



THE CONSTRUCTION OF A WEB-BASED LEARNING PORTFOLIO SYSTEM THROUGH LEARNING STYLE AWARE ADAPTIVE SYSTEMS

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Abstract - Social, economic, and technological forces are coming together to fundamentally change the training and education worlds as we know them today. The merging of computer-based multimedia technology with the efficient delivery capability of the Internet is generating major shifts in the styles of education, both inside and outside the formal education systems. This paper focuses on the development of a model for classifying and evaluating e-Learning. It compares the effects of e-learning versus those of traditional instructor-based learning, on student learning, based on student learning styles to determine if e-learning is more effective for those with a particular learning style. The Kolb Learning Style Inventory (LSI) measured the learning styles of students. This post-test, intact-group design examined the dependent variable of student knowledge based on the learning style of each subject and the learning method to which each was exposed.

Keywords: Learning management system, E-learning, Internal Portal, External Portals, Learning Styles.

I. INTRODUCTION

Nowadays, stakeholders, educators, content providers, software providers and e-learning developers have come to understand that for e-learning, in order to be effective and inclusive for all, it is crucial to create awareness around the “added value” which it brings with it, which does not mean simply transposing face-to-face classes online, on the Internet or on a CD Rom. E-learning should bring novelty, should support users’ creativity, active

participation, relationship building, connections, information sharing, collaboration inclusion and should innovate the old educational frameworks. Everything still needs to be reinvented.

Digital technologies continue to influence the way we find, create, share, and negotiate information and ideas – even influencing the ways that we think about knowledge itself. Learning, education, and training continue to extend the reach of classrooms and training rooms by including a more organic, integrated array of learning experiences and support – available “anywhere, anytime, and just-in-time.” Perceptions of competence have expanded; today we balance demonstrating personal mastery of knowledge and skills on criterion-referenced tests with assessing how well someone can leverage their inter-connected networks of connections to resources, information, and subject matter specialists. Work styles are shifting from individual accomplishment to teams, communities of practice, and collaboration. Nevertheless, individual accomplishment is still important, providing a measure of the contribution that each individual offers [19]. And smart enterprises understand that investments in people and in technologies that serve their needs can have a direct positive effect on business success metrics such as profitability, reduction of operational overhead, and employee retention, to name but a few. As Figure 1 notes, the content and mechanisms for delivering e-Learning have become more sophisticated, so too have the systems intended to manage e-Learning content,

distribution, and experience [12]. E-Learning organizations are looking to do more than simply measure the number of course hours taken, tests passed, modules completed, or certificates earned. Systems are beginning to shift from a focus on learning management to learning management, where the learning is finally taking center stage.

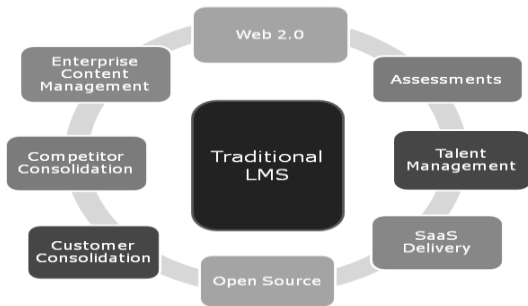


Figure 1: The trends and demands facing LMS systems and vendors.

For organizations already deeply invested in Web 1.0-focused LMS products, or for those organizations that rely on third-party commercial software to satisfy regulatory compliance, the traditional LMS will continue at the center of the enterprise learning strategy for the next several years. Nevertheless, the traditional functionality provided by a “publish and distribute” LMS addresses only a part of today’s ever expanding set of e-Learning delivery methods and media. We see shifts to new learning tools across enterprise, higher education, and K-12. Learners are leaping over firewalls, while new networks and knowledge are constructed and shared via Web 2.0 applications, such as social networks, Wolfram Alpha, Bing, Google Squared, and Caffeine searches.

II. RELATED WORK

E-learning has been attracting considerable interest, and a variety of perspectives have developed. Although much of e-learning research is based on formal courses in educational institutions such as [13], workplace elearning or web-based training is being studied by a significant number of groups. PROLEARN, a “Network of Excellence” financed by the Information Society Technology program of the European commission dealing with technology-enhanced professional learning, is working on approaches and guidelines for companies to implement knowledge work and learning management according to business needs and business processes [17]. PROLEARN has developed a web portal supporting learning performance assessment, including the selection of learning performance metrics, validation of scales, executions of online surveys, and interpretation of results [10]. Another project, APOSDLE, supported by the European Union, aims to enhance knowledge worker productivity by supporting informal learning activities in the context of knowledge workers’ daily work processes.

They have developed a flexible framework for enterprise modeling that contains formal and informal knowledge and integrates the modeling of domain, processes, and competences within an enterprise [6]. Other related work includes competency-based learning, where learning is driven by development of specific competencies for dealing with needs and challenges in competitive environments. [11] used the competency performance approach to extend the theory of knowledge space. Based on the work of [11], [3] investigated a competency method with a focus on organizing learning content in line with competencies. Regarding e-learning systems development, extensive research and practices have been carried out in the analysis, design, and delivery of learning systems, which integrates concepts, processes, and principles of instructional design, software engineering, and knowledge engineering [7].

III. THE DESIGN OF E-LEARNING METHODOLOGY

A. E-learning Technology

The proposed e-Learning Technology Framework helps us understand the role of products and the kinds of products required to fulfil specific needs. It also provides us with a means of assessing individual products. Specifically, the objectives of the e-Learning Technology Framework are to enable us to:

- Classify products based on role
- Assess specific solutions and products
- Match products to specific e-Learning requirements
- Design an overall architecture or design a framework for a combination of products.

At the highest level, the e-Learning Technology Framework is about understanding which types of product exist, and their role in building an e-Learning solution. The following diagram summarizes the e-Learning environment.

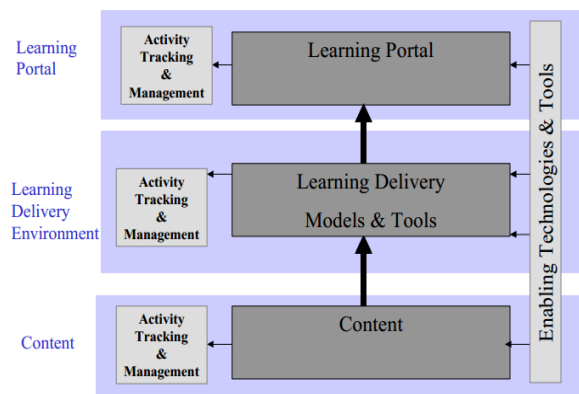


Figure 2. e-Learning Technology Framework

B. Learning Portals

The term “portal” is a relatively recent addition to Internet terminology. Although definitions vary slightly between organisations, in essence a portal is an access-point to a set of services via a web-browser [9]. A Learning Portal is really a concept rather than a specific product. It is an aggregation of learning services and associated products into a single (hopefully) coherent access point [16]. Typically this will include course catalogues, course registration, need assessment, instructional support, learner forums and so on.

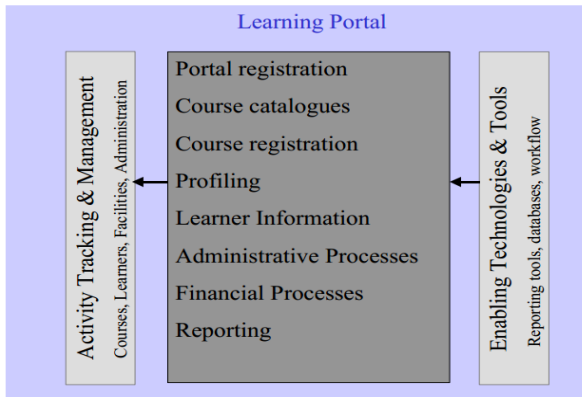


Figure 3. e-Learning Technology Framework -Portals

A. Portal Functionality

Portals are really a set of products to support the learning services provided. The products can range from a Learning Management System (LMS) to manage access to a course catalogue, through to collaborative tools to support discussion forums, and content tools to create and manage specific content. Access for online courses can be directly managed via the LMS component of the portal [2].

The following is a list of functionality that a Learning Portal could provide:

- Catalogue of courses and learning available
- Registration and enrolment services
- Personal activity tracking
- Organisational tracking
- Personal profiling
- Personal information storage areas
- Learning forums
- Instructional support
- On-line course/learning fulfillment

There are two pretty distinct types of portal – Internal Portals and External Portals. Internal Portals are private, organisation-specific environments. External Portals are public environments accessed by many organisations.

(1) External Portals

Many of the external portals currently “aggregate” course schedules for the purposes of supplying a single point of

booking and confirmation. They may also provide access to discussion forums and other learning management services [14]. Whilst an External Portal can be tailored to specific organisations, it is likely to contain a subset of total learning services needed within an organisation, or be used as a purely public learning environment. An External Portal by definition cannot be closely integrated into internal HR or ERP systems. Examples of External Portal providers include THINQ, Click2Learn (formerly Asymetrix), Smart Force (formerly CBT Systems), SmartPlanet.com (formerly ZDU), Learn2.com and many more. Other related products include BlackBoard.com.

(2) Internal Portals

An internal portal is generally available on the corporate intranet, and may provide access to the “Corporate University”, internal courses, forums etc. It is usually integrated with the internal Human Resources (HR) or Enterprise Resource Planning (ERP) systems. Whilst the portal may be internal, some of the courses could in fact be external, such as public courses running on the Internet [5]. An Internal Portal can therefore be completely unique to a specific organisation, and is custom-developed for that organisation, often being closely integrated into other key corporate systems [1]. The design and architecture will vary significantly based on learning service requirements, scale and underlying infrastructure. It is also possible that an Internal Portal could be hosted externally via an External Portal provider. In this case a customized External Portal is provided, including organisational-specific content in a secure environment. The external hosting probably limits the kind of private information on the portal, and limits the integration into internal systems and information.

C. Learning Delivery Environments

This is the environment that contains and manages the learning process and integrates together the content, collaboration, instruction, facilitation, assessment and so on. Content may be of many types including documents, web references, references to physical media including books, interactive media, video, audio etc. Depending on the specific learning requirements and the associated learning model, the relative mix of content, collaboration and instruction/facilitation varies enormously [8]. The role of the Learning Delivery Environment is to tightly integrate these components of learning together for the student in a transparent way. It should enable them to move between the activities of accessing detailed content, discussing it, collaborating on projects based on it, assessing it or submitting assignments or test work in a seamless way.

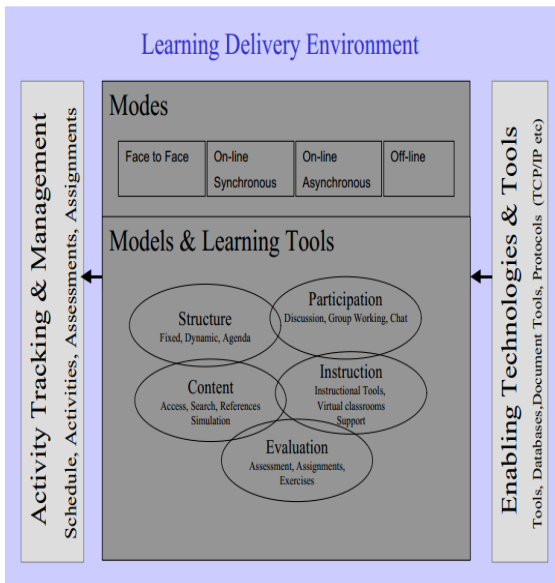


Figure 4. e-Learning Technology Framework– LDE

Key Functional Components of a Learning Delivery Environment (LDE) include the :-

- A way of structuring the detailed learning processes and activities
- A library of supporting resources or content.
- Integrated collaboration tools – potentially both synchronous and asynchronous.
- Tools for assessment and work assignments.
- Personal profile information and activity tracking.
- Instructional support tools for use by instructors/facilitators
- Potential integration between learning events and personal diaries.

IV. DISCUSSIONS

This research empirically investigated the impact of e-learning on student knowledge based on learning styles. In addition, this study attempted to provide evidence that e-learning is more effective for those with a particular learning style. Results were compared with the traditional instructor-led course format [15]. The outcome of this study should help instructors and instructional designers to develop more efficient and effective instructional methods based on student learning styles. Furthermore, the outcome of this study could help training and learning centre’s look for efficient and effective methods to keep up with the ever-growing need to upgrade the skills of their workforce based on their learning styles.

Participants

The study examined undergraduate students at a major university who were enrolled in a subject course that was offered as an on-campus instructor-based (traditional) option and a web-based (e-learning) option. For this study, students of only one instructor were involved. The

instructor taught both the web-based class and the instructor-based class in two different sections. Therefore, the possibility of interaction between the methodology and having different instructors was minimized. All students participated in the knowledge exam on the same day.

Instrumentation

The Kolb LSI was used to measure the learning styles of students. Kolb’s learning styles are defined by four levels: Diverger, Assimilator, Accommodator and Converger

Features of learning styles

Learning style	They best learn through
The Diverger	Feeling and watching
The Assimilator	Thinking and watching
The Converger	Thinking and doing
The Accommodator	Feeling and doing

Table 1

The LSI is well respected and used in business organisations and academia. It is designed to measure the degree to which individuals display the learning styles derived from experiential learning theory. The LSI requires students to resolve the tension between the abstract concrete and active-reflective orientations. For this reason, the LSI format requires respondents to rank-order their preferences. It was hoped that the measures of learning styles would predict behavior in a way consistent with the theory of experiential learning. The LSI, in conjunction with the teaching strategy, comprised the independent measures. The performance measure that was investigated in this study as a dependent measure was the knowledge gained at the end of the semester for each method of learning. The LSI test, a 12-item questionnaire in which respondents attempted to describe their learning style, was first given to the students three weeks before they took the exam. Finally, students took the end-of-semester, knowledge based, comprehensive exam.

V. DATA ANALYSIS

The data were translated into an ASCII database e file and placed on a floppy disk. They were analyzed using SPSS version 10.0. Based upon the results of the LSI and post learning exam, a series of two-way analysis of variance (ANOVA) techniques and independent variable tests were Used for the dependent variable, knowledge based on a student’s learning style.

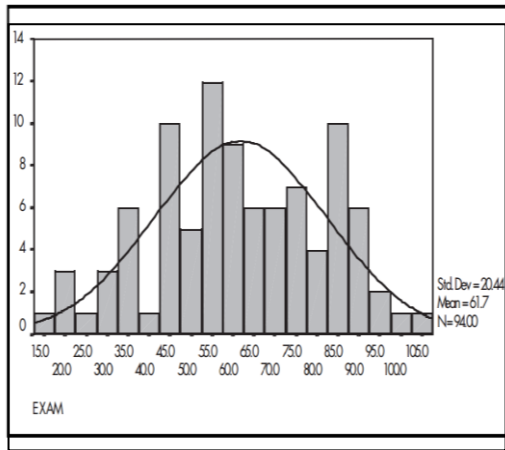


Figure 5. Distribution of subjects' knowledge exam

To determine if any difference existed between the two groups, an analysis of student knowledge (final exam grade) for both groups was done. Student knowledge exam (dependent variable) Subjects took a knowledge-based exam at the semester's end to investigate how learning was impacted owing to the learning methods. The science department, with the instructors' help, created the end-of-course exam, which was the same across both sections, whether the students enrolled on the web-based or instructor-based option. The comprehensive exam consisted of 21 questions with few sub-questions and had a two-hour time limit. Figure 5 shows the distribution of subjects' knowledge exam. The N = 94 is the total number of students who took the exam. Standard deviation is 20.44 and mean is equal to 61.7 for the knowledge-based exam.

VI. RESULTS

A two-way ANOVA procedure was conducted, involving two independent variables. The first independent variable was Kolb's learning style categories and the other was learning methods. Kolb's learning styles are defined by four levels: Diverger, Assimilator, Accommodator and Converger. The learning method was made up of two levels: e-learning and traditional learning. The student knowledge was analyzed in a 4 by 2 ANOVA. Table 2, a two-way ANOVA summary, provides three F values. These three F values are associated with three research questions. The following are the three independent research questions that were tested in terms of the relationship between methods of instruction and knowledge gained by students during the semester. In addition, the interaction effect of methods of learning and student learning styles on the same dependent variables was tested.

1. Is there a statistically significant main effect for the learning style?
2. Is there a statistically significant main effect for the learning method?

3. Is there a statistically significant interaction between the learning style and learning method?

These three research questions deal with learning style and learning method at the same time. Two main effects and one interaction effect were assessed.

Table 2. Summary of ANOVA for student knowledge

Source	SOS	df	MS	F	p	η^2
LS	3299.24	3	1099.75	2.74	.048	.085
LM	96.63	1	96.63	.24	.625	.002
LS*LM	1961.08	3	653.69	1.63	.189	.050
Error	34530.11	86	401.51			
Total	38863.66	93				

Note: SOS = sum of square; df = degree of freedom; MS = mean square; F = computed F value; p = level of significance.

The first F value is concerned with the main effect, which dealt with the learning styles. The two-way ANOVA, with student knowledge (grade score) identified correctly as the dependent variable, yielded a significant main effect for learning style [$F(3,86) = 2.74, p = 0.048$ in which $p < 0.05$]. This means that learning style main effects are statistically significant in the student knowledge grade. Therefore, based upon the data collected and analyzed in Table 2, there was a significant difference in student knowledge based on learning styles when learning on the web versus instructor-led. The other two sources, learning methods and interaction of learning styles and learning methods, were not significant as the F value is greater than 0.05 ($p > 0.05$). The e-learning mean was 60.78 (SD = 22.59) and the IBL mean was 62.28 (SD = 19.18); see Table 3. The means and standard deviations for both groups were not significantly different, giving some confidence that they represented the same population. At the same time, this findings confirms earlier findings that delivery strategy does not significantly impact student outcome. If this is true, then the use of web-based strategies should be based on other factors. There was no significant interaction between learning style and teaching methodology, but it is possible a larger sample could have shown significant differences. Figure 6 show that the students with learning styles one (Assimilator) and four (Converger) did better with the elearning or web-based learning style. In addition, students with learning styles two (Diverger) and three (Accommodator) received better results with traditional instructor-based learning.

Learning method	Student knowledge	
	M	SD
IBL	62.28	19.18
e-learning	60.78	22.59

Note: M = mean; SD = standard deviation.

Table 3. Means and standard deviation of student Knowledge based on e-learning and instructor-based Learning

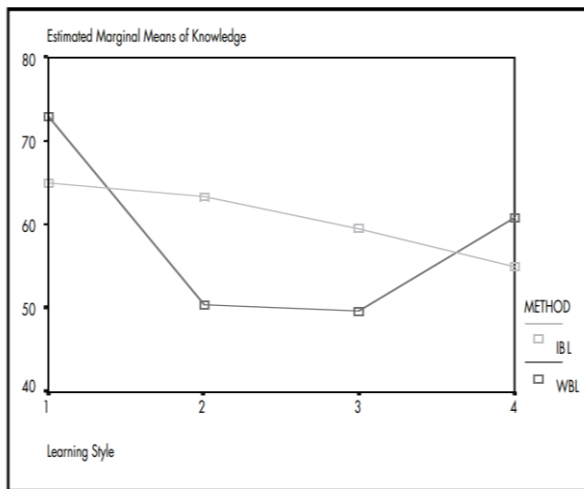


Figure 6. Interaction effects of learning style and learning method on student knowledge Note: Learning style 1 = Assimilator; 2 = Diverger; 3 = Accommodator; 4 = Converger.

VII. CONCLUSION

The results of this research paper revealed that students' learning styles were statistically significant for knowledge performance. This conclusion is consistent with earlier findings on the importance of learning style. For the instructor-based learning class (traditional), the learning style was irrelevant, but for the web-based learning class (e-learning), learning style was significantly important.

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