejected). This assertion can be deduced from logic that if the applied professional learning approach had no perceived effect then survey responses would have approximately equal counts of all levels (1-5, disagree to agree).

Table 7: Chi-Square Analysis of Survey & Interview Responses

MBA Course Participant Survey Analysis	Chi-Square χ^2 H_1=Factor impact different				Significance Level α = .05			
Factors	**Observed Frequencies**				Factors	**χ^2 Conditional Probabilities**		
Survey Questions:	Scale 1-3	Scale 4	Scale 5	Total	Survey	Scale 1-3	Scale 4	Scale 5
Q#21: Andragogy	1	11	**29**	41	Q#21	3.008333	2.117647	5.002083
Q#22: Course Design	4	**31**	6	41	Q#22	0.133333	11.52941	9.075
Q#23: Learning Goals	**17**	**21**	3	41	Q#23	31.00833	0.941176	13.66875
Q#24: Delivery	1	**22**	**18**	41	Q#24	3.008333	1.470588	0.075
Outcome / performance:	No Write	Fail	Pass		Outcome	No Write	Fail	Pass
Test/Final exam result	**1**	0	40	41	Test/exam	3.008333	17	22.53333
Total	24	85	96	205				
Hypothesis Testing Results								
Chi-Square Critical Value	15.50731	Expected frequency assumption 20% cells counts >= 5, 100% >= 1 met.						
Chi-Square Test Statistic	123.5797	Decision = reject null hypothesis. Observed frequencies differ from χ^2						
p-Value	6.04E-23	distribution. Theoretical aspects of online courses statistically different.						

Even beyond the statistical conclusions (from Table 7), the high survey response frequency counts for "Andragogy" (agree=11, strongly agree=29), "Course Design" (agree=31), "Learning Goals" (agree=21), and "Delivery" (agree=22, strongly agree=18) prove that MBA participants considered these significant towards their satisfaction with the learning experience. "Andragogy" was the dominant factor, which refers to the survey question about how effective the instructor approach, leadership style and teaching

methods were. This is an important point because the mathematical power of the Chi-Square contingency matrix was underutilized in the sense that at its best the results can only show that certain professional learning theoretical perceptions of participants were more or less significant than others.

A three-dimensional statistical model was created to better harness the Chi-Square analysis for this research. To accomplish this, the χ^2 factor values calculated from the observed/expected conditional and marginal probabilities were inspected at the group rather than the overall level of analysis. Each χ^2 factor value was used to build a 'plot bubble' on a chart, as shown in Figure 4.

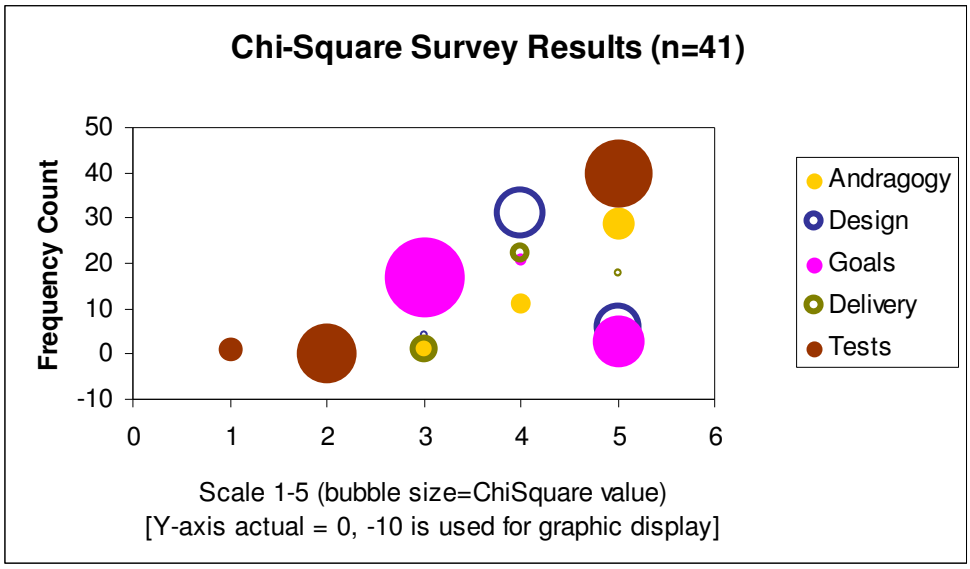

Figure 4: Three-Dimensional Chi-Square Analysis of Survey & Interview Responses

Each bubble's size represents the χ^2 factor value. A larger intermediate χ^2 value mathematically represents a larger contribution to the overall Chi-Square independence, and thus support for the alternative hypothesis that the factors are significantly higher from a normal Chi-Square probability distribution. The rationale for using χ^2 factors instead of the frequency counts to calculate the bubble area is grounded in statistical logic since Chi-Square results transform the raw count data into standardized units that may be compared with other research to make deductions and draw inferences, much like *Z scores* and *student t-test* values. The other two dimensions are built by the x-axis of survey response scales (1-5 as explained earlier in Table 6), and the y-axis of frequency counts per factor class (andragogy, assessments, design, goals, *final exam* outcome). As noted on the graph, the actual y-axis is zero (adhering to proper statistical graphing practices), but the scale is modified down to –10 for display purposes only.

In this three-dimensional statistical model, larger and smaller bubbles are theoretical exceptions worthy of further investigation. Technically, the threshold bubble size (χ^2 value) to signify a higher than expected

joint probability would be 1.03382 as calculated by reducing the critical Chi-Square value (see Table 7) to a uniform cell ratio (to derive this, just divide the critical χ^2 value by number of rows 5, and columns 3, in the matrix: 15.50731 / 5 / 3 = 1.03382). Any χ^2 bubble factor value above this should be investigated because it statistically indicates the variable in the experiment is impacted by more than just probability. The higher the χ^2 bubble factor value, then the more significantly that variable is influenced by a factor. This three-dimensional area graph can be directly compared with the two-dimensional line chart in Figure 3, keeping in mind that the former (Figure 4 just discussed) shows standardized statistical χ^2 factor values, as contrasted with categorical frequency counts (Figure 3).

At this point in the analysis of the survey and interview responses, the results have shown that course participants did perceive that the applied learner-centered theories were beneficial and improved their overall satisfaction. The Chi-Square results supported the research hypothesis that theoretical professional learning goal factors were higher than expected from a normal χ^2 probability distribution, at a statistically significant level. The next sub-sections explore variable relationships in the participant responses.

Factor correlation summarized in Table 8 reveals interesting relationships in the survey responses, which are bolded to emphasize them. There is a moderately strong positive correlation between andragogy motivation and learning goals ($r \approx +0.61$), and course design/materials ($r \approx +0.45$) as well as between performance outcomes (tests) and course design/materials ($r \approx +0.34$), learning goals ($r \approx +0.27$), delivery/interaction activities ($r \approx +0.41$). This suggests motivating students and having them set learning goals (as well as design good courses) go hand-in-hand to create positive satisfaction. It also suggests performance outcomes are correlated with course design, goal setting, and delivery technique (interaction, problem based learning). Multiple factor regression is used next to explore specific cause/effect.

Table 8: Inter-Correlation between Survey Response Factors and Performance Variable

Correlation (α = .05)	Andragogy	Design	Goals	Delivery	Tests
Andragogy	1				
Design	0.157450613	1			
Goals	**0.605577591**	**0.449073216**	1		
Delivery	-0.053477924	0.015694121	0.18885558	1	
Tests	-0.097329822	**0.337423591**	**0.265267541**	**0.414285714**	1

The multiple regression and analysis of variance results highlighted (bolded figures) in Table 9 reveal moderate support towards the research hypothesis that the professional learning approach theories are perceived to positively improve the online learning experience and outcomes (*F-test* = 4.326667225, *p*-

value = 0.005843624, H_0 rejected at 5% level of significance). Theoretical learning factors isolated from the survey responses explain approximately 32% (r^2adjusted for number of factors = 25%) of the variation in *final exam* performance outcome, a medium effect but a significant size as compared with a typical baseline of 10-20% for human behavior studies (Carlson and Thorne 1997, p. 647). Since this experiment is a replication of a previous case study (Strang 2004a), it should be noted that this was also supportive of that finding (specifically, earlier experiments reported 42% cause-effect variation).

Table 9: Multiple Regression of Survey Response Factorial Effect on Performance Outcomes

Multiple Regression of Survey Factors on Final exam Event					H_1=Factor effects differ, Significance Level α = .05	
Regression Statistics			Coefficients of Partial Determination		***Durbin-Watson***	*1.999*
Multiple R	**0.569791505**		**Factor:**	**Y/Constant**	**Coefficients**	**VIF Stats**
R Square	**0.324662359**		Andragogy	r2 Y1.234	0.057852094	1.712670713
Adjusted R Square	0.249624844		Design	r2 Y2.134	0.07413815	1.303990374
Standard Error	0.541137071		Goals	r2 Y3.124	0.038103658	2.175503659
Observations	41		**Delivery**	r2 Y4.123	0.141506955	1.102382716
Two-Way ANOVA	df	SS	MS	F	Significance F	Results
Regression	4	5.067900245	1.266975061	4.326667225	**0.005843624**	H_0 rejected
Residual	36	10.54185585	0.292829329			Significant
Total	40	15.6097561				Factor Impact
Multiple Regression	Coefficients	Standard Error	T Stat	P-value	Hypothesis Testing Results	
Intercept	2.694700346	1.409346734	1.912020854	0.063857564	Not significant by itself	
Andragogy	-0.319241959	0.214718132	-1.48679553	0.14577545	Not significant by itself	
Design	0.333405237	0.196369209	1.697848858	0.098165849	Not significant by itself	
Goals	0.167854832	0.140560533	1.194181807	0.240216256	Not significant by itself	
Delivery	0.400349347	0.164349116	2.43596897	**0.019930415**	Significant as single factor	

Overall, the combined positive factor correlation was +0.57 on the *final exam* performance outcome, which is a moderately strong relationship in empirical social science research. At a more detailed factor level of analysis, the *coefficients of partial determination* reveals course delivery techniques (interaction, etc.) is the most significant factor (14%) directly affecting the *final exam* performance outcome. Factor level regression (isolating each and holding the other constant) show that delivery techniques were moderately significant by themselves (with a *t-test statistic* = 0.400349347), in terms of impacting performance outcomes, with all results calibrated at the 95% confidence level. A benchmark *t-test-statistic* for significant impact in multiple regression for this type of procedure is > ±2 (Carlson and Thorne 1997, p. 106). The interpretation of this is that the perceived quality of course delivery (along with other identified factors combined) were statistically significant predictors of the performance outcome. In closing this section, here is a brief interpretation of statistical regression reliability. As noted in the far top right of Table 9, the Durbin-Watson statistic of 1.99 was given to show autocorrelation (independent factors on the x-axis), is at the acceptable benchmark of ±2 (Carlson and Thorne 1997, pp. 805-806; Tamhane and Dunlop 2000, pp. 147-148). Furthermore, in the top right of Table 9, the Variance

Inflationary Factor (VIF) was calculated to measure the collinearity (combined linear association) of the independent X factors (andragogy etc.), on the dependent variable (exam score), with all VIF's calculated at below 2, which is a good result since they are below 5 (Tamhane and Dunlop 2000, pp. 415-417).

Theoretically-Coded Analysis of Participant Comments

This section presents a qualitative analysis of the course survey question item # 25 in terms of categorizing the comments into theoretically-coded factors, then performing a quantitative analysis of the results. These results support earlier quantitative conclusions that course participants perceived the design methods and learning approaches were identifiable and improved their overall course satisfaction.

It was hypothesized that the improved professional learning goal approach would manifest in the participant comments, and this is evident in the observed frequency counts by theoretical factor category shown in Table 10. For example, "Goal Choices" with 21 counts, "Social Learning" with 28, and Motivation at "31", all indicate participants implied this from their comments. Also of interest are the relatively low levels of negative comments. The Chi-Square analysis summarized in Table 10 did not indicate any particular dependent relationship between the factors, based on the author's classification and coding of the participant comments ($\chi^2 = 6.087283$, p-value = 0.192724, $\alpha = .05$). Note that the "Absolute" values were computed by multiplying negative values with "-1" to support the mathematical requirements of the Chi-Square formula (these are shown on the right portion of Table 10).

The interpretation of the result for this component of the research is that the theoretically-coded participant comments did not point to any particular factor as being overly negative or positive in the course, albeit the results obviously indicate strong support in favor of high levels of motivation, social learning, and goal setting being noted by participants in their comments after the course.

Table 10: Chi-Square Analysis of Participant Comment Theoretically-Coded Tags

MBA Participant Comment Analysis			Chi-Square χ^2 H_1=Comment impact different		Significance Level α = .05
Factors	**Actual Observed Frequencies**			**Absolute (no "-") Observed Frequencies**	
Comment Code Levels:	Negative	Positive	Total	Comment Levels:	Negative	Positive	Total
Motivation	-1	**31**	30	Motivation	1	31	32
Social Learning	-2	**28**	26	Social Learning	2	28	30
Goal Choices	-2	**21**	19	Goal Choices	2	21	23
Critical Thinking	-3	12	9	Critical Thinking	3	12	15
Admin & IT	-1	2	1	Admin & IT	1	2	3
Total	-9	94	85	Total	9	94	103
Hypothesis Testing Results							
Chi-Square Critical Value	9.487728	Expected frequency assumption 20% cells counts >= 5, 100% >= 1 NO.					
Chi-Square Test Statistic	**6.087283**	Decision = accept null hypothesis. Observed comment frequencies by					
p-Value	**0.192724**	coding are typical of χ^2 distribution. No major factor difference found.					

In an attempt to further explore if any particular theoretically-coded category of participant comments might signify a major factor, the Marascuilo procedure was applied to the (Table 10) Chi-Square results. As shown in Table 11, the Marascuilo comparative analysis did not illuminate any significant factor, which corroborates previous Chi-Square results being that any coded comment count differences are by chance. The bolded figures at the bottom section of Table 11 disclose the higher results of the Marascuilo group comparisons between theoretically-coded factor categories. This indicates "goal choices", "social learning", and "motivation", have 'close to significant variation', which supports the hypothesis.

Table 11: Comparative Chi-Square Analysis of Theoretically-Coded Comment Categories

Post Chi-Square Marascuilo: Participant Negative/Positive Comments			Significance Level α = .05
Marascuilo Sample Proportions			
Group 1: Goal Choices	0.086956522		
Group 2: Social Learning	0.066666667		
Group 3: Motivation	0.03125		
Group 4: Critical Thinking	0.2		
Group 5: Admin & IT	0.333333333		
Marascuilo Factor Group Comparisons			
Proportion Group Compared	Absolute Differences	Critical Range	Result
| Group 1 - Group 2 |	0.020289855	0.228974918	Not significant
| Group 1 - Group 3 |	0.055706522	0.20427207	Not significant
| Group 1 - Group 4 |	0.113043478	0.365996855	Not significant
| Group 1 - Group 5 |	**0.246376812**	0.857639763	Not significant
| Group 2 - Group 3 |	0.035416667	0.169275128	Not significant
| Group 2 - Group 4 |	0.133333333	0.347679002	Not significant
| Group 2 - Group 5 |	**0.266666667**	0.84998409	Not significant
| Group 3 - Group 4 |	0.16875	0.331931099	Not significant
| Group 3 - Group 5 |	**0.302083333**	0.843664933	Not significant
| Group 4 - Group 5 |	0.133333333	0.896658875	Not significant

Since the qualitative response analysis was subjective and there was no guarantee of a normal *Chi-Square* distribution in these results, the *Kruskal-Wallis Rank Sum Test* was conducted to determine if the means of the theoretically-coded tag count frequencies were different. Once again these results (shown in Table 12) confirm the previous ones, being that the median differences between participant comment frequency coding categories were not statistically significant, based on a normal Chi-Square distribution (*H Test Statistic* = 1.2, p-value = 0.878099, $\alpha = .05$). In this situation, these results can be interpreted to mean that the theoretically-coded frequencies of participant comments are normal in terms of an expected Chi-Square distribution, and no particular category (median) had unexpected higher or lower variances of negative or positive comments.

Table 12: Kruskal-Wallis Analysis of Theoretically-Coded Participant Comment Categories

Kruskal-Wallis Rank Sum Test: Participant Comment (Coded Factor) Analysis				Significance Level $\alpha = .05$	
Coded Category Factors	Sample Size	Sum of Ranks	Mean Ranks	KW-Rank Sum Calculations (Sorted by Rank)	
Motivation	2	**14.5**	7.25	Sum of Squared Ranks/Sample Size	313.5
Social Learning	2	11.5	5.75	Sum of Sample Sizes	10
Goal Choices	2	10.5	5.25	Number of Groups	5
Admin & IT	2	10.5	5.25		
Critical Thinking	2	8	4		
Hypothesis Testing Results					
H Test Statistic	**1.2**	Positive/negative results related (median locations NOT different).			
Critical Value	9.487728	Decision = accept null hypothesis. Median differences between			
p-Value	**0.878099**	participant comment frequency by theoretically-coded category not statistically significant. Not different from a normal χ^2 distribution.			

The most notable observation in Table 12 is the relatively higher statistical ranking of motivation (14.5) as a theoretically-coded reason from participant feedback (despite similar medians for all factors). Albeit the previous Marascuilo comparative Chi-Square value analysis was not sorted (unsorted makes it easier for the reader to follow the group-by-group contrasts), those results also reveal that motivation (Group 3) had the highest absolute statistical difference in the coded participant comment analysis (see Table 11). The same three theoretically-coded factors (motivation, social learning, and goal choices) identified as almost significant in the Marascuilo comparative analysis (see Table 12) were again ranked the highest in the Kruskal-Wallis results (Table 12). These results strengthen the earlier Chi-Square finding (in Table 10) pointing to motivation as a strong factor perceived by course participants in learning satisfaction.

These findings of higher motivation from the theoretically-coded participant feedback results are important despite statistically insignificant test results (Table 10, Table 11, Table 12), because the frequencies alone provide some support toward the hypothesis that learner-centered andragogical and

course design techniques are noticed and appreciated by professionals. These conclusions are slightly bolstered by the fact that the frequency counts were not transformed from negatives to positives in the Kruskal-Wallis nonparametric test (Table 12) as was necessary in the Chi-Square analysis (Table 10).

Conclusions

This paper has hopefully contributed to the 'online' educational psychology body of knowledge by sharing the action science and empirical results of applying a professional learning goal model for eLearning. Key theories from adult learning, such as andragogical motivation, self-efficacy, self schema critical thinking, and goal-driven self-regulation, were used to design and deliver online education to 47 MBA students, with 41 useable survey responses. Participants were satisfied with their learning experience to a statistically significant level. In particular, course delivery and andragogy (learner-centered teaching approach) stood out a highly valued learning factors. Participant comments indicated that the online interaction using problem-based learning approaches, and motivation, improved learning.

From a quantitative standpoint, Chi-Square probabilities were further examined using a three-dimensional statistical model to compare factors by category frequencies, response scale levels, and χ^2 probabilities. A meaningful interpretation from this analysis was that "course delivery technique" was the most significant factor impacting learner satisfaction, closely followed by goal-setting, and course design. There was a strong positive correlation between performance outcomes and design/materials, delivery techniques, as well with learning goal setting. Multiple regression and ANOVA showed moderate support towards the research hypothesis that the professional learning approach was perceived by MBA students as improving their online learning experience and grade outcomes (andragogy, design, goal-setting and assessment factors accounted for approximately 32% of the variation in performance outcome, with +0.57 correlation). The coefficient of partial determination indicated all factors combined were predictors.

The qualitative analysis of course survey question item # 25 (participant comments) indicated support towards the earlier quantitative conclusions that course participants perceived that the interactive learning delivery approaches and online module design methods were identifiable and improved their overall course satisfaction. The theoretically-coded factor analysis did not point to any particular element as being overly negative or positive in the course, albeit the results indicated strong support in favor of high levels of motivation, social learning, and goal setting being noted by participants in their comments. Distribution-free statistical methods were used to ensure conservative analysis of the theoretically-coded results. The most notable observation was the relatively higher statistical ranking of motivation from

participant feedback. The non-parametric Marascuilo factor comparisons and Chi-Square analysis also revealed that motivation was perceived as very important by the students.

In summary, the results show that course participants did perceive that the applied learner-centered theories were beneficial towards grade performance and it improved their online learning satisfaction.

Limitations

The key limitation of this research is the small sample size of 41 in comparison to other studies being an order of magnitude larger. Additionally, the second statistical analysis section (participant feedback) employed a subjective approach using theoretically-coded factor tags to assess the survey responses into frequency counts. Notwithstanding this work was verified by a research colleague, it is subjective.

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