Dynamic Evaluation Of The Multimedia Interface In Computer Supported Learning

Mark Zaidel, (Email: zaidel@northern.edu), Northern State University

ABSTRACT

As information technology applications become widespread in education, new innovations in computer systems and communication technologies stimulate changes in students' visual preferences. In a university environment each new cohort of students is more comfortable in the digital world, expecting that new technology will enhance teaching and learning. This study analyzes changes in perception on graphic user interfaces in a four-year period both by college students and instructors; the surveys were used to compare different formats of e-learning presentations designed accordingly to student preferences and curriculum requirements. Using factor analysis the principal characteristics of preferred multimedia interface in 2006 are compared with interface preferences four years earlier.

INTRODUCTION

This paper attempts to identify dynamics of the perception of the educational multimedia interface at university-level education. Regardless of the type of the course the multimedia are defined as instruction encompassing both hypermedia and hypertext (Tolhurst, 1995). Quality of multimedia instruction depends on two components: contextual data they present and its visualization commonly identified as an interface. The objective of this study was to identify factors measuring quality of multimedia presentations. Research has indicated that cognitive style and student learning experiences lead to individual preferences related to the format of multimedia presentations (Riding & Rayner, 1998; also Chuang, 1999). Many studies in this subject indicated that further empirical studies are needed (Witkin *et al*, 1977; also Ghinea, 2003) to guide development and evaluation of multimedia systems. The effectiveness of multimedia systems became much more important in online learning (Schnotz & Lowe, 2003) since bandwidth requirements are no longer significant quality limitations.

The interactive multimedia instruction enriches cognitive learning experiences, especially in complex topics (Azvedo, 2005). New generations of students are much more interested in what technology offers them to study in media rich environments than in particular issues of technology itself (Oblinger, 2005); consequently interface should be aligned with student needs and the topic presented. Design presentation templates and interfaces for e-learning need to comply with interoperability, reusability and quality standards; knowing how they relate to students' cognitive needs became as important as fulfilling educational needs (Sweeney, 2005).

Research focus and design

As previous research indicates (Zaidel, 2003) the discussion of effectiveness of multimedia presentations should consider the following issues:

- alignment with the curriculum requirements,
- learning environment and principal teaching strategy,
- student learning preferences,
- user computing experience, and
- student satisfaction from assimilating/processing knowledge.

To evaluate interface preferences of students and instructors the pool of individuals was interviewed in 2002 and 2006 at a university campus. Anonymous participants completed paper survey in 2002 (37 instructors and designers; 40 students) and online Web survey in 2006 (29 instructors and designers, 32 students). Participants were asked to have personal bias toward the evaluated interfaces in their learning/teaching subject matters. The framework of evaluated digital presentations includes Web templates in 8 flexible layouts with following elements: text-based information, digital audio, video, static image interface, interactive image interface, animations, and control elements. Participants evaluated current capabilities of educational interfaces at the time of taking the survey and in subjects of their interest and expertise. Participants assessed current e-learning multimedia instruction ranking:

A. Following aspects:

1. Similarity with classroom teaching
2. Clarity/consistency of current presentation interface
3. Contextual completeness of academic curriculum.
4. Enhancement of student focus on instructional objectives
5. Interactivity increase
6. Enhancement of academic curriculum

B. Most effective combinations

7. Small video and hypertext
8. Interactive images and hypertext
9. Large video and hypertext
10. Scrolling text with audio and images
11. Hypertext with audio and images
12. Hypertext with animations

C. Features of the layout

13. More than two elements present on the page
14. Intensive use of color
15. Format of controls

D. Most important multimedia elements

16. Audio
17. Video
18. Simulations
19. Images
20. Interactive images
21. Animations/Flash

E. Applicability in current teaching/learning experiences

22. Allow delivery of academic curriculum.

The discrete ranking scale for the interface properties is listed in Table 1.

Table 1: Grading Scale

Question Number	Grading Scale	Numerical Representation
1, 6, 22	No - Somewhat - Yes	-1 - 0 - 1
2	Not good - Unsure - Fine - Good	-1 - 0 - 1 - 2
3, 4, 5, 7-14, 16-21	No - Yes	-1 - 1
15	Underlined text - As above + Buttons - As above + color effects	1 - 2 - 3

To further analyze multimedia interface preferences and users' perception of cognitive benefits from computer supported learning, the factor analysis methodology was used to explain dynamics of the e-learning experiences for students and instructors.

Lets compute matrix $R[r_{ij}]$ where r_{ij} is the correlation coefficient between survey data column “i” and column “j”; $i, j = 1, 2, \dots, n$. For this matrix the eigenvalue-eigenvector equation can be written as:

$$(R - \lambda I) x = 0, \quad x \neq 0 \quad (1)$$

This implies that $(R - \lambda I)$ is singular and hence that

$$\det(R - \lambda I) = 0 \quad (2)$$

Eigenvalues are roots of the above polynomial equation. Lets $\lambda_1, \lambda_2, \dots, \lambda_n$ be eigenvalues of matrix R and let $X_1, X_2, \dots, X_n$ be a set of corresponding eigenvectors.

$$X_j = \begin{bmatrix} x_{1j} \\ x_{2j} \\ \vdots \\ x_{nj} \end{bmatrix} \quad j = 1, 2, \dots, k; \quad k \leq n \quad (3)$$

In the above model each eigenvector $[X_j]$ explains variability among correlation coefficients in terms of a smaller number of unobservable variables called factors. Eigenvalues are in proportion to the amount of variation in the total sample accounted for by each factor. Note that the eigenvalue is not the percent of variance explained but rather a measure of amount of variance in relation to total variance. Factor loadings x_{ij} are correlation coefficients between “n” original variables (survey questions) and computed factors. Coefficients with the highest absolute values are used to assign names to a factor.

DATA ANALYSIS

Collected surveys were discriminated by year and teacher/student group. The analysis of raw data demonstrates significant discrepancies in grading multimedia interfaces for e-learning instruction and in assessment of their utilization by the computer-supported instruction. These discrepancies are highly visible in the teacher’s group in the 2002 survey; some answers show instructor disbelief in computer-supported learning as a method of academic instruction, when other instructors had demonstrated reasonable enthusiasm. The perception of electronic learning by individual instructors has slightly higher acceptance in the 2006 survey that can be interpreted as growing interests in applying e-learning concepts and solutions. The survey summary is presented in Table 2.

The variance of majority survey data is high as it was expected. Differences in answers relate to distinctive applicability of multimedia instruction in specific study topics or subject curriculum. The data from students’ surveys is more consistent than from instructors’ surveys, with a higher level of acceptance of e-learning instructional offerings. Does this mean that students are better prepared to use electronic instruction than their teachers?

To select factors describing e-learning interface preferences the following classical eigenvalue-eigenvector computational procedure (Basilevsky, 1994; also Jackson 2003) was adopted:

1. Original survey data (22 questions) was used to find correlation matrix R
 2. Compute eigenvalues and sort them in descending order
 3. If next eigenvalue is equal to or smaller than 1 go to END
 4. For a given eigenvalue compute corresponding eigenvector X_j as defined in (3)
 5. Use coefficients with absolute value greater than α to name this factor.
 6. Compute amended correlation matrix $R = R - X_j * X_j^T$
 7. Go to 3
- END

Table 2: Summary Of Collected Data: Average Numerical Values And Variance

Survey Question	Instructors (2002)	Instructors (2006)	Students (2002)	Students (2006)
1	-0.13 (0.69)	0.07 (0.64)	0.08 (0.57)	0.47 (0.38)
2	0.92 (1.08)	1.07 (0.92)	1.28 (0.80)	1.33 (0.49)
3	-0.08 (0.99)	0.29 (0.92)	0.05 (1.00)	0.73 (0.46)
4	0.42 (0.83)	0.43 (0.82)	0.55 (0.70)	0.87 (0.25)
5	-0.25 (0.94)	0.14 (0.98)	-0.15 (0.98)	0.60 (0.64)
6	0.13 (0.61)	0.57 (0.24)	0.05 (0.65)	0.47 (0.52)
7	0.08 (0.99)	0.43 (0.82)	-0.15 (0.98)	0.07 (1.00)
8	0.25 (0.94)	0.29 (0.92)	0.00 (1.00)	0.20 (0.96)
9	-0.50 (0.75)	-0.14 (0.98)	-0.50 (0.75)	-0.20 (0.96)
10	-0.58 (0.66)	-0.57 (0.67)	-0.65 (0.58)	-0.33 (0.89)
11	0.25 (0.94)	0.29 (0.92)	0.40 (0.84)	0.73 (0.46)
12	0.08 (0.99)	0.57 (0.67)	-0.45 (0.80)	-0.07 (1.00)
13	-0.33 (0.89)	0.29 (0.92)	-0.45 (0.80)	0.07 (1.00)
14	0.58 (0.66)	0.43 (0.82)	0.25 (0.94)	0.33 (0.89)
15	2.17 (0.81)	2.79 (0.17)	1.91 (0.82)	1.93 (0.73)
16	0.33 (0.89)	0.14 (0.98)	0.35 (0.88)	-0.07 (1.00)
17	0.58 (0.66)	0.71 (0.49)	0.15 (0.98)	0.33 (0.89)
18	-0.17 (0.97)	0.29 (0.92)	-0.23 (0.92)	-0.33 (0.89)
19	0.42 (0.83)	0.86 (0.27)	0.45 (0.80)	0.73 (0.46)
20	0.58 (0.66)	0.57 (0.67)	-0.10 (0.99)	0.20 (0.96)
21	0.50 (0.75)	0.14 (0.98)	-0.70 (0.51)	-0.07 (1.00)
22	0.25 (0.52)	0.57 (0.24)	0.45 (0.45)	0.80 (0.16)

All computations were completed in Microsoft Excel with the help of Matrix and Linear Algebra Package for Excel (Volpi, 2005). The arbitrary level for α was set on 0.25. Table 3 and Table 4 contain factors corresponding to the instructors' vision of the multimedia role in computer-supported learning; the following two tables present the students' approach to multimedia instruction.

DISCUSSION

In 2002 focus of teachers was more on the instructional design (Factors I and III) than it was in 2006. The multimedia quality and error-free design seems to be more important in 2006 (Factors II and VI) than it was four years ago. Teachers interviewed in 2006 agreed that the hypermedia presentations should have a format similar to traditional instruction (Factor I). The major drawback in teachers' opinions in 2002 was improper use of multimedia elements (Factors II and V), in 2006 it were mistakes in the interface design (Factors III, IV, VI, and VII). It can be explained as a consequence of progress in instructional design induced by new computer technologies. Designing, developing and delivering instruction is easier today than it was four years ago. As a consequence standards in educational technology are higher - teachers give much more attention to quality of content and interface today than they did four years ago.

In 2002 multimedia presentations most often were evaluated by students based on the similarity with traditional teaching methods (Factor I) and easy/relaxing content presentation by the hypermedia system (Factors III and V). Some students preferred just watching video instruction; however others were seeking interactivity (Factor IV). In 2006 students' evaluations are much more mature - accordingly to the survey they recognize that the focus of multimedia presentations must be on the content (negative influence of Factor I). In addition students like to have full and consistent control over computer-driven presentations (Factors III, IV, VI). This dynamic change from visualization to the need for well-organized and rich contextual instruction is a very positive element of students' expectations related to multimedia instruction.

Table 3: Multimedia Factors As Seen By Instructors In 2002

Factor – Eigenvalue (ratio of variance) Factor Description	Loadings	
	Variable	Coefficient
I 4.567(20.8%) Good instructional design with pleasant look and feel	1	0.36
	2	0.34
	4	0.33
	14	0.29
	15	0.32
	22	0.30
II 3.385 (15.4%) Improper or extensive use of video and images competing with each other; insufficient use of animations	7	-0.41
	12	0.35
	13	-0.33
	17	-0.34
	19	-0.33
III 2.475 (11.3%) Well-prepared curriculum instruction utilizing video and other non- interactive visual effects.	3	0.34
	9	0.31
	10	0.36
	18	-0.35
	20	-0.30
IV 2.045 (9.3%) Confusing interactive content or confusing interface for this content	5	0.41
	11	-0.30
	18	-0.34
V 1.819 (8.3%) Misuse/overuse of audio and visual effects competing with proper hypertext interface	3	-0.29
	11	0.29
	16	-0.53
	20	-0.37
VI 1.292 (5.9%) Improper interface of basic multimedia elements competing with small size of video presentation	1	0.27
	7	0.27
	9	-0.45
	11	-0.30
	12	-0.36
	13	-0.33
VII 1.075 (4.9%) Low quality content or improperly designed multimedia interface	7	-0.32
	11	-0.71

It is interesting that one of the most important factors of evaluating hypermedia instruction is its similarity with traditional classroom teaching - students elected it in 2002 and 2006, teachers in 2006. Concerns related to incorrect hypermedia interface were expressed by both groups in 2002 and 2006, but teachers and students noted it much more extensively in 2006 than four years earlier. Current concerns of teachers include insufficient or improper use of audio, images, animations and simulations. In teachers opinion these elements lead to curriculum enhancements when embedded in proper interface. In 2006 the students' critique these multimedia instructions that focus on visual elements instead of content and have non-standard or complicated interface.

CONCLUSION

This research was conducted at mid-size traditional university campus that does not facilitate significant number of e-learning courses. However, participants were very familiar with e-learning concept and multimedia technologies because of their field of study (students) or professional interests (instructors). Results of this small study can be extended to similar educational environment and in larger scale represent this environment in assessment of multimedia instruction. In summary, this research outlined both positive aspects and concerns of applicability of multimedia instruction at university level teaching.

Table 4: Multimedia Factors As Seen By Instructors In 2006

Factor – Eigenvalue (ratio of variance) Factor Description	Loadings	
	Variable	Coefficient
I 5.178 (23.5%) Similarity of the interface to traditional classroom teaching but enhanced with visual effects.	1	0.31
	13	0.35
	17	0.36
	19	0.33
	22	0.31
II 4.093 (18.6%) Visual quality of interface and quality of animations	2	0.33
	12	0.30
	14	0.41
	21	0.30
III 2.741 (12.5%) Flaws in interface composition or lack of necessary elements (audio, images, animations, simulations) affecting presentation of academic curriculum	6	-0.46
	11	-0.32
	12	-0.27
	18	-0.28
IV 2.491 (11.3%) Non-standard interface design, inappropriate use of scrolling text or audio on interactive pages	21	-0.28
	2	-0.28
	8	0.33
V 2.073 (9.4%) Student focus disturbed by incorrect visual interface to interactive elements or their inappropriate combination	10	-0.44
	7	-0.30
	15	-0.32
VI 1.347 (6.1%) Low quality of visual elements	18	-0.48
	20	0.46
	8	-0.57
VII 1.075 (4.9%) Video clips properly aligned with instructional objective	19	-0.36
	21	-0.29
	4	0.33
	7	0.48
	17	0.28

REFERENCES

1. Azevedo, R. (2005). Using Hypermedia as a Metacognitive Tool for Enhancing Student Learning? The Role of Self-Regulated Learning. *Educational Psychologist* 40(4), 199-209.
2. Basilevsky, A. T. (1994). *Statistical Factor Analysis and Related Methods: Theory and Applications*. New York: Wiley-Interscience.
3. Chuang, Y. R. (1999). Teaching in a Multimedia Computer Environment: A Study of the Effects of Learning Style, Gender, and Math Achievement. *Interactive Multimedia Electronic Journal of Computer-Enabled Learning*, 1(1). Available: <http://imej.wfu.edu/articles/1999/1/10/index.asp>.
4. Ghinea, G. & Chen, S. Y. (2003). The impact of cognitive styles on perceptual distributed multimedia quality. *British Journal of Educational Technology*, 34(4), 393-406.
5. Jackson, J. E. (2003). *A User's Guide to Principal Components*. Hoboken, NJ: Wiley-Interscience.
6. Oblinger, D. G. & Oblinger, J. L. (2005). Educating the net generation. Available: http://www.educause.edu/content.asp?PAGE_ID=5989&bhcp=1.
7. Riding, R. J., & Rayner, S. (1998). *Cognitive styles and learning strategies*. London: David Fulton Publisher.
8. Schnotz, W. & Lowe, R. (2003). External and internal representations in multimedia learning. *Learning and Instruction*, 13(2), 117-123.
9. Sweeney, R. T. (October 5, 2005). Higher education for multi-taskers. *Chronicle of Higher Education*. Available: <http://chronicle.com/colloquy/2005/10/millennial/>.
10. Tolhurst, D. (1995). Hypertext, hypermedia, multimedia defined? *Educational Technology*, 35(2), 21-26.
11. Volpi L. (2005). Matrix and Linear Algebra Package for Excel v. 2.0. Available: <http://digilander.libero.it>.
12. Zaidel, M. & Bertsch, L. (2003). Combining Student Preferences and Teacher Standards in the Design of Multimedia E-learning Interfaces. Paper presented at South Dakota Distance Education Conference, Aberdeen, SD.

Table 5: Multimedia Factors As Seen By Students In 2002

Factor – Eigenvalue (ratio of variance) Factor Description	Loadings	
	Variable	Coefficient
I 4.088(18.6%) Imitation of classroom teaching with multimedia instruction.	1	0.30
	2	0.32
	3	0.36
	4	0.27
	11	0.36
	22	0.28
II 2.619 (11.9%) Focus on visual and interactive multimedia elements	7	0.30
	13	0.35
	15	0.40
	17	0.41
	18	0.31
III 2.118 (9.6%) Passive learning by watching without participation	5	-0.39
	7	-0.40
	9	0.43
	18	-0.36
IV 1.645 (7.5%) Need for interactivity between student and online system	7	-0.36
	8	0.39
	20	0.48
V 1.534 (7.0%) Listening and watching is preferred over higher level academic activities	6	-0.34
	8	-0.34
	10	0.52
VI 1.468 (6.7%) Increase of academic focus by reducing audio and special visual effects when promoting quality animations	4	0.45
	10	-0.31
	16	-0.35
	21	0.36
VII 1.180 (5.4%) Increase student control over contextual and visual context	8	0.66
	9	0.38
	12	-0.33

Table 6: Multimedia Factors As Seen By Students In 2006

Factor – Eigenvalue (ratio of variance) Factor Description	Loadings	
	Variable	Coefficient
I 4.245 (19.3%) Insufficient instruction focused on visual perception instead of content	3	-0.29
	4	-0.39
	17	-0.28
	19	-0.32
II 3.496 (15.9%) Complex imitation of classroom teaching environment enhanced by animations	1	0.32
	6	0.32
	12	0.36
	13	0.33
	21	0.28
III 2.596 (11.8%) Exploration/navigation of content using traditional hypertext interface	3	0.28
	5	0.38
	10	0.30
	11	0.41
IV 2.232 (10.2%) Quality of interactive multimedia interface	8	0.40
	11	0.29
	18	0.25
V 2.140 (9.7%) Negative effects on academic curriculum originating from too complex multimedia interface	2	-0.29
	6	-0.28
	7	-0.25
	13	0.36
	14	0.36
	16	-0.31
VI 1.559 (7.1%) User control over online instruction	15	0.48
	22	0.28