The Role of Pen-Based Learning Technologies within Commercial Learning Content Management Systems: I-Trace Final Report for Eedo Knowledgeware

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Abstract

Eedo's mandate was to assess the potential for pen-based learning technologies (PBLT) within the commercial elearning market, meaning what is the perceived value of pen-based capabilities as a feature of commercial e-learning platforms (from both learners' and developers' perspectives) and within the training function located in corporate and public sector organizations. What are the possible applications, and what are any relevant obstacles?

Eedo integrated Web-trace, an open-source annotation tool, within the industry-leading LCMS platform, ForceTen. Content, including learner interactions and tasks created via Web-trace, was created in collaboration with customers representing two industries. This content was used as the basis for exploring the attributes of annotation in a learning environment and gathering internal feedback. A survey was subsequently carried out, with twenty organizations responding, addressing the use and value of PBLT as well as technical and organizational obstacles or constraints that would impede adoption. Overall, results suggested PBLT is recognized as valuable from a learning perspective, but certain industries in particular are wary of any annotative capability (note-taking, annotation, wiki-based commentary etc) for reasons related to privacy and exposure to risk in highly regulated industries.

Technical challenges that arise for annotation in learning content management systems platforms relating to scalability, security and content management were identified as issues. Web-trace, the open source annotation tool the formed the basis for our experimentation, is Java-based, which is also an obstacle in some corporate environments.

In a later phase, Eedo undertook to develop an e-portfolio component of the LCMS, and integrate some pen-based capability to enhance the portfolio – allowing annotation of content and free-hand commentary by either learner or qualified appraisers. In the context of the I-trace project, the goal was not to assess the general value of e-portfolio within commercial elearning and HR systems (though this is a new area of application and the

goal is of interest to Eedo), but rather to investigate perceptions and potential regarding enhancement of such systems with pen-based capability.

Overall, we have concluded that pen-based technology and digital ink are important innovations that can enhance learning and make administrative and collaborative and evaluation tasks within an LCMS more efficient. We also believe that early adoption will be a differentiator in our highly competitive commercial market. Hence, we have integrated some initial capability within the current version of our LCMS platform and have added further enhancements to our roadmap for our next full release (v. 6.0). We are currently investigating alternatives for a full implementation of pen-based capability and the InkML standard which is not Java-based. The project has also furthered our belief that e-portfolio will be an important new application within the field of HR and learning related systems in commercial, corporate settings. Both e-portfolio and pen-based interfaces are, in our view, keys to addressing the requirements of technology-based support for life-long learning in large organizations.

1. Introduction

1.1. Eedo Profile

Eedo Knowledgware (Eedo Germany) represents the sole commercial partner among the groups comprising the I-trace project team. The firm is recognized by industry analysts in North America and Europe as the leading provider worldwide of enterprise infrastructure for elearning and knowledge management (e.g., Bersin & Associates, Gartner in the US, eLearnity in the UK), based largely on the innovative technology we have developed and continue to evolve. The head office is located in Canada, however, many of our customers are global organizations and about 45% of our business currently is based in the UK and Europe, where we operate from offices in London, the Hague and Berlin. Eedo is a global organization comprised of businesses incorporated in the US, Canada, Germany, the Netherlands and the UK. Our European organizations include sales, marketing, R&D and product management. There is a European marketing director, and product management is based in the Netherlands.

Our role within the project was explicitly identified as providing input regarding the commercial viability of pen-based learning technology. Eedo is well-positioned to provide this input. Eedo's flagship product is a learning content management system called ForceTen. Forceten is used by a good cross section of the world's largest organizations concentrated within the following industries: Finance and Insurance, Health and Pharmaceuticals, Aviation and Aerospace (both civilian and military), High technology, and also the public sector. The list of customers includes organizations such as Shell, Eli Lilly, Pfizer, Xerox, Dell, Boeing Civil Aviation and Boeing Defense, Lufthansa, Northwest Airlines, MetLife, American Management Association, UK government agencies and departments (Foreign and Commonwealth, Customs and Revenue, Department for Work and Pensions), US government (Internal Revenue Services, Department of Energy, Treasury) and Canadian Government (Correctional Services Canada). These include very large enterprise implementations that also integrate our platform with other enterprise systems: HR systems, business applications and ERP. The world's largest implementation of LCMs technology (as confirmed by Industry analysts Bersin & Associates) is currently an implementation of ForceTen within an insurance firm, where the system runs on 24 dual-processor servers, load balanced and with a terabyte of SAN storage available.

While many of our more recent customers represent large enterprise implementations, early adopters (4-6 years ago) were often departments or divisions within organizations that adopted the technology for specific initiatives. In both cases, it is safe to say that our customer base, and the market we target, comprises those organizations that are on the cutting edge of innovation in terms of their adoption of technology and strategies to support learning in different formats and through different modalities. Thus, data collected from these organizations (who represent early adopters and investors in leading edge technology) concerning the utility and potential for other innovations in elearning (such as pen-based learning technologies) is, arguably, likely to predict the future direction of thinking in the broader marketplace.

1.2. Eedo project goals and responsibilities

The initial scope of Eedo's involvement can be summarized with the following objectives.
(1) Conduct a general literature review concerning the educational benefits of annotation in general, Some specific areas that were relevant to I-trace were to be addressed, also: for example, the theoretical literature on the learning of visual discrimination tasks.
(2) Integrate the I-trace digital tracing program into ForceTen
(3) Create some content and interactions using the I-trace program within ForceTen
(4) Use this experience (3) and the content produced to assess the potential for this type of functionality within commercial elearning contexts, across a variety of industries. Here we would address the perceived utility and also perceived obstacles.

Apart from these specific goals, we intended to contribute to the general progress of the I-trace Minerva program by hosting team meetings at our premises, participating in discussions and discovery regarding issues such as standards, contributing to discussion about research design and methodology.

Over the course of the project, our role, our perceptions of the potential for pen-based learning technologies (PBLT), and our plans to incorporate pen-base capabilities in our own products changed. To begin with, we took on an additional component related to the project mandate, by developing an e-portfolio application, enhanced with pen-based annotation capabilities, within our LCMS, and collecting some industry feedback about this application. Further, we initially did a simple integration of the web-trace open source tool within the LCMS to create content that could be used as a basis for exploring the different ways this particular annotation tool and its capabilities could be used in commercial elearning situations. However, later we decided (as reported in the mid-project external evaluation) that we had focused too narrowly on this specific functionality, and that real benefits could come from incorporating general pen-based annotation capabilities – pen-based entry of notes and annotations, and secure, digital signatures. This shift was reflected in our work late in the project, with the e-portfolio application, and also in current product development planning and work in which we are addressing pen-based capabilities in our product.. We also became increasingly interested in the opportunities to leverage the work of other partners, in particular the work carried out with annotation of 3-d learning objects, which has obvious applications in aviation, aerospace, manufacturing and automotive industries.

In the following sections we: summarize our findings in literature review conducted at the start of the project; detail the work carried out with integrating web-trace and creating content and interactions based on this tool; report the results of a survey conducted at an Eedo user conference related to PBLT; document an attempt to collect additional feedback from an online survey distributed after a series of demonstrations of web-trace, 3-d learning object annotation, and e-portfolio; describe the technical work and requirements involved in creating the e-portofio application; present the results of one-to-one evaluations of the e-portfolio collected through demonstrations and discussions held between an Eedo partner in the Netherlands and customers and prospects in the European market; provide a summary of feedback collected from a focus group run in a university setting involving faculty and an internship coordinator responsible for placing and supervising graduate students in workplace internships; summarize the technical issues related to PBLT in commercial settings, including our stand on standards, from an industry perspective. Finally, we comment on our future actions and our overall perception of the value potential for PBLT in commercial elearning contexts.

2.0. Literature review

Our very first deliverable (August 2006) was a literature review focusing on the effects of note-taking and annotation on learning and performance. We reviewed the wider literature on the subject, which extends back some five decades, and the more recent literature that focuses on information-technology mediated situations. The product was a concise (25 pg) review that focused on delivering the best information, based on best evidence, in a format that could be digested easily and used to inform other partners in the I-Trace project. The literature review also uncovered two recent, comprehensive syntheses of the extant empirical literature, in the form of meta-analyses. The review is appended to this report (**Appendix H – I-Trace Literature Review**). Here we present only the highlights, as they provide a general backdrop for other elements of this report.

The long history of research on note-taking using traditional pencil and paper shows quite large effect sizes for retention, comprehension and application of learning to high-order cognitive skills, such as problem-solving. These effects are for individual note-taking. There is also evidence that note-taking can be an effective strategy for accommodating learning disabilities of some forms.

The contemporary literature of "instructional technology" focuses on collaborative note-taking, note-sharing, and predominantly addresses situations where the mode of input is a keyboard. There is good evidence that users find this awkward and have resistance to using the keyboard as a device for note-taking. Effects for learning are not so obvious, large or consistent as is found in the traditional literature. It seems clear that the power of note-taking and annotation is related to the fluid representational affordances and capabilities of the pen as an input device, and the transparency of the pen as a tool.

A significant HCI issue for keyboard entry is whether notes are taken in a separate note-pad or whether they can be anchored directly in the text, as they often are in pencil and paper situations. Notes anchored directly in the text may be taken more efficiently (no need to provide as much context in the notes themselves, and various forms of direct reference via highlighting of one form or another are possible) and may provide for more efficient review of the notes and the complete text. As an anecdotal report, Eedo's ForceTen includes a note-pad application for taking notes in courses. In an informal survey of developers and administrators from nine organizations, all nine reported that the function is not used.

The contemporary technology-oriented literature also has a heavy focus or emphasis on either collaborative note-taking or note-sharing in electronic environments. There is not much evidence that either strategy has a meaningful impact on learning. Given the idiosyncratic, personal and elliptical nature of notes, and the fact that the effect presumably comes from the cognitive elaboration activities involved in note-taking, it is not surprising that reading someone else's notes has little impact on learning or performance.

The literature review addressed note-taking and annotation, as a general topic, but also the theory involved in learning to perform visual discrimination tasks and developing visual discrimination skills of specific kinds. This was a response to the inclusion of the web-trace intelligent tracing program as one of the tools under investigation in the I-trace project, and the intended use of this tool to address specifically the acquisition and improvement of visual identification and discrimination skills with respect to medical imagery. The basic theoretical models that purport to explain how these skills work and are learned were summarized. Of particular note is the distinction between pre-attentive and attentional processing. We summarize the issue here, quoting from the summary of the literature review:

> "Pen-based interfaces also offer the opportunity to improve on computer-based approaches to various interactive practice and learning tasks, such as acquiring skills in visual discrimination tasks. With regard to the latter the distinction between pre-attentive and attentional processing. Traditional approaches to teaching and practicing visual discrimination tasks within elearning environments typically exploits the use of "hot spots" to offer alternative choices. This approach converts the activity to a recognition type interaction rather than a recall task, and likely limits learning and retention as a consequence. From a theoretical perspective, the approach is likely to short-circuit the more complex discriminations that are required of the attentional phase of processing, again, limiting learning. The potential of interactions based on web-trace or other "intelligent" tools that can examine user input in the form of a trace or outline of a region of interest and then compare this for the degree of agreement or match with an expert's trace, based on selected parameters, is thus great in terms of facilitating the learning of complex, subtle visual discriminations, within an electronic environment."

Overall, the findings in the literature review pointed quite clearly to the potential contribution of pen-based interfaces for improving learning in terms of text or discourse-based comprehension, retention and transfer of learning and for both acquisition and assessment of development of visual discrimination skills.

Since the completion of the project, we have initiated further literature searches to uncover any recent empirical studies that have identified the effects of pen-based computing on learning (for example, pen-based digital note-taking). There is a complete dearth of such studies. One future goal of Eedo is to carry out such studies once customers take up pen-based capabilities that are being integrated into our products. As section **4.4** of this report documents, there are some obstacles to adoption in many organizations that must be addressed and that may limit or preclude utilization within certain industries.

3.0. Integration of web-trace

Our initial development work involved two phases. Integration of the Web-trace open source application tool within ForceTen, followed by the development of content using the features and capabilities of Web-trace to explore the potential and uses within commercial or industry-based elearning environments. Would it be useful as a tool for elearning vendors or content developers? Would it provide useful interactions and capabilities for learning within commercial firms in different fields or industries?

3.1. Content development and evaluation of Web-trace-ForceTen integration.

We selected two partners (customers) to help us develop appropriate use-cases for web-trace functionality in our LCMS. In the first instance we worked with FERIC, the Forestry Engineering Research Institute of Canada (www.feric.ca). FERIC is a private, non-profit research and development organization that develops and helps industry members implement best practices regarding engineering, human, operational and environmental aspects of forestry and wildland fire operations.

The particular content we agreed to address concerned the classification of hardwood lumber through a process carried out in the field called "bucking". Basically, an agent in the field is responsible for stamping logs according to the quality of lumber that different segments of the tree can be used to produce – from furniture grade through to construction grade and finally conversion to wood chips used to manufacture other products. Every year, millions of dollars are lost to the industry through the inappropriate classification of lumber. Classification of lumber requires the ability to identify and rate severity of a wide variety of defects, and to understand the relative importance of defects across different species.

We developed a module in which the learner is required to indicate the appropriate cuts that will be used to partition a log into portions stamped with different grades, in an optimal fashion. Drawings and photographs of logs were used. A reference trace and classification was generated with input from an expert. Learners were then given the task of identifying appropriate division of the logs and classification, using the web-trace functionality. Learner input was compared to the expert trace and appropriate feedback provided in the form of a "percentage match" and exposure or display of the expert trace.

This prototype demonstrated the potential for Web-trace or intelligent annotation tools to be used in commercial contexts where classification and visual discrimination tasks are important. Customers who have viewed the prototype have suggested similar applications in their own industries. For example:

- Insurance industry: use of web-trace functionality to train insurance agents who do inspections (e.g., of damage to commercial or residential properties) to verify claims, or who must do pre-inspections to determine whether property qualifies for coverage ("is up to specification") or has pre-existing conditions that affect eligibility or premium rates.
- Aviation: train maintenance staff in visual inspection tasks (e.g., checking for signs of metal fatigue) or component damage.

In a second application of the web-trace functionality, Eedo partnered with Apria Healthcare (www.apria.com), a home health care services company headquartered in California. Apria offers a range of home respiratory, home infusion therapy and home medical equipment services throughout the US.

We chose to address a performance problem related to the fitting of a specific medical apparatus. Apria, as part of their services, provide installation of medical equipment for home care. One example of technology they provide is oxygen systems and masks for patients who suffer from sleep apnea. These patients must wear a fitted oxygen mask while sleeping or will be woken constantly as their breathing falters during sleep.

Masks are custom selected from a wide range of fittings to ensure adequate comfort. In many instances, technicians fit the wrong mask. This results in a second trip to the patient's home to replace the accessory, and the original equipment must be discarded. This is an expensive proposition. Overall, the performance task here is one that is critical in many technical fields (aircraft or automotive maintenance for example); it is an example of "right first time" performance requirements.

Conventionally, technicians can use a "fit kit" which comprises a set of three-dimensional templates which can be applied to the patient's face to determine which model of mask and fittings is most appropriate. Not all technicians have this kit, and even with the kit, some errors persist. Use of the kit also typically requires two trips into the field: one to conduct the fitting, and the second to supply the correct model of mask.

The object in this case was to create a bank of images of faces with different critical facial features or dimensions. Learners were to trace the salient features and, based on this identification, select an appropriate mask. Two scenarios were considered. In the first, users would trace relevant features on the faces, then select an appropriate model of mask.

In this case, the user-generated traces would be compared to expert traces for a match that would associate the individual to an appropriate model of mask. (That is, the expert traces would be mapped to appropriate models, the user trace would be compared to the expert trace for a closest match, and then the user selection of model would be compared to the model corresponding to the nearest expert trace). In this scenario, we have to assume that the user-generated trace is an accurate trace of the determining features, and the images must be in the same scale. A training set would be used, first, to ensure that the user can identify the features correctly.

In a second scenario -- the one implemented, finally -- a bank of images was used to train users to make the appropriate delineation of features, by comparing their traces to expert traces for each image. From there, the selection of the appropriate mask was treated as a second step in the performance.

The implementation for this particular use case was admittedly somewhat artificial, as we addressed only critical dimensions in one plane (distance between, and width of, nose and mouth) whereas proper fitting must address variation in two planes (includes relative height of nose, cheeks, chin, mouth). Nonetheless, it was apparent that this approach would allow for rapid preparation of a bank of images for use in developing skills regarding identification of a critical feature set, and could automate successfully the evaluation of user input for each image.

A focus group comprising a production manager, two graphic artists, two instructional designers and a content integrator (an Eedo development team), production managers from Apria and FERIC agreed on these points:

- Interactions with images could be created more quickly using web trace than with typical techniques (e.g., creating hot spots in images using Flash).
- These interactions could be created by non-technically trained personnel (subject matter experts, for example), leading to more efficiencies in terms of cost and development cycle times.
- The interactions created with web-trace were a superior way to present a choice of discriminations compared with hot-spots (predefined areas revealed with a mouse-click or roll-over), since they require unprompted (no cues provided) input (based on problem-solving or recall) from the user. Interactions based on hot-spots amount to multiple choice type items, allowing guessing and providing prompts to memory that reduce the task to "recognition" rather than "recall".

General usability was not rated very high; there were interface and HCI issues – some due to the interface of the Web-trace tool, and some due to the nature of the intitial integration of Web-trace with Forceten (see comments in section **6.0 – Technical Integration and Issues**). However, we used an early version of web-trace available at the start of the project. A version provided by the Catania researchers in 2007 showed significant improvements in interface and functionality, but was not used in our prototypes. In our case, though, the goal was not to establish, or improve, the usability of web-trace, *per se*, but rather acquire some sense of the capabilities, potential uses, instructional or learning benefits, and possible efficiencies.

Based on the restricted integration of web-trace within ForceTen, a focus group exercise and interactions with several other developers on an informal one-to-one basis, we concluded that this type of "intelligent" tracing algorithm has very significant value and potential within a commercial elearning authoring and learning content management system. It fits well, also, with the Eedo philosophy which stresses web-based applications and thin-client capable delivery, in opposition to approaches in the elearning market which are currently dominant, such as pure Flash-based development. ForceTen contains a large number (around 40) of native objects which provide for different types of interaction (e.g., different test items formats, scenario objects, slide-show, case-based instruction object).

Our work with web-trace and the prototypes developed with the tool established the utility of this specific type of "intelligent" algorithm for tracing as the basis for interaction with content. At the same time, our interest was beginning to shift towards more general pen-based capabilities. This was reflected in the title of the paper and presentation we produced for the First International Workshop on PBLT held in Catania, Italy, in may 2007: *Pen-based techniques to support lifelong learning in large scale organizations.* Here we presented the prototypes developed with Web-trace, but also began to situate the capabilities offered by PBLT within the wider context of informal and life-long learning. We concluded that in large-scale private and public sector organizations:

> "The audience is usually very heterogonous and consists of different age groups and various technical skill levels. Therefore, finding the right blend of tools is the most important thing to make technology supported learning acceptable to non-technical people in large organizations. Digital note taking is considered as crucial to create the blend, ideally further supported by mentoring and virtual classrooms."

Later in the project we were fortunate to be able to explore this broader theme through the development and evaluation of an e-portfolio application, intended to facilitate the management and documentation of informal learning and the alignment of this learning with individual and organisational goals.

4.0. User Survey – November 2006

To explore more widely and more generally the potential for PBLT in commercial elearning platforms and within private and public sector work-based learning settings, we conducted a survey at one of the annual Eedo User Group conferences. On this occasion (November 2007), the event was held in Montreal. This was the third annual User Conference, and attracted 60 participants representing several roles within a representative sample of industries (representative for Eedo's customer base and targeted market). In this case, we sought input regarding organizational strategy (looking, for example, for any focus on informal learning as opposed to formal programs, or the degree to which coaching, mentoring and blended learning strategies were pursued or envisaged for the future) as well as specific findings regarding the participants' perceptions concerning PBLT.

A simple protocol was followed. A paper-based survey with 24 questions was produced (see **Appendix H – User Conference Survey**). The survey was distributed at the end of the key-note address that began the second day of the conference. The topic was blended learning. At this point in the event there had been no sessions or demonstrations (no specific instruction or education) regarding PBLT specifically, so the goal was to collect feedback about industry perceptions that might reflect broader industry views current in the marketplace. Participants were asked to return the surveys to an information desk at the event by noon of the same day. 36 individuals attended the session, and 20 surveys were returned completed. These were analyzed using parametric statistical tests. Given the number of items, and limited number of participants it is not surprising that results of tests looking for differences in responses across different categories of respondents (based on industry, size of organization, role, scale of elearning program development, etc.) were not significant: too little "power". Nonetheless, the descriptive results are informative, overall, and suggest some differences that confirm anecdotal findings and experience of those who deal directly with our customer base. Given the size of our organization, and the nature of the services and products we offer, this list includes account managers, sales personnel, chief learning officer, sales engineers, customer experience director, product management and marketing teams.

The following sections report the findings of the survey that are directly related to PBLT. The raw data, including responses for all items is provided in **Appendix C – User Conference Survey Data.**

4.1. Survey Participants

Respondents placed themselves in the following roles within their organizations:

ROLE	Executive	Manager	Instructional developer	Technical services	Other
%	0	35	45	35	5 (Analyst)

One individual self-identified as belonging to both "Manager" and "Instructional Developer" roles, and a second as fulfilling both "Technical" and "Instructional Developer" roles.

4.2. Characteristics of respondents' organisations

Respondents identified their industry affiliations as follows:

INDUSTRY	Aviation	Finance & Insurance	Health & Pharma	High Tech	Public Sector	Professional Group	Education
%	35	40	15	5	5	5	5

95% of respondents revealed that they work in organizations that have two or more years delivering extensive elearning programs. One individual (5%) indicated they work in an organization that is just beginning to use elearning extensively (less than one year).

Most respondents came from large organizations that deliver more than 100 hours of elearning programs/year (13 respondents or 65%). 15% gave the figure for hours of content as less than 50 and 15% indicated between 50 and 100 hours of curriculum.

4.3. Perceived importance of PBLT

To assess the perceived importance of PBLT item16 in the survey asked respondents to indicate which technologies would have a significant impact on learning in their organizations in the next five years. Rather than ask for a rank ordering of 18 selections, the format required that significant technologies be selected, without ranking. Frequency counts provide some indication, perhaps, of relative importance, but should not be so interpreted except with caution. The response choices were selected with the following frequencies, as indicated in parentheses:

1. Tablet-based PCs (3)
2. Pen-based interfaces (whether with Tablet or regular PCs) for interacting with content (user input, navigation, manipulating objects on-screen) (2)
3. Pen-based interfaces for annotating content or note-taking? (4)
4. Virtual classroom tools (13)
5. Wiki (4)
6. Blogs, Vlogs (2)
7. Computer conferencing (8)
8. Visual representation tools for online collaboration (e.g., electronic whiteboards) (5)
9. PDAs or hand-held devices (Blackberries, cell phones) (4)
10. EPSS (5)
11. Podcast (4)
12. Low bandwidth video conferencing (PC video cam or other) (4)
13. Simulation/gaming engines (11)
14. Immersive environments (4)
15. Search tools: data mining, search & retrieval, federated search (12)
16. Social computing applications: knowledge-sharing, expertise locators, social tagging of content (5)
17. Digital libraries (7)
18. E-books (2)
19. Other(s) (please specify) *(1 selection, specified as "virtual worlds" and re-coded as item (14), immersive environments*

The responses to this particular question are open to interpretation, but we may note the following. Highest frequencies are associated with technologies and approaches that are already in play in many organizations: *virtual classroom tools* (selected 13 times) and *computer-conferencing* (eight times) and *simulation/gaming* (11 times). *Search tools* (selected seven times) play an integral part in most organizations from a performance perspective, also, and the importance of search and retrieval has been highlighted recently in the organizational and human performance literatures and by industry analysts. Digital libraries (seven selections) are common in large organizations in the form of libraries of off-the-shelf training programs for generic business and IT skills, and have been in abundance for nearly two decades.

Beyond these items, individual selections had frequencies in the range of 2-5. Items related to PBLT has frequencies of 2, 3 and 4, respectively, which places them on an equal footing with *mobile learning* (item 9, 4 selections), *social computing* (item 5 selected four times; item 6 selected twice; item 16 with five selections; item 11 selected four times) and *immersive environments* (four selections). These are all more future-oriented, speculative or predictive selections, as they are not so commonly employed as the items mentioned in the preceding paragraph. Interestingly, *mobile learning*, *social computing* and *immersive environments* all have received enormous press in both the academic and business literatures, as compared with PBLT which has a very low profile. Therefore, this result at least suggests that practitioners working in advanced organizations (in terms of their innovation in the sphere of learning) rate the potential and importance of PBLT quite highly.

4.4. How should pen-based functionality be used?

Four questions in the survey addressed how PBLT might be used in the respondents' organizations, the relative importance of strategies that might be implemented with pen-based technology, and the role of PBLT with respect to learning and cognition (questions 20-24).

Question 20 asked respondents to rank order four instructional strategies in terms of their efficacity. Results are indicated in the following table (note: 45% of respondents did not answer this question):

Strategy	Individual note-taking & annotating content	Collaborative electronic note-taking	Embedded questions, activities	Concept mapping or structured outlining
Rank (frequency)	1 (10%) 2 (20%) 3 (15%) 4 (10%)	1 (5%) 2 (10%) 3 (15%) 4 (25%)	1 (35%) 2 (10%) 3 (10%)	1 (5%) 2 (15%) 3 (15%) 4 (20%)

The responses show that *individual note-taking and annotating content* is ranked ahead of *collaborative note-taking* and *concept mapping or structured outlining* in terms of perceived impact on learning, and surpassed only by *embedded questions, activities.*. *Concept mapping* and *embedded questions or activities* were chosen as response options because they have both been researched extensively. Embedded activities and questions are probably the most common strategy in elearning Industry elearning norms often employ the ratio of the number of pages per embedded activity as one important index or indicator of instructional quality. Thus, embedded questions and activities could possibly be interpreted as a reference point to assess the perceived importance of other strategies.

Again, the results here suggest that individual note-taking activities are perceived as an important strategy to improve learning, compared to alternatives. The perceptions of practitioners are congruent, also, with the findings of research that show less or little impact for collaborative note-taking strategies. The actual results are not different statistically (see **Appendix D – Chi-Square Results – Instructional Strategies**), but this is obviously a very low power test (low ***n*** and low observed frequencies)

Question 21 asked what are the *cognitive effects* of note-taking? Sixty-five percent of respondents indicated they believed note-taking has a significant impact on "retention" (remembering what was learned), 45% indicated an effect for transfer or the ability to apply what is learned (to solve problems, make decisions…), and 40% selected improvement of comprehension as an effect. Five respondents (25%) picked all three effects, five (25%) selected two of the three, and five (25%) selected only one. No respondent selected none of the three options. Thus, practitioners in these organizations seem to recognize that note-taking has an effect on different cognitive outcomes. However, it is also clear that further education is required to convey the results portrayed in the research literature, regarding the full extent of the benefits of note-taking.

Another question (# 22) that was posed concerned the *format* for note-taking. Fifty-five percent of respondents asserted that note-taking is more effective when it is anchored in the content (an annotation), while only twenty percent felt it would be more effective when created in a second document. It is not clear from the research literature, in fact, which approach is superior, and one can well imagine that the answer might be quite context-dependent in any case.

But this issue is also far from merely learning theoretical, from the perspective of designing and implementing commercial-grade platforms for elearning. The two scenarios pose quite distinct sets of technical or practical challenges for software developers and users. In the case of anchoring content within content, for example, one must decide what to do as content is revised or updated (and management of volatile content is a prime reason for adopting learning content management systems technology), or as content is retired or archived. This issue does not necessarily arise if notes are maintained separately, without hard-coded links to content, or without integrating them within the content. We like to call these two alternatives the “notebook” and “annotated text” paradigms. While the “notebook” paradigm is more easily implemented, intuitively it would seem that the “annotations” approach can be much more efficient, both for the process of creating notes and for facilitating a review of a source text. Moreover, the two may serve quite different purposes. A notebook is useful for recording thoughts and observations or questions. They are often used to summarize main points and to serve as an aide-memoir. Annotations in-line or within a text are commonly a means of working through an interpretation of a discourse using a form of representation to exteriorize internal thought processes. While the two paradigms obviously have overlap, we use notebooks and annotations in different circumstances and, sometimes, for different purposes.

Anecdotally, we have considered the possibility that one of the reasons for the relative lack of adoption of ebooks as a format is that they do not allow for the kind of flexible, pen-based annotative practices that are possible with books. Yet at the same time we acknowledge that annotation of texts seems increasingly rare as a practice, at least among students, if not professionals or workers. This is, in the case of students, possibly in part a question of not wishing to affect the re-sale value of an expensive textbook. Also, more recent paper oriented technology, namely, the “high-lighter” seems to replaced other forms of annotation. From a research perspective, there seems to be a dearth of literature that addresses how people make annotations, who makes them (individual differences), and what purposes these annotations fulfill, from the annotator’s perspective. There is a well-developed, related literature on the role of representation and visualization in design and scientific thinking, but this is not quite the same thing as annotation as understood in the current discussion.

Finally, question 24 addressed what are the obstacles to using PBLT in large commercial and public sector organizations. Responses were solicited in an open response format. These were coded, with the following results:

Category	Technology/tools	Legal (privacy, discovery, regulatory constraints, confidentiality, copy write, organized labour concerns)	Accessibility (storage, long-term accessibility)	Budget	Content concerns
Frequency	3	7	2	1	1
Respondents’ industry affiliation	Aviation, Finance	Finance/insurance, Aviation, Education, High tech, Pharma	Finance	Finance	Pharma

These results confirm our initial perceptions acquired through regular contact with customers and prospects from our selected markets. Finance (banking, financial services and consulting and insurance), Health/Pharmaceuticals and Aviation industries relate serious concerns about legal issues and liability. Apart from the liability issues, there are practical concerns about the legal requirement to store any notes created within an elearning or KM platform (a requirement akin to email retention), and make these retrievable at a future date. Lack of budget or available technology or tools was also identified as an obstacle, but obviously the problem here is a practical concern, rather than an objection based in principle, as per the concerns of legal liability.

Some of these concerns may be allayed with suitable requirements and software features. A related, but wider, set of technical challenges identified by Eedo were enumerated in our contribution to the First International Workshop on PBLT.

> "Encouraging or enabling note-taking, on a scale that approaches behaviours typical with print media, brings up questions regarding a large number of technical issues including: *authentication* (ensuring that only authors can view annotations); *storage* (where are the notes stored); *accessibility* (from where can they be accessed); *versioning* (can authors revise or edit notes, with some form of version control or history; how are changes indicated); *scalability* (how does the organization support high volumes of electronic note-taking); *deployment* (what apps and modifications are required server and client sides); *search* (can notes be searched, tagged). If the decision is taken to allow notes to be shared or collaborated about, then, of course, an additional set of issues emerges. None of these issues has yet been addressed in commercial grade, enterprise-level infrastructure for learning in organizations."

4.5. Survey results – conclusions

The results of the User Conference Survey clearly show that, at least in the portion of the commercial market to which this sample may generalize, there is a reasonably good understanding of the value and benefits of pen-based technology. At the same time, there is also evidence that further education and sensitization of the market is required, and this will occur naturally as Eedo and our competitors begin to build in pen-based features and capabilities into our products and begin to market these capabilities as differentiators in the market. It is also clear that there are conceptual and technical challenges that must be addressed. So far as the highly regulated industries such as banking, financial services, insurance and pharmaceuticals, are concerned these challenges must be met or adoption will not occur.

4.6. On-going efforts to collect feedback

A second survey was designed in November 2007, based on the input received from the User Conference Survey. In December 2007 we ran a web-based virtual meeting (using Microsoft's Livemeeting platform) of I-trace project work highlighting Eedo's e-portfolio and web-trace work, and the 3-D annotation capability developed by Technical University of Cluj-Napoca group, partner in the I-TRACE project, also participated.
This was a scheduled session of the Eedo user group which meets online, monthly, and was advertised via the Eedo website and an email notification to members of the user group.
A survey was available on-line, accessible from a link provided in an email notification, after the meeting (see **Appendix E – Online User Conference Survey**). To date, there have not been sufficient responses to warrant analysis of the data. The event was poorly attended (we wanted to squeeze this event in before the project end-date and did anticipate low attendance owing to the closeness to the Christmas holiday season), however, the meeting and presentations were recorded and are available from the Eedo customer web site where user group members have been notified they can view the session. We hope to collect sufficient data over the next two months to acquire useful insights for product development and marketing purposes.

Future efforts to gather more information concerning industry perceptions and needs in the area of pen-based technology will include a survey carried out by Checkpoint learning (web-based European elearning publishing site). We have also been invited to participate in Boeing's internal worldwide learning conference in 2008, and have proposed a presentation focusing on pen-based technology and annotation capabilities and use cases.

5.0. Pen-based Annotation in Digital or E-Portfolios

In the latter (late) phases of the project we were given the opportunity to experiment with electronic portfolios and the use of pen-based interfaces to enhance portfolio quality and functionality. We worked with a partner in the Netherlands to develop general specifications and requirements for an e-portfolio enhancement to the ForceTen LCMS. A first version of this component was completed and is to be included, with improvement, with our next commercial release.

Most attention in the sphere of e-portfolios has been in the realm of education (primary, secondary, largely). There has been much less interest in the sphere of corporate HR and learning, though there are related initiatives in the form of standards for specifying HR information, including competencies, and applications such as data-mining applications that can extract candidates from a database of online resumes and "talent management" systems. In Europe, there are initiatives related to standards for defining competencies and systems, including e-portolio, to support life-long learning. Eedo product management has believed for some time that e-portolio will become important in corporate and employment-related settings. E-portfolio offers additional capability for learners to manage life-long learning activities, for organizations to orient this learning to organizational or institutional needs (and to compare this learning across the organization with organizational needs), for organizations to locate candidates for particular roles, and for individuals to carry the record or evidence of their experience and attainments from job to job. E-portolios offer some of the same information that one might try to extract from a resume, but in a form that is generally more valid and more difficult to manipulate in ways that may be misleading.

The Eedo e-portfolio has some usability issues, as one would expect of a first-cut at an application created with a rapid prototyping or "agile development" process and methodology. It also has functional limitations, not least the circumstance that it is an integral part of the LCMS and individual e-portfolios are not currently "portable". In the larger picture, integration of e-portfolio with other HR databases and systems (such as competency databases, employee databases and performance and talent management systems) and learning systems (like LMS) will become an industry requirement, and interoperability will be an imperative, also. These requirements were beyond the scope of our initial internal objectives and of the I-trace project, however. For the current purposes, the goal was to identify the importance of pen-based capability.

5.1 E-Portfolio Requirements

General requirements for the e-portfolio are included in **Appendix F – E-portfolio Specifications.** Additional screen shots from a prototype are included in **Appendix G – Additional Screen Shots, E-Portfolio.**

. Terminology in the requirements is based on IMS e-portfolio standards.
Implementation of the e-portfolio is based on open standards – SOAP and XML – which is critical to allow the e-portolio to leverage existing ForceTen LCMS services such as workflow, workspace, knowledge sharing, taxonomy and metadata and portal services.

5.2 E-Portfolio Evaluation

A focus group exercise was conducted with representatives external organizations and internal Eedo staff to address general issues with the e-portolio and pen-based input and annotation, in particular. The focus group was lead by Eedo's Director of Product Management, and included Eedo's CLO, a senior Eedo developer, a training manager from a business intelligence software firm, a training director from a pharmaceutical firm, a coordinator of industry placements for an internship program for a graduate degree, and an HR consultant who has experience in the pharma, health, energy, transportation and retail industries. An industry analyst in North America who specializes in the related field of "talent management" systems was invited but could not attend.

The demonstration was based on stripped-down version of e-portfolio developed specifically for I-Trace. Since developing that version we have also begun development of a more fully-featured system that will be integrated within a partner's HR and learning portal framework. The I-Trace version is easier to demonstrate (simpler interface, less functionality, and more stable) and provides a good basis for collecting feedback from potential end-users and other actors.

The following issues and suggestions emerged:

(1) There was some discussion of the concept of "competencies". In the e-portfolio these are created from lists of objectives that can be managed in ForceTen, and attached to content and assessments in the LCMS. They are associated to a role or job within the e-portfolio. A hierarchy of objectives may be required to better manage objectives as constitutive of competencies.

(2) How are e-portfolios to be exported from the system? There are some requirements for being able to print the portfolio in some format. There was discussion regarding which format, and what would be included. There was concensus there is a need for some kind of reporting functionality, so that items to appear in the report could be selected (certifications, comments from assessors, comments from peers, comments from owner etc), then printed in a PDF format. Currently there is no way to export the e-portfolio from ForceTen. At some point we will have to address interoperability, but for the moment standards are not sufficiently mature to persuade us this we should base "portability" on the premise applications that can "read" or process an e-portfolio will be widely available in the next 18 months. Currently you can "download" individual elements of the portfolio, but any annotations would not be included. The annotations are also not evident in thumbnails that are presented in views within the e-portfolio. A suggestion made was that we should make it possible to export an HTML package that would include all constituent elements of the portfolio (all files and all annotations), which could then be viewed through a browser. This is a feature we will implement.

(3) E-portfolio is the first element in ForceTen that will have advanced annotation capabilities and features. A number of issues were identified. Should we have a way to distinguish annotations made by different people? (This can be implemented, as the annotations are separate layers). At different times? Should it be possible to remove annotations? In which situations? Currently only images can be annotated; what about audio and video? Should annotations be accessible directly from the thumbnails of images? One participant suggested we consider incorporating the capabilities of current commercial software that can identify text/words within images. This would allow key word search on annotations that are textual in nature, using existing search capabilities within the LCMS.

(4) The capability to record video and audio directly within e-portfolio would contribute to usability and represent useful functionality. This feature could be used to enhance the e-portfolio with commentary by either the owner or assessors.
(5) It was suggested it should be possible to adjust the terminology within e-portfolio, to reflect different industries, sector councils, industry associations, vocational services etc. This requirement may be implemented. There was also some discussion of providing ability for the learner to configure new tabs in the system. Our position is that, given the requirement for some kind of standardization, this is not feasible. However, it might be possible for users to configure the arrangement of elements in their view, as users currently can within the LCMS end-user portlet, by setting preferences.
(6) There was discussion regarding "ownership" of the portfolio. Though one North American training specialist suggested it might reside with the organization, an explanation of current trends and initiatives in Europe regarding life-long learning led to a consensus that the e-portfolio should be "owned" and controlled by the end-users.
(7) There was some discussion centering on the nature of e-portfolio, that lead to clarification regarding the use of the tool in other than formal educational settings. In North America, the use of e-portfolio in adult vocational and professional development is less familiar. Applications rather are limited to the portfolios that are used in education, particularly primary education, in support of new educational reforms focusing on problem-based learning and "constructivist" approaches to learning and instruction. Portfolios in this context are often "process-oriented" (they are a tool to support "portfolio-based learning" and assessment), though some are of the "show-case" variety. The requirements for a development and certification portfolio designed to allow adults to manage their learning and accreditation are somewhat different. To illustrate this, one member of the focus group, the "internship coordinator", had reviewed an established "school-based" product and had rejected this product as inappropriate to her needs. She now will be using the Eedo portfolio, which will be made available free of charge in return for serving as beta test site.
(8) There was broad discussion of the utility of annotation. Generally, there was a concensus that pen-based capability was of particular value in cases where graphics are concerned, and in situations addressing design work of one form or another and related competencies. In text, "highlighting" was identified as a potentially useful mechanism for annotation (possibly with the capability to provide notes or "call-out" boxes). Again, the discussion also broadened to include commentary regarding the capability to use other media for annotation (audio and video), recorded directly using desktop computer functionality.
(9) Finally, workflow should be implemented. The version demonstrated did not include workflow, though our commercial product will utilize the workflow engine that is part of the LCMS platform.

Overall, it was agreed that e-portfolio could be a useful enhancement to the LCMS, and that annotation capabilities of a variety of forms, as outlined above, would represent an important feature. Portability and standards were viewed as key requirements. Given the current state of standards, and lack of broad utilization of e-portfolio in the commercial world (lack of commercial-grade applications, too), portability (e.g., the ability to export an individual's e-portfolio to an html package including all constituent files) was considered crucial to all but one participant. This particular participant viewed the e-portfolio more from an organizational or institutional perspective (part of talent management or HR functionality) than from the broader perspective of life-long learning. Generally, we do expect the North American market, including industry analysts and HR practitioners, will require more education regarding the use and value of e-portfolio. In a recent briefing with a major industry analyst in North America specializing in elearning and HR applications, for example, we found ourselves having to explain e-portfolio as a concept for employment-related purposes.

6.0. Technical integration and issues

As explained above, our first focus in the project was to integrate Web-trace into our LCMS, ForceTen. In the first phase, we integrated Web-trace as another tool for building content or creating interactions, produced content using the tool, and evaluated the usefulness of this feature. In phase 2, we developed some e-portfolio capability as a separate component (still within the LCMS). This has currently some limited capability for annotation and signatures.

Web-trace will be integrated to enhance the ForceTen note-taking functionality in the new e-portfolio functionality. Within the e-portfolio, collaboration with (peer) reviewers, and efficient capture of comments and evaluations relating to artifacts included in the portfolio, are important to further develop the quality of the portfolio. Additionally, Web-trace will be integrated for assessment purposes and annotation of content in ForceTen for reviewing purposes in the content creation process. While annotation capabilities were addressed in this project from a learning or learner's perspective, there are also obvious benefits and efficiencies from pen-based annotation applied to the collaborative processes involved in the content creation process. Eedo has focused significant effort on improving the toolset within ForceTen to support collaboration. Features include a workflow engine and the first collaborative workspace tool within this type of application (LCMS), called, simply, *Workspace.* Support for collaboration among a distributed workforce and project teams is crucial to efficient development of content, to effective localization of content in global organizations, and to creation of higher quality content through capturing more structured input from the various specialties that may be involved (subject matter experts, media experts, instructional designers, marketing, legal reviewers and so forth). Pen-based input will facilitate all these outcomes. We anticipate that adoption of pen-based interfaces within LCMS platforms might come first on the developer side of the application, rather than the learner side, not least because some of the organizational concerns and barriers related to annotation described earlier in this report are not an issue for the development side activities and use cases, and because lack of general availability of digital pen hardware is less of an issue (easier to equip a development team or teams than everyone in the organization who consumes learning content).

Our work throughout most of the project focused on Web-trace as a tool to develop content and interactions. However, in the latter stages, and with input from industry as recounted in previous sections of this report, it became clear that pen-based annotation is an important and useful capability to support collaboration in content development (reviews of work-in-progress, for example), and also in the elaboration of an e-portfolio.

With the logon to ForceTen, users are connected to the Web-trace server so they can use all the functionality of the software and have access to stored traces.

Running the e-portfolio functionality on the learning portal side of ForceTen, users have the possibility to make notes to self-evaluate their work. Additionally, a user can invite other users (peers or coaches) to annotate their work. This functionality is implemented as a thread for collaboration purposes. Using Web-trace this note-taking functionality is enhanced by a graphical, pen-based annotation element.

The integration with ForceTen LCMS was relatively straightforward because there was an existing PHP integration layer available, and adds value to the product by providing a natural interface for threaded annotation which is implemented within the e-portfolio first and will be evaluated within several pilots for e-portfolio within business environments in Europe (related to lifelong learning initiatives and principles). At a later stage, pen based technology will be included in ForceTen to add value to the existing note-taking capability and also for graphical assessment purposes.

From a technology perspective, one issue is that currently Web-trace is based on Java technology, a circumstance that can be a problem within certain IT environments (particularly in North America, where corporate IT is often anti-open source and Microsoft-centric). EEDO is currently investigating other technologies such as AJAX or SVG to enable pen-based functionality. Another issue is that Web-trace needs a separate server and database. This issue has been resolved by integrating the server and database with the ForceTen LCMS server.

The prospect of general capabilities within an LCMS to support annotation and note-taking also raises several pragmatic problems that we have begun to address internally. These include, notably: (1) security (How do we ensure only authors of notes or annotations can view their notations?); (2) scalability (If tens of thousands of users can annotate content, what are the storage requirements, particularly if this user-generated content must be retained and archived for reasons of liability or regulatory compliance, and what are the implications for system performance?), and (3) content management (If notations are anchored in content, and content is revised frequently -- as is often the scenario with LCMS in dynamic business environments – then how can the system identify and retain annotations that are still relevant?). If collaborative note-taking or note-sharing is considered, then additional issues present themselves; however, based on our review of literature, we are of the opinion that collaborative note-taking is of very limited value. Our user survey indicated a similar perception on the part of LCMS users in industry and the public sector.

On the standards front, the major general standard to consider is InkML, a standard maintained by W3C. Further general support for InkML that will leverage other tools and applications, in the future may come through implementation via SVG: formulation of InkML as a set of namespaced attributes in a subset of SVG. It is also possible we can look forward to implementation of InkML in desktop browsers[1].

With respect to e-portfolio, there are many standards to consider including IMS e-portfolio specification[2], British Standard 8788 (UK Lifelong Learner Information Profile), the e-portfolio Interoperability XML Specification (EPIX)[3] and HR-XML[4]. The IMS specification is the most complete and includes a best practice guide, Binding, Information Model, Rubric Specification. It supports a number of additional IMS standards including an accessibility specification (ACLIP), RDCEO (Re-usable Definition of Competency or Educational Objective), and an IMS enterprise services spec. These standards are still evolving, and while we will follow their development, as we do a wide variety of standards, the first version of the Eedo e-portfolio does not implement these standards and specifications and is essentially a proprietary, integrated Eedo LCMS capability. In future versions, interoperability standards will have to be addressed, and the issue of portability will be resolved.

[1] Cf http://lists.w3.org/Archives/Public/www-multimodal/2008Jan/0001.html, retrieved Dec 4, 2007
[2] http://www.imsglobal.org/ep/index.html
[3] http://www.epixxpec.org
[4] http://www.hr-xml.org/

Most work related to e-portfolio outside primary, secondary or tertiary education is based in Europe. North Americans are less familiar with the concept from an HR perspective, despite the advances regarding the use of data-mining techniques with online resumes and the evolution of talent management systems and applications. It will be interesting to see the reaction to e-portfolio in ForceTen among our customer base on both sides of the Atlantic as they begin upgrading to new versions incorporating this component over the next 12-24 months.

To summarize, Web-trace has been integrated into ForceTen to support creation of content and interactions for learning, and to enhance the new e-portfolio functionality. The integration was simple, but raised some issues that were resolved by integrating the Web-trace database with the LCMS. The fact Web-trace is Java-based raises some barriers in the commercial environment. Therefore, looking forward, we are planning to integrate general pen-based capability through alternative technologies within ForceTen version 6.0. Standards are an issue: standards for e-portfolio are not yet mature and, as mentioned, on the broader front there are several possible paths to more general support for pen-based computing and the InkML standard that could leverage existing tools and platforms (via SVG or through the browser, for example).

7.0. Conclusion

Our participation in the I-trace project was a useful exercise which allowed us to assay the benefits of pen-based technology for learners, developers and administrators, within LCMS generated content, LCMS authoring and collaboration tools, and e-portfolio. As a result of these activities we are in fact incorporating these capabilities into our commercial platforms and will continue to evolve and improve this technology over the next year. Moreover, we have made a commitment to integrate an e-portfolio application within our platform.

In our view, pen-based technology is one of the next major innovations in LCMS technology, and promises important efficiencies and benefits for learning, content development and management and administration of learning. There are obstacles and barriers, as identified in this report, of both a technical and an organizational nature, and there are practical and theoretical problems or issues to be resolved in the future. Despite the low cost of pen-based hardware, and the options currently available to enhance conventional desktop computers and laptops with pen-based capabilities, adoption will be impeded in the short term, in large organizations, by lack of widespread implementation of pen-based interfaces. Given the development and improvement of software and hardware to support pen-based interfaces (improvements in word recognition, for example) and the decrease in cost over the last years, digital ink or pen-based computing will inevitably enter the mainstream of personal computing in support of general business-oriented computing requirements. A link with mobile computing (pen-based interfaces offer some advantages for usability with mobile, hand-held devices) will help to accelerate adoption. As in other instances, this will lead to the widespread diffusion of the technology that will enable its broad application and exploitation on the learning front.

As the currently acknowledged leader in the LCMS marker, Eedo's investment in pen-based capabilities will influence the market and competitors' products. Our conviction that pen-based technology is a critical enhancement to learning systems infrastructure, in particular in support of lifelong and informal learning, is a direct result of our experimentation within the I-trace project, the feedback we have collected during the project and the quality of the work and innovations produced by the other research partners collaborating in the project.

List of Appendices

Appendix A – PBLT Workshop Paper

Pen-based Knowledge Transfer Techniques to Support Lifelong Learning In Large Scale Organizations

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Abstract

This paper will focus on multimodal knowledge transfer techniques to facilitate lifelong learning for workers in large scale corporate and government organizations. Learners in large scale organizations are provided with access to high quality digital e-learning materials to address specific learning requirements such as procedure, policies, procedures and applications. The audience is usually very heterogonous and consists of different age groups and various technical skill levels.

Therefore, finding the right blend of tools is the most important thing to make technology supported learning acceptable to non-technical people in large organizations. Digital note taking is considered as crucial to create the blend, ideally further supported by mentoring and virtual classrooms. Examples of application of note-taking and pen-based technology across different types of organizations and use cases will be presented.

1. Lifelong and informal learning

Lifelong learning and informal learning are two of the biggest 'buzzwords" in both educational policy and the world of training and HRD. Virtually ever country in the western world has related policies. For example, in the EU we have the communication adopted in 2001, *Making a European Area of Lifelong Learning a Reality* which has spawned a variety of concrete policies and programs such as the Lifelong Learning Programme 2007-2013 and the EFQ or European Qualifications Framework for lifelong learning adopted by the Commission in 2006. Increasingly, the connection between social inclusion, personal fulfillment, economic productivity and firm-level competitiveness is made with lifelong learning. With this recognition comes the understanding, also, that that promoting lifelong learning broadly will require the efforts of individuals, educational institutions, organizations, governments – civil society in general.

Lifelong learning has several definitions, though increasingly very broad definitions are favoured. In broad terms, lifelong learning refers to the requirement for continuous education or training and up-skilling, via both formal means (educational programs, certifications, training courses) and informal means. The latter includes everything from unstructured on the job training to informal collaboration, and self-directed self-study or information search and retrieval. Informal (meaning unplanned, unmonitored) learning plays a large role. A slew of recent studies on the topic of informal learning in the workplace have converged on estimates that indicate only something in the range of 10-20% of workplace learning results from formal programs or training interventions..

Research on the determinants of lifelong learning has focused on motivation, self-direction or self-regulation, content or skills scaffolding, (Longworth *et al*, 1996; Candy, 1991) accessibility (technology as a means of providing broader access) and the impact of organizational factors such as the lack of clear career paths, resulting from the flattening or "delayering" of organizations that has effectively created a "job ladder gap" (Grimshaw et al, 2002). Generally, the educational technology field views technology as a key to providing accessibility for all, and thereby to enabling lifelong learning. Sharples (2000), for example writes of a "theory of lifelong learning mediated by technology". Those in the educational management and policy fields, on the other hand, argue that patterns of inequality in access to work-based and informal learning cannot be circumvented by technology alone (Rainbird, 2000; Gorard & Selwyn, 1999) and responsibility for learning cannot be placed solely on the mantle of the individual, no matter how much we improve on accessibility.

2. Scope of informal learning and its central role in lifelong learning.

It is difficult to get a clear picture of the scope of activity involved in informal learning, for obvious reasons. However, we can get a grasp of the magnitude of the need for both lifelong and informal learning. Consider the following data.

Studies have shown that in some sectors in developed countries, individuals may have as many as five to seven career changes and as many as 20 different specific job placements over a lifetime. Studies of enterprise search activity by IDC (2002; 2003), Working Council of CIOs, AIIM, Reuters and the Ford Motor Co (Feldman, 2001) also show that individuals spend as much as one fifth of their time searching for information related to their job tasks, with a success rate of about 50%.

A recent large scale study sponsored by Cognisco (2003), an independent employee assessment firm, surveyed hundreds of organizations across a wide variety of industries, collecting data concerning employee and employer perceptions of competence gaps. Results uncovered very low rates of confidence for a large proportion of individuals in their ability to do their jobs based on their current levels of preparation and understanding. For example, 37% of those surveyed reported they misunderstood at least one crucial aspect of their job, while the average level of employees' confidence in their performance was only 63% on a scale of zero (no confidence) to 100 (total confidence). Staggeringly, 82% of employees failed to meet their employers' standard for reasonable understanding of their jobs.

Finally, while the number of days of formal training per employee is usually less than 10 in large enterprises (and usually none for small enterprises) (Keep, 1999), a survey in Canada conducted by the Network for Advances in Lifelong Learning in 1998 found that adults were spending on average 15 hours of time per week on informal learning activities (NALL, 2007). Even much earlier case studies of self-directed learning conducted by Trough in 1971 and 1978 and a US survey by Penfeld in 1977 all yielded findings over 10 hours per week .

The sheer volume and rate of change in modern organizations related to organization, technology, regulation, procedures, policy, products, markets and business strategies dictates that informal and lifelong learning increasingly is at the core of viability and competitiveness. Recognition of this reality has lead to adoption of enterprise-level infrastructure for learning content management, investment in search and retrieval and personal KM tools, and adoption of more flexible approaches to facilitating learning. The latter includes a move away from the "learning is identified with formal courses" paradigm to models that include other strategies such as: just in time learning, access to electronic learning objects, personalization of training content, blended learning models, electronic performance support, and multi-channel distribution or publishing of content to different media and devices. Along with different delivery strategies, it is also more generally accepted that different media must be supported.

3. The potential of pen-based technology to facilitate learning through note-taking and annotation features.

The spread of pen-based computing technology provides several interesting avenues for both the study and practice of technology-based learning, based largely on the affordances of the technology with relation to note-taking and annotation.

With regard to practice, studies show quite convincingly that use of keyboard based input severely restricts the diversity, frequency and volume of note-taking activities. In general, learners are accustomed to using their own flexible strategies for physical formatting, abbreviating, syntax and graphical representations (Piolat *et al*, 2005). Input with keyboard is generally perceived to be restrictive and unnatural. Despite the benefits of electronic notes (legibility, ease of revision, potential to share or merge), users overwhelmingly prefer pen and paper annotation capability to electronic mark-up via keyboard and mouse input (cf. Fox, 2005).

As an example close to home, within our own content management system users can attach notes to content (like electronic post-its), and reviewers working within the content development cycle can annotate screens. There is also the ability to associate wiki pages with content for collaborative or personal elaboration of the content. None of these features is widely used. Some organizations who use our technology do not want the wiki capability available, especially those operating in highly regulated environments, where liability issues intrude with the possibility of end-users communicating ideas around interpretation of regulations or policy and procedure.

Beyond this anecdotal evidence, it is fair to claim that electronic note-taking is not common outside the realm of academic studies of, primarily, structured note-taking (e.g., inline coding or annotation of content, studies of collaborative web-based note-taking and note sharing) of one form or another.

At the same time, note-taking *per se* has been studied for many decades, and the evidence is quite clear regarding the benefits. A recent meta-analysis (Koyabashi, 2006) found large effect sizes for note-taking activity. Effect sizes were in the range of .75 for both comparisons of learning outcomes for students who took notes versus those who did not and for groups who took notes contrasted with groups who were able to review materials or other student's notes. Overall, in the literature the evidence is clear that taking personal notes has a very powerful effect on development of understanding and recall (Divesta and Gray, in Kobayashi).

The theoretical bases for these effects are also clear and well-substantiated, across some eighty years of research. From a process perspective, cognitive processes of selection, integration and organization are activated, leading to schema development and elaboration. Taking notes also provides an external representation of information that reduces cognitive load on working memory, allowing us to process information at a pace that is feasible (Kiewra, 1989). Apart from the value derived from the process of taking notes, research also shows that the activity of re-reading or reviewing notes also has benefits, in terms of activating required schema and helping to move information into long-term memory.

Given the clear evidence that note-taking has benefits, and the obvious role that note-taking plays in informal learning, the following sections present some examples of how pen-based technology could function within the context of informal learning in organizations using technology-based delivery or access to learning content. Some of the challenges associated with note taking are highlighted.

4. Use Case 1

This use case is for a large government organization (100.000 plus) dealing with learning to apply complex rules and regulations in practice. Classroom training alone is no longer an option because of cost. New people need to be trained on a relatively short notice and existing personnel needs to be continuously trained with regard to new and updated software applications. Elearning is seen as an important solution within the blend of available training.

They have found that the overall approach to elearning design within the organization should project a different look and feel compared with a generic web page. Learners must perceive that they are accessing "learning" and not just web-based information, and interaction is therefore quite different. The look and feel is influential in targeting learners towards "how to do the job".

Tabs cross the screen were included in the design to mimic the job tasks and provide interaction during the learning within the proper context. A *Forms* tab contains relevant documents and also provides interaction during the learning. These are especially relevant in simulations where the user needs to cross-reference a form or document to perform tasks on the system. A *Colleague* tab contains helpful information expressed as help and support from a colleague. If there are any practical hints and tips that apply to the learning points on screen at the time the tab is selected, this is the place for them. A *Rules* tab contains notes and procedural and process information that relates to the learning points on screen at the time the tab is selected.

A *Notes* function is always available to the learner and allows the learner to input notes at any time. These notes are printable but not saved off on exiting the learning.

A usability evaluation of the e-learning content designed in this way was very positive and underlined the importance of adding "interactive" tools which make the learning experience lifelike and close to reality.

5. Some issues

This use case also highlights some common obstacles to implementing note-taking strategies in large-scale private or public organizations. First, there is often a prohibition on printing learning content within the organization. This restriction is enforced simply but effectively through limitations imposed through the browser, lack of print-friendly formatting, or lack of connections to network printers. At the same time, in many cases, content is not available outside the organization, beyond the firewall. Together these conditions essentially eliminate the possibility of printing notes or annotations exactly as they may appear anchored within the actual content. Organizations impose these restrictions either because of concerns over loss of control of valuable IP, or simply because of the costs involved when thousands of learners begin to print large proportions of online courses. In many cases, elimination of reprography and distribution costs for print materials forms an important component of business cases for online publication. Lack of ability to print notes in context, however, is likely to have an impact on note-taking behaviour and the perceived value of electronic note-taking, within at least some circumstances.

In the current use case, we find a different limitation. Here, the organization is prepared to allow printing, but any notes created during a session must be printed before the session ends, else they are lost. This raises practical concerns, including, for example: access to available printers; amount of context from content required to make notes useful or valuable in the future; lack of context if notes are not anchored within content; time required to establish context when creating notes, if notes are dissociated from the learning content.

In an alternative scenario, with printing disallowed, notes must be saved electronically. This raises the issue of how notes are to be accessed subsequently: anchored within the learning content to provide context, or in separate, personal, electronic spaces. If anchored within the content, then practical issues concerning the availability of the content over time intrude. In large organizations, with high volumes of content development and short content lifecycles, content is constantly retired, revised or replaced with newer versions.

Encouraging or enabling note-taking, on a scale that approaches behaviours typical with print media, brings up questions regarding a large number of technical issues including: authentication (ensuring that only authors can view annotations); storage (where are the notes stored); accessibility (from where can they be accessed); versioning (can authors revise or edit notes, with some form of version control or history; how are changes indicated); scalability (how does the organization support high volumes of electronic note-taking); deployment (what apps and modifications are required server and client sides); search (can notes be searched, tagged). If the decision is taken to allow notes to be shared or collaborated about, then, of course, an additional set of issues emerges. None of these issues has yet been addressed in commercial grade, enterprise-level infrastructure for learning in organizations.

From a design and usability standpoint, there also remain the questions of what types of annotations will be supported and what the interfaces will be like. It is tempting to argue that pen-based interfaces are crucial. There is some argument in the literature on electronic note-taking that reluctance to use more restrictive and keyboard-oriented systems is due at least in part to the circumstance that we generally are not trained in any specific ways to take notes. On the other hand, there is also some reason to believe that the power of note-taking is due largely to the fluidity and flexibility of formats, and personalization of strategies and representations. There is, in any event, little or no empirical evidence that training can have a major impact on off-setting reluctance to use more limiting forms of electronic note-taking or annotation. So the case that training can overcome limitations of the tools has not been made.

6. Use case 2

Pen-base technology has obvious applications with regard to strategies to teach visual discrimination tasks, and it is hardly surprising that much cognitive research currently focuses on instruction for tasks related to interpretation of medical imaging. However, more generally, learners in large organizations are often interacting with graphical content, where the requirement is to recognize what parts of a plan, image, diagram are relevant to a particular task. Simple examples would be: select the area within an image of some construction that indicates damage or elements that are not “within code” (say, for an insurance inspection); indicate which part of a schematic drawing corresponds to a particular system function or fault; show which part should be removed first in a system breakdown for an inspection of, or repair to, a mechanical device.

Learners interacting with online content in a variety of subject areas commonly engage in these types of tasks. The usual mechanism from a design standpoint is to use hot spots to constitute different responses. The learner moves a pointing device or tabs across the different available options and selects one as his or her response. Effectively, this reduces the task to the cognitive equivalent of a multiple choice task, with different options providing cues and effectively rendering the task one of recognition, rather than pure recall, and possibly providing the basis for good “guessing” strategies to prevail, where the learner has no real idea of the exact correct response. This approach has limited value where the training outcome is intended to be “right first time” performance in the job context: for example, in case of field service technicians for technical equipment (e.g., automotive repair specialists), or in the medical diagnostics field.

The availability of pen-based interfaces, and applications that support sophisticated evaluation of traces or annotations, offers some intriguing possibilities for improving on the type of interaction and assessment described above. In our current work with the open course tool, *Webtrace*, we have looked at two different examples of subject matter. The first is the selection and fitting of medical apparatus (oxygen masks for patients suffering sleep apnea). The second is the categorization (grading) and cutting of hardwood lumber to extract maximum value from each log.

In the former, learners (medical technicians) are expected to be able to match appropriate fittings or models to different configurations of facial features and dimensions. In the latter, learners (commercial logging industry representatives out in the field), in a process called “hardwood bucking”, must identify the qualities inherent in hardwood lumber (defects, primarily) and indicate where cuts should be made to a log and what grade each piece of lumber should be assigned, with higher grades (furniture grade, for example) yielding more profit.

Conventionally, elearning materials would use multiple choice or list-matching tactics to match facial “types” to masks, or graphical hotspots to require user input to identify regions of hardwood that have a particular characteristic, or correspond to a particular grade. With the use of an application that allows an expert to create a trace indicating a correct response or input, and then compare that trace to a learner-generated trace within specified tolerances, more direct and challenging assessment of the learners knowledge and discrimination is possible. In theory, more sophisticated types of feedback could also be incorporated, based on some form of parameterized comparison of the two traces. A simple kind of feedback would simply expose the expert trace to the end-user in an overlay, to be directly compared by the user with his or her own effort.

Apart from the benefits of testing discrimination and knowledge directly and eliminating effective guessing tactics, there is also potentially some efficiency to be gained from this approach on the content development side. With good interfaces, a subject matter expert could prepare a bank of images for instruction or assessment more rapidly using pen-base technology to create outlines, and specify parameters for comparisons, than a media specialist or elearning developer could take expert information and create multiple hotspots and interactions for each image.

7. Conclusion

Pen-based technology offers a variety of ways to enhance electronic delivery of content in large organizations and improve commercial applications of elearning content and strategies. Above all, there is the untapped potential of note taking as a powerful mechanism to improve individual learning and retention, and to provide more congenial, familiar and authentic mechanisms to support informal learning in particular. While much academic research focuses on collaborative note-taking, the research suggests that in fact the most powerful and efficient benefits to be gleaned may come from supporting and encouraging note-taking to improve the depth and speed of individual learning. Improvements in usability and flexibility to applications for note-taking promise to transform the experience of individual learners accessing online content in large organizations. Apart from changing the way learners interact with elearning content, such developments may fuel wider acceptance and utilization of other technologies that could support independent, lifelong, informal learning, such as the eBook.

Despite the availability of low cost, powerful hardware for pen-based interactions, the applications to support more powerful and flexible interactions with content are still in early stages. As mentioned above, there are practical considerations of a very rudimentary kind that also impose, for now, some restrictions on what can be accomplished. Such restrictions, throughout the history of computing applications, tend to be trumped by the efficiencies that can be gained, or the weight of users' desires to adopt something that makes life better, different or easier.

It is popular to say that "collaboration" is the next, or current, killer app. Quite possibly, "annotation", facilitated by widespread adoption of pen-based technology (rather than semantic web-driven automated tagging strategies) will prove to be a killer app.

References

Candy, P.C. (1991). *Self-direction for lifelong learning. A comprehensive guide to theory and practice*. San Francisco, CA: Jossey-Bass. Eric Document ED353470.

Feldman, S. (March 1, 2001). The high cost of not finding information. Retrieved from http://www.kmworld.com/articles/ReadArticle.aspx?ArticleID=9534.

Fox, J. (2005). *A survey of electronic note-taking behavior in information and library science students.* Unpublished Master's paper. Chapel Hill: University of North Carolina.

Gorard, S. & Selwyn, N. (1999). Switching on the learning society? Questioning the role of technology in widening participation in lifelong learning. *Journal of Educational Policy*, vol 14, no 5, pp 523-534.

Grimshaw, D et al. (2002) The restructuring of career paths in large service sector organizations: 'delayering', upskilling and polarization. *The Sociological Review*, vol 50, no. 1, pp 89-116.

IDC. (May 2002). Quantifying enterprise search. http://www.idc.com.

IDC. (2003). The high cost of not finding information. Susan Feldman and Chris Sherman, April 2003, IDC #29127

Keep, E. (Dec 1999). Employer attitudes towards adult training. ESRC Centre on Skills, Knowledge and Organisational Performance, Warwick Business School, University of Warwick, Conventry. http://www.voced.edu.au/td/tnc_62.647

Kiewra, K.A. (1989). A review of note-taking: the encoding-storage paradigm and beyond. *Educational Psychology Review*, 1, 147-172.

Kiewra, K. et al. (1995). Effects of note-taking format and study technique on recall and relational performance. *Contemporary Educational Psychology*, vol 20, 172-187.

Kobayashi, K. (2006). Combined effects of note-taking, reviewing on learning and the enhancement through interventions: a metaanalytic review. *Education Psychology*, vol 2, no 3, pp 459-477.

Longworth, N. & Davies, W.K. (1996). *Lifelong learning: New vision, new implications, new roles for people, organizations, nations and communities in the 21st century*. London: Kogan Page

Penland, P. (1977). *Self-planned learning in America*. Pitsburgh, PA: University of Pitsburgh.

Piolat, A., Olive, T., Kellogg, R.T. (2004). Cognitive effort of note taking. *Applied Cognitive Psychology*, 18, pp. 1-22.

Rainbird, H. (2000). Skilling the unskilled: access to work-based learning and the lifelong learning agenda. Journal of Education and Work, vole 13, no 2, pp 183-197.

Sharples, M. (2000). The design of personal mobile technologies for lifelong learning. *Computers and Education*, vol 34, pp 177-193.

Tough, A. (1978). Major learning efforts: Recent research and future directions. Adult Education Quarterly, 28(4), 250-163.

Tough, A. (1971). *The adult's learning projects*. Toronto, OISE Press.

Trafton, T. G. & Tricektt, S.B, (2001). Note-taking for self-explanation and problem-solving. *Human-Computer Interaction* 16 (2001) 1-38.

WALL (Work and Lifelong Learning) Research Network. (2000). Annotated bibliography. http://fcis.oise.utoronto.ca/~plar/databse/toc.html.

Cognisco (2003). Employee survey report. http://www.cognisco.com/media-resources/Cognisco%2082%25%20of%20Employees.pdf

Appendix B – User Conference Survey

A Few Questions!

1). My role:

- Executive
- Manager
- Instructional Designer/pedagogical consultant
- Technical services
- Other (please specify) ____________________________

2). My organization:

- Aviation
- Finance
- Public sector
- Health
- High tech
- Education
- Other (please specify) ______________________________

3). My organization has been developing or delivering elearning solutions for:

- More than two years
- Two years or less

4). We use blended learning as a strategy with:

- Less than 10% of courses/programs
- 10-20% of courses/programs
- 21-30% of courses/programs
- Other (please estimate) ___________

5). We currently deliver:

- Less than 50 hours of elearning programs
- 50-100 hours of elearning programs
- Over 100 hours of elearning programs

6). I am part of a local learning and development team or training department with:

- Less than five members
- 5-12 members
- 12-20 members
- More than 20 members

7). What proportion of courses/programs in your organization do you estimate will use blended learning strategies in 2010?(please estimate)

____

8). Does your organization have a "formal" or explicit design strategy/model/practice regarding blended learning?

- Yes
- No
- Additional comments/explanations?

9). Which of the following elements do you currently use in blended learning practices:

- Mentoring/coaching
- On-the-job-training
- Virtual classroom tools
- Elearning
- Classroom instruction
- Computer conferencing
- Siimulation or role-playing (virtual or face-to-face)
- Other (please specify)

10). What additional elements may be implemented in the next two years?(please list)

11). We use blended learning to:

- Reduce costs of development and delivery
- Address limitations in infrastructure (e.g., need different delivery models for different locations/circumstances)
- Provide flexibility for learners
- Manage transition to elearning
- Design more effective learning programs
- Produce the most effective instruction possible
- Better align learning with business needs/objectives
- Other (please specify)

____

____

12). The single most important reason for using blended learning in our organization is:

- Reduce costs of development and delivery
- Address limitations in infrastructure (e.g., need different delivery models for different locations/circumstances)
- Provide flexibility for learners
- Manage transition to elearning
- Design more effective learning programs
- Other (please specify)

____

13). The greatest challenge in implementing blended learning in my organization is/would be:

- Selling the approach to customers/business lines
- Selling the approach to executives
- Selling the approach to end-users
- Selling the approach to curriculum/program managers
- Educating staff in instructional development services regarding best practices, design models and principles
- Other (please specify) ____

14). Which pedagogical strategies does your organization employ?

- Case-based learning
- Collaborative learning
- Scenario-based learning
- Problem-based learning
- Simulations
- Gaming
- Didactic strategies (conventional teach and test)
- On-the-job training
- Coaching
- Other (please specify)

---

15). How do you manage content for non-elearning components of learning content?

- Shared network drives
- Document management/content management systems
- Other (please specify)

---

16). Which technologies do you believe will have a significant impact on learning in your organization in the next five years?

- Tablet-based PCs
- Pen-based interfaces (whether with Tablet or regular PCs) for interacting with content (user input, navigation, manipulating objects on-screen)
- Pen-based interfaces for annotating content or note-taking?
- Virtual classroom tools
- Wiki
- Blogs, Vlogs
- Computer conferencing
- Visual representation tools for online collaboration (e.g., electronic whiteboards)
- PDAs or hand-held devices (Blackberries, cell phones)
- EPSS
- Podcast
- Low bandwidth video conferencing (PC video cam or other)
- Simulation/gaming engines
- Immersive environments
- Search tools: data mining, search & retrieval, federated search….
- Social computing applications: knowledge-sharing, expertise locators, social tagging of content
- Digital libraries
- E-books
- Other(s) (please specify)

____

____

17). In my organization we build "parallel" courses (elearning and face-to-face versions)

- Often
- Sometimes
- Never

18). In my organization we adapt content to different audiences:

- Based on role
- Based on region/market
- Based on experience
- Based on other factors (please specify) ___________________________
- Never or infrequently

19). In my organization we (check off those which apply):

- Rely heavily on formal, centrally planned training programs
- Rely heavily on informal learning and *ad hoc* training interventions
- Base learning plans or manage learning based on competencies
    - Assess for competencies
    - Our competency models are adequate to manage learning effectively
- Have strong assessment capability (testing, test management)
- Evaluate the quality (reliability, validity) of our tests

20). Which strategies have the biggest impact on learning (please rank 1-4):

- Individual note-taking & annotating content
- Collaborative electronic note-taking
- Embedded questions, activities
- Concept mapping or structured outlining

21). Note-taking affects, significantly:

- Retention
- Comprehension
- Ability to apply what is learned (solve problems, make decisions…)

22). Note-taking is most effective when it is (check one):

- Anchored in the content (annotation)

OR

- Created in separate document

23). There are organizational obstacles to providing electronic note-taking capabilities built into courseware delivery technology in my organization (e.g., liability, privacy, accessibility (section 508 requirements):

- No
- Yes (specify) ____

24). In my organization we would have significant opportunity to use pen-based tools to interact with content delivered electronically:

- To learn, practice or evaluate performances related to visual discrimination tasks
- To annotate technical diagrams (learners)
- To develop annotations on technical diagrams – highlights, call-outs etc. (for developers)
- To facilitate virtual classroom delivery of visual or graphic content
- To facilitate review of draft content or intermediate deliverables (storyboards, draft production content) and communication among development team

Appendix C – User Conference Survey Data

This appendix is a spreadsheet available as a separate Excel file:
AppendixC_UserConfSurveyData.xls

Appendix D – Chi-Square Results – Instructional Strategies

NPar Tests

Notes

Output Created		18-FEB-2008 14:43:39
Comments		
Input	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	20
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics for each test are based on all cases with valid data for the variable(s) used in that test.
Syntax		NPAR TEST /CHISQUARE=ind_note coll_not emb_qn conc_map /EXPECTED=EQUAL /MISSING ANALYSIS.
Resources	Number of Cases Allowed[a]	149796 cases
	Elapsed Time	0:00:00.00

a. Based on availability of special working memory.

Chi-Square Test

Frequencies

Individual notetaking & annotating content

	Observed N	Expected N	Residual
Rank 1	2	2.8	-.8
Rank 2	4	2.8	1.3
Rank 3	3	2.8	.3
Rank 4	2	2.8	-.8
Total	11		

Collaborative electronic notetaking

	Observed N	Expected N	Residual
Rank 1	1	2.8	-1.8
Rank 2	2	2.8	-.8
Rank 3	3	2.8	.3
Rank 4	5	2.8	2.3
Total	11		

Embedded questions,activities

	Observed N	Expected N	Residual
Rank 1	7	3.7	3.3
Rank 2	2	3.7	-1.7
Rank 3	2	3.7	-1.7
Total	11		

Concept Mapping/structured outlining

	Observed N	Expected N	Residual
Rank 1	1	2.8	-1.8
Rank 2	3	2.8	.3
Rank 3	3	2.8	.3
Rank 4	4	2.8	1.3
Total	11		

Test Statistics

	Individual notetaking & annotating content	Collaborative electronic notetaking	Embedded questions,ac tivities	Concept Mapping/ structured outlining
Chi-Square[a,b]	1.000	3.182	4.545	1.727
df	3	3	2	3
Asymp. Sig.	.801	.364	.103	.631

a. 4 cells (100.0%) have expected frequencies less than 5. The minimum expected cell frequency is 2.8.

b. 3 cells (100.0%) have expected frequencies less than 5. The minimum expected cell frequency is 3.7.

Appendix E – Online User Conference Survey

1. Eedo User Group Survey December 2007

Thank you for taking the time to answer these questions. Your input will help us, at EEDO, make decisions that lead to designing a product that better matches the needs of your organization.

Please note that round buttons indicate single choice multiple choice format; square buttons indicate you may select more than one response.

* 1. Which of the following is correct?

- I attended the December 13 webinar on PBLT
- I have viewed the recording of the webinar
- Neither of the above

2. My role is:

- Executive
- Manager
- Instructional designer
- Technical services
- Graphic developer

Other (please specify)

3. My organization is within the field of:

- Aviation/Aerospace
- Finance
- Public Sector
- Health
- High Tech
- Education

Other (please specify)

4. My organization has been developing or delivering elearning solutions for:

- More than two years
- Two years or less

5. We currently deliver:

- Less than 50 hours of elearning
- 51-100 hours of elearning
- Over 100 hours of elearning

6. I am part of a local learning and development team or training department with:

- Less than five members
- 5-12 members
- 12-20 members
- More than 20 members

7. Which of the following elements do you currently use in your instructional delivery (either in a blend, or separately):

- Mentoring/coaching
- On-the-job training
- Virtual classroom tools
- Elearning
- Classroom instruction
- Computer conferencing
- Simulation or role-playing

Other (please specify)

8. Which technologies do you believe will have a significant impact on learning in your organization in the next five years? Please rank the following:

	No impact	Low impact	Moderate impact	High impact
Social computing applications (e.g., wiki, blogs, "Facebook", social tagging)				
Mobile learning/performance support				
E-portfolio				
Immersive simulations (e.g., "Second Life")				
Pen-based learning technology				
Virtual classrooms				

9. Before attending the user group webinar I was:

- Unfamiliar with pen-based technology
- Somewhat familiar with pen-based technology
- Very familiar with pen-based technology

10. I have used digital pen-based technology (Tablet PC, graphics tablet, etc):

- Never
- On one, or a few, occasions
- Often

If "often:, for what applications or activities?

11. Which strategies have the biggest impact on learning (please rank in order from 1, low, to 4, high)

	1	2	3	4
Individual note-taking & annotating content	jn	jn	jn	jn
Collaborative electronic note-taking	jn	jn	jn	jn
Embedded questions, activities	jn	jn	jn	jn
Concept mapping or structured outlining	jn	jn	jn	jn

12. Note-taking affects, significantly:

- Retention
- Comprehension
- Ability to apply what is learned (solve problems, make decisions, formulate judgements...)

13. "Learners find note-taking with a keyboard interface (as available in ForceTen) useful and willing use this feature."

- Agree
- Disagree

14. Note-taking is most effective when it is:

- Anchored in the content (annotation)
- Created in a separate document

15. "I believe users would take notes or annotate content in courses to aid learning, and for future reference, if they were able to do this with a digital pen."

- Agree
- Disagree

16. In my organization we would have significant opportunity to use pen-based tools to interact with content delivered electronically in order to:

- learn, practice or evaluate performance related to visual discrimination tasks
- annotate technical diagrams (learners)
- develop annotations on technical diagrams or images (developers or instructors/subject matter experts)
- facilitate virtual classroom delivery of visual or graphic content
- facilitate review of draft content or intermediate deliverables (storyboards, draft production content...) and communications among members of development team
- improve interaction within class in instructor-led training

Other (please specify)

17. I can foresee uses for:

- 3-d animation of 3-d learning objects
- 2-d annotation of 3-d learning objects
- annotation of 2-d objects

18. I-trace is an application that allows comparison of an expert's trace (outlining significant regions or features in an image) with a learner's trace. The program allows developers to set parameters indicating how close the learner's trace must match the expert's trace. Can you think of applications for this tool in your domain? Would it be useful as an type of interactve object in ForceTen? Please comment.

19. E-portfolio is a tool to manage individual learning, over a lifetime, accross different jobs, and with reference to competency models associated with different roles in different fields. It is a tool that may be used both by a learner to manage and document their self-directed learning, and by the organization to assess who has acquired the skills and experiences required for different roles. The functionality overlaps with some HR and LMS functionality, but goes beyond what these applications offer in terms of managing, qualifying and tracking individual learning. For one, thing, a porfolio is "portable", and goes with a learner throughout the span of her working life.
Based on what you have heard in the user group session, do you believe this application would be useful, and would be adopted, in your organization. Please comment. Mention any obstacles you can think of. For example, would lack of industry-wide competency models in your field pose a limitation?

20. "Availability of pen-based annotation capability would be a key element for e-portfolio."

- Agree
- Agree somewhat
- Disagree

Other comments

21. In an e-portfolio application, pen-base annotation capability would be important for:

- Learners
- Assessors
- Managers

Other (please specify)

22. I would like to see the following capabilities within Forceten:

	High priority	Moderate priority	Low priority	No perceived use
I-trace annotation and evaluation functionality	jn	jn	jn	jn
Ability for learners to annotate 3-d learning objects with pen device	jn	jn	jn	jn
Ability for learners to annotate 2-d learning objects with pen device	jn	jn	jn	jn
E-portfolio functionality	jn	jn	jn	jn
Ability to share notes (make them viewable to other users)	jn	jn	jn	jn
Ability to annotate content and documents within development process using pen based device	jn	jn	jn	jn

23. "Pen-based learning technology has the potential to radically change the way we design, interact with, or learn from content."

jn Agree
jn Agree somewhat
jn Disagree

Comments

2. Eedo User Group Survey -- December 2007

Thank you again for your time!

3. Eedo User Group -- PBLT (cont'd)

Appendix F – E-portfolio Specifications

iTrace Project – Requirements Specification
Penbased ePortfolio

EEDO Knowledgeware
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Date : 27 November 2007
Version : 3.0

1 EPORTFOLIO – OVERVIEW

1.1 Assumptions

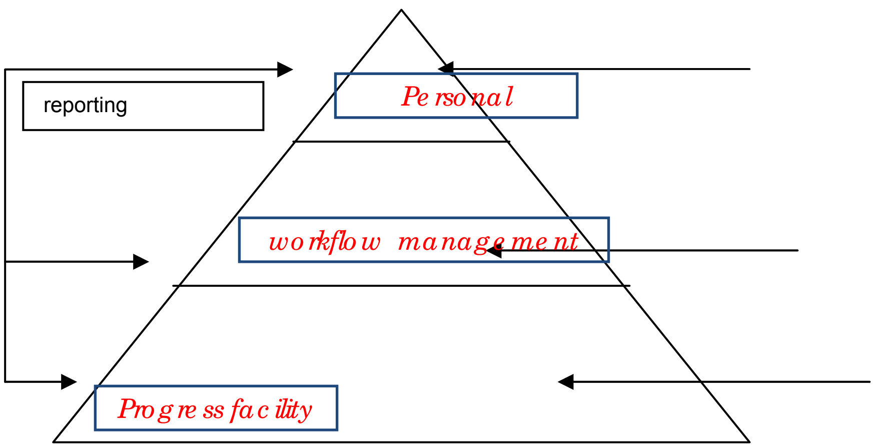
The terminology in this requirements specification is based on the IMS Learning Design and IMS ePortfolio standards (www.adlnet.org). Basically, learning *activities* are performed by different *roles* (learners, instructors, etc.) within a learning environment consisting of *learning objects* or *services* starting from *learning objectives*. E.g. in portfolio learning, *properties* store information about a person or role (e.g. progress dossier, grades) and *conditions* are constraints such as circumstances, preferences, characteristics (prior knowledge) or learning styles. *Notifications* trigger new activities (e.g. grading upon submittal). After the setup everything comes together in a method which is played back as a sequence of acts by role-parts. It is important that the ePortfolio is very flexible and configurable to allow for different use cases. The Learning Design and ePortfolio standards provide this flexibility and also provide exchange and reusability.

For the implementation of the ePortfolio in EEDO ForceTen it is also important that it is based on open standards for interoperability such as SOAP and XML and to contain pen-based annotation capability as specified within the iTrace project. Existing ForceTen LCMS services such as workflow, annotation, e-signature, e-acknowledgement, workspace, knowledge sharing, taxonomy and metadata and portal services will be used for this purpose.

1.2 Introduction

This requirements document describes the particular business requirements regarding ePortfolio. The e-portfolio will be an extension to the current ForceTen Learning Portal to support the so-called APAC procedure (or Acknowledgement of Prior Acquired Competencies) and consists of the following main components:

1. a Digital (learning) Portfolio to manage various (also external) learning activities related to learning objectives within the system
2. Task management (workflow within the portfolio procedure)
3. Pen based Annotation capability
4. Competency management (mapping of content to learning objectives in relation to individual profiles)



These functionalities will be added as a separate module (portlet) to the Forceten Learning portal, based as much as possible on existing functions in ForceTen. The most important extension is the implementation of the ePortfolio and ePortfolio procedure.

In this Requirements document the components that need to be developed to support the ePortfolio procedure within ForcdeTen, including an ePortfolio, are functionally described as a guideline for design and implementation.

1.3 Business Objectives

The goal of Forceten in using the ePortfolio is to achieve the following outcomes:

- shorter training time for all employees in an organization
- increase employees' job skills quickly
- provide higher level of job satisfaction

1.4 What is an ePortfolio?

An ePortfolio is a module accessible from a learning portal to support the roles of instructors, tutor/coaches, managers and students in managing ongoing learning developments while reaching skills/competencies. The student uses the portfolio to submit work documents, assignments or CV type information. The teacher and mentor/coach use the portfolio to maintain test results and show them to the student and to monitor progress within learning paths or APAC procedures for final certification. The ePortfolio is unique for every student and can only be viewed by the student and instructor or mentor/coach. The student can decide to open the (personal) portfolio for others to view.

The ePortfolio should support the following services:

- a personal storage facility for uploading documents and evaluations
- a penbased annotation facility for the ePortfolio
- secure digital signatures
- a reporting facility for students and mentor/coaches
- a progress facility to manage test results and schedule assignments.
- workflow management services to allow for the management of the activities between the several roles

The ePortfolio can be seen by the individual learners and the instructor/tutor can see/annotate the portfolios of all learners. The ePortfolio supports different types of learning activities and results related to an existing content structure and/or learning objective structure (skills/competencies framework):

- Learning by doing, e.g. workplace functioning: evaluation via a form
- Classroom training (ILT) via assignments: via a document from the system and an evaluation form
- Online learning: Results of courses: Courses and tests from the LCMS

The difference between ePortfolio learning and pure e-learning is that not in all cases the interaction and feedback consists of online learning content. Feedback can also consist of evaluation documents using a form or by a live learning event evaluated using a form or pen based annotation. This is very typical for competency based learning and portfolios. Learning proofs can also come from the outside, for example, a document which will prove that you are a chairman of a youth club to evaluate your management competencies. However, the evaluation/annotation and validation takes place in the LCMS.

2 EPORTFOLIO REQUIREMENTS SPECIFICATION

2.1 Deliverables

The following immediate deliverables for ForceTen will be part of the deliverables:

1. Provide interface for learner upload documents, edit, and enter information
2. Assessor/job coach will be able to use workflow portfolio (route forms/documents through workflow, provide pen based annotation and feedback, connect documents).
3. Instructor will be able to generate learning paths and automatically distribute content to the specific learner based on Assessors' findings.
4. Administrator will be able to assign rights/permissions for each portfolio.
5. Learners will be able to launch personal learning plan from their portal. Usability Issue: Instructors and/or administrators will be able to define what content must be viewed in what order (assign prerequisites).
6. Browser compatibility: ePortfolio will run in IE 6 and later.

2.2 Three Portfolio Views/Types

In essence the digital learning portfolio is an overview of knowledge objects (documents, forms) and results/reports per student available to the learner themselves and their instructor, mentor/coach. The portfolio is in development until the portfolio procedure is ended.

Three different views of the portfolio support different stages within the learning process. They can be regarded as user interfaces or layers for different roles and learning activities. Respectively they are called personal portfolio, workflow portfolio and competency portfolio. Depending on a users' role, they will have different permissions for each of the layers/interfaces.

Once a cycle for a specific job role is complete, this could become consolidated in a new layer in the portfolio. The final student portfolio consists of:
1. an overview of the documents/forms per student
2. the learning path (content) and results.

a) Personal portfolio

The 'Personal Portfolio' is the main interface for the learner (and can be accessed by managers, instructors, etc.). The Personal Portfolio will provide the following:

- The ability to upload, view and edit personal documents, forms, certificates (comparable to the current My Space and Workspace features). Forms will be made available to the learner by the administrator (the current Form editor for Knowledge Sharing could be used).
- Any ForceTen report type should be available for the learner to view (scores, completion, etc.). The Administrator will decide which particular reports should be made available in each portfolio. Reports should be presented in a simple graphical layout.
- Tutors/job coaches can monitor the portfolio and provide pen-based feedback or comments.

- Managers can access additional reports (not available in the learner's portfolio). Managers could use the existing ForceTen reporting tool to generate group reports.
- List of competencies for a particular job role.

Figure 1. Example of Personal Portfolio using Workspace

	Assessor/evaluator	Student
Group	Read	-
Individual	Read/write	Read

Figure 2. Roles/rights scheme portfolio

b) Workflow portfolio

A workflow portfolio tracks and organizes the interaction between assessors and learners leading to validation of the materials (documents, etc.) in the personal portfolio. This occurs via:

- properties (user profiles or progress)
- conditions (e.g. storage of prior knowledge)
- notifications.
- Provide pen based feedback

The end result of a workflow (validation process) will be visible in the personal portfolio view.

In the case of a certification process the forms could be published to the competency portfolio view, connected to learning goals/competencies (certification process).

Workflow Setup
The following functionalities are required to set up workflows within the ePortfolio:

- Setting up the workflow (multiple workflows are possible within one ePortfolio procedure);
- Setting up the required forms*;
- Setting up task management*.

The following functionalities are required to manage the workflows:

- Definition of tasks within the workflow;
- Connection tasks to users and roles;
- Assigning the accompanying forms;
- Initiating the workflow;

- Provide pen-based feedback/annotations;
- Notifications via the user interface (Forceten Portal) and via e-mail.

*Forms can be used as part of the process of creating a final learning plan per student.
*Task management is required to manage the workflows for evaluation and certification.

The workflow process consists in exchanging dynamic forms to managing the competency profiles and to documenting the learning proof. They are used for the company specific competency profile per student (PDP - Personal Development Plan) and are also used to qualify the competency profile per student.

The last step of this process consists of generating the personal learning plan (individualized course/module) based on the PDP (databased form – see technical appendix for detailed information on how this functionality works). Within this step the company specific competency profile is further refined and linked to individual students.

Forms Setup
Two types of forms are required to create workflows within the ePortfolio: database forms and webforms:

- Forms related to the qualifying portfolio;
- Forms in the personal portfolio of every student. The EPortfolio procedure takes place mainly using these forms in the staging/development portfolio.

Forms are also related to the formal aspects of the portfolio. These are stored per individual student and are used to create the personal learning arrangement automatically. There are five main steps in the workflow using forms:

1. An intake form to create the user in the database
2. Create a advice report based on the required competency profile
3. ePortfolio (community per student where all related persons get access)
4. Education advice (Different forms)
5. Final advice report (which creates a personal learning arrangement based on the learning objectives (criteria) connected to content clusters in ForceTen)

Additionally, forms are used to store information per student and are used to support qualification. There are several different forms e.g.:

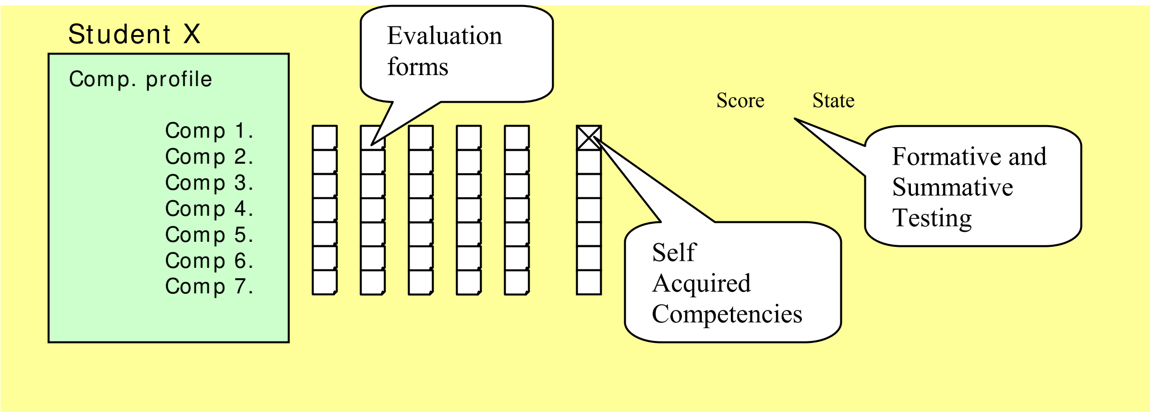
- Establishing level;
- Internal assessment;
- External assessment.

c) Competency portfolio

The third interface is the competency portfolio which displays the end result of the process monitored in the workflow portfolio. This view contains:

- connections to required learning objectives/competencies.
- a graphical representation of the competency/ learning objectives structure for the particular student profile.
- learning objectives/competencies connected to the content structure (learning objectives connected to clusters) can be signed off allowing for the generation of a personal learning path.
- A learning path can be generated conditionally for those learning objectives/competencies not yet met for the particular student.
- The conditions are also set up in the admin part of the portfolio.

Dynamic forms are used to store intermediate results and can also be used to upload documents. All required forms are defined in the workflow and task management of the ePortfolio module and will be linked to the user profile of the individual student. The portfolio of each individual student consists of an overview of the required forms. For mentors, teachers, coaches and students the competency portfolio functionality is displayed as an overview of the personal competency profile (based on the individual competency/ learning objectives or content structure). Next the evaluation forms and learning objectives are shown which can be clicked to get access to the dynamic forms. Together they form a portfolio dashboard for every student. Teachers can edit this information when they first select the student from a list. Students only see their own portfolio initially and can view the information.

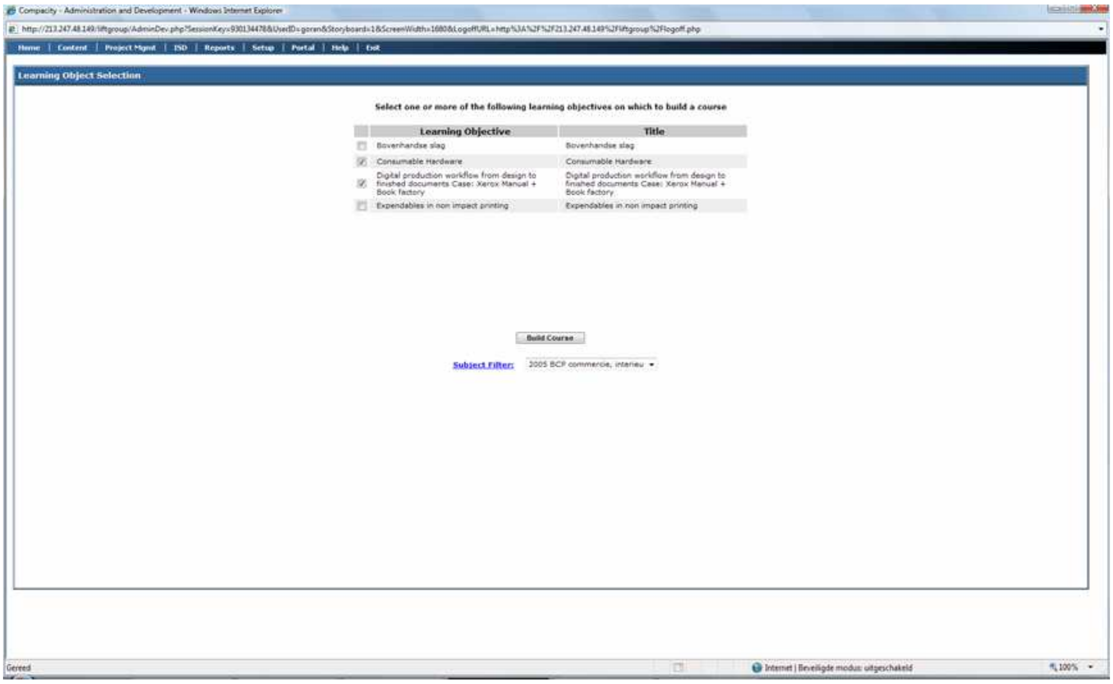


Personal Portfolio dashboard

The end result of the e-portfolio is the e-APAC procedure. The resulting learning arrangement/path itself is available as a course in the learning portal of each individual student. The results of the learning arrangement (content with tests) are also available in the portfolio dashboard next to the proof materials (documents, forms) and acquired competencies. They are the result of the formative and summative testing in the learning materials. This information is available from the reporting function of ForceTen. Together the portfolio dashboard allows for a display of the whole portfolio process as displayed underneath (from personal portfolio to development portfolio and qualifying portfolio.

2.3 Competencies and Learning Plan

The course/lesson structure is available in the form of a content structure and/or a connected competency/learning objectives structure. This means a content structure or a series of content structures will be published to an individual student to accomplish his/her IDP (Individual Development Plan), which is actually a personalized course in the LCMS.



Some learning plans consist of instructions, followed by 2 courses, for instance. When learners are presented with the content they should be forced to follow the content in a particular sequence. For example, instructions should be read before content begins. Instructors should be able to define prerequisites for ForceTen courses. As a result, learner will not be able to click and open course B until they have completed course A.

2.4 Roles

The following roles are required for the ePortfolio module for the learner and to manage competencies and workflows. Roles can be set up in ForceTen using the existing user profile data and security options:

- Learner: Employee who uploads their learning and skills records to the portfolio and monitors their own progress
- Jobcoach provides feedback towards the portfolio using pen-based feedback
- Assessors/evaluators: Assessors can be external to the organization or internal managers who have read rights or a 'monitoring role' on each foregoing step in the selected workflow and write rights on forms. such as portfolio and route coaches can start the workflow;
- Instructor: Based on the results from the Assessor, the Instructor can initiate the learning path for the learner.
- System Administrator: sets up rights within ForceTen for which users have access to certain aspects of the EPortfolio.

2.5 Use Case

In the retail industry, employees can enter new employment with a variety of skills. This use case will describe a typical application of EPortfolio for an entry level employee at a furniture store.

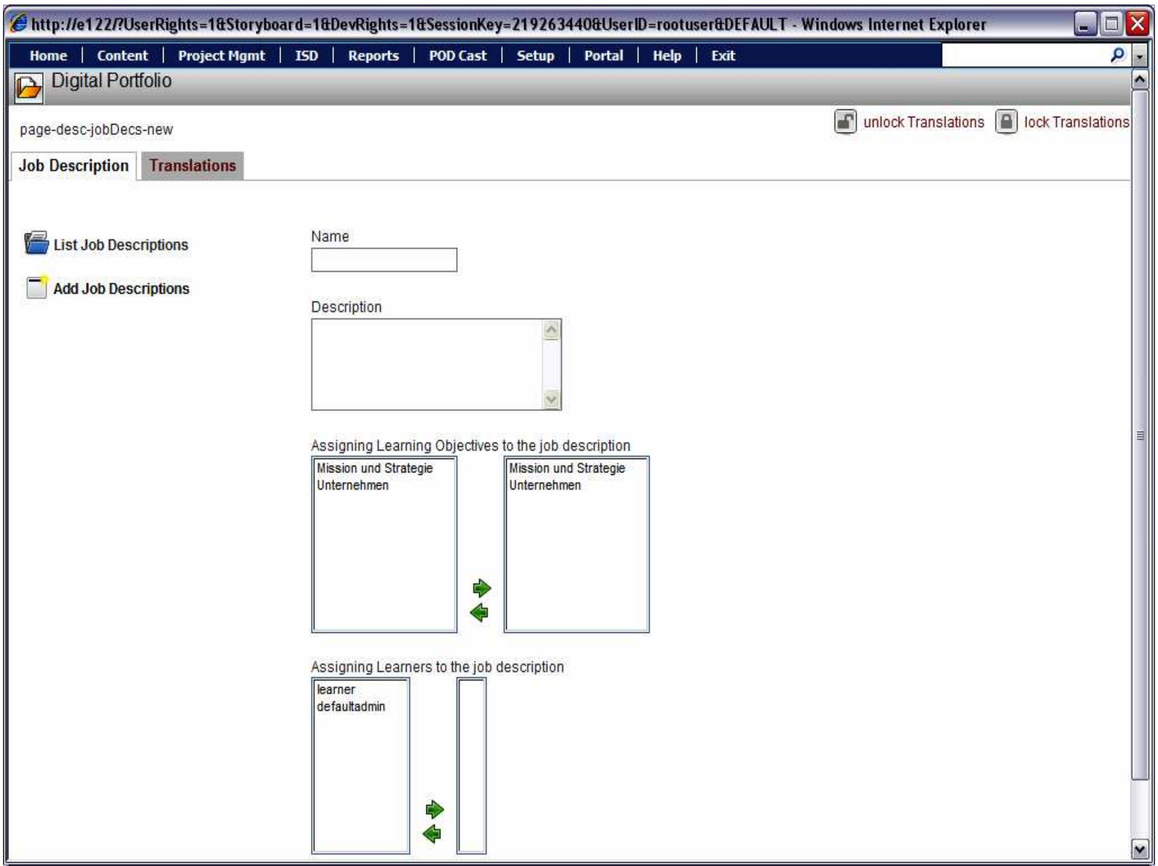
1. Employee is a cashier who has developed skills from a previous job at a café.

2. When the employee begins at the furniture store, they are given access to their own ePortfolio. They begin uploading records from home: documents, certificates and filling out forms that relate to their existing skills. These records are in word format, pdf, graphics of certificates, etc.
3. A jobcoach/tutor is invited to provide feedback towards the portfolio and is able to use pen-based annotation
4. Once the employee has uploaded all of their relevant records, they indicate that their portfolio is ready for the assessment process to begin. The Assessor begins the competency evaluations. (assessments/competencies are regulated in The Netherlands)
5. The Assessor matches skills against competencies and find that the learner meets 2 of the 3 competencies for cashiers: handling cash and customer service.
6. Assessor puts evaluation through workflow (indicating the steps they have been following).
7. Assessor updates portfolio to include information regarding the skill gaps which the learner is unable to change.
8. The Instructor or Manager then looks at this and matches to competencies which in turn will generate a learning path for the learner. The Competence Portfolio is filled in. In this case the learner needs to meet the 'Taking Inventory' competency. Content for this competency is already available in the LCMS.
9. The learner is sent a notification through the system and/or by email that a learning path is available. The learner accesses and completes the Learning Path (course) from the organization's portal for the 'Taking Inventory' competency. The learner only accesses content that is relevant to their learning needs and/or skill gaps. The portfolio has enabled the learner to avoid taking courses on their existing skills ('handling cash' and 'customer service') which would take time and likely cause frustration for the learner.
10. In 6 months time, the learner has been performing well as a cashier and will be promoted to floor sales. Upon their promotion the process will begin again as there will be a new set of competencies for the new slaes position.

The ePortfolio will be for use inside a particular organization and trusted information will not be shared outside of the organization.

Note that procedures are different for different organizations.

Appendix G – Additional Screen Shots, E-Portfolio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unlock Translations
lock Translations
Job Description
Translations
List Job Descriptions
Add Job Descriptions
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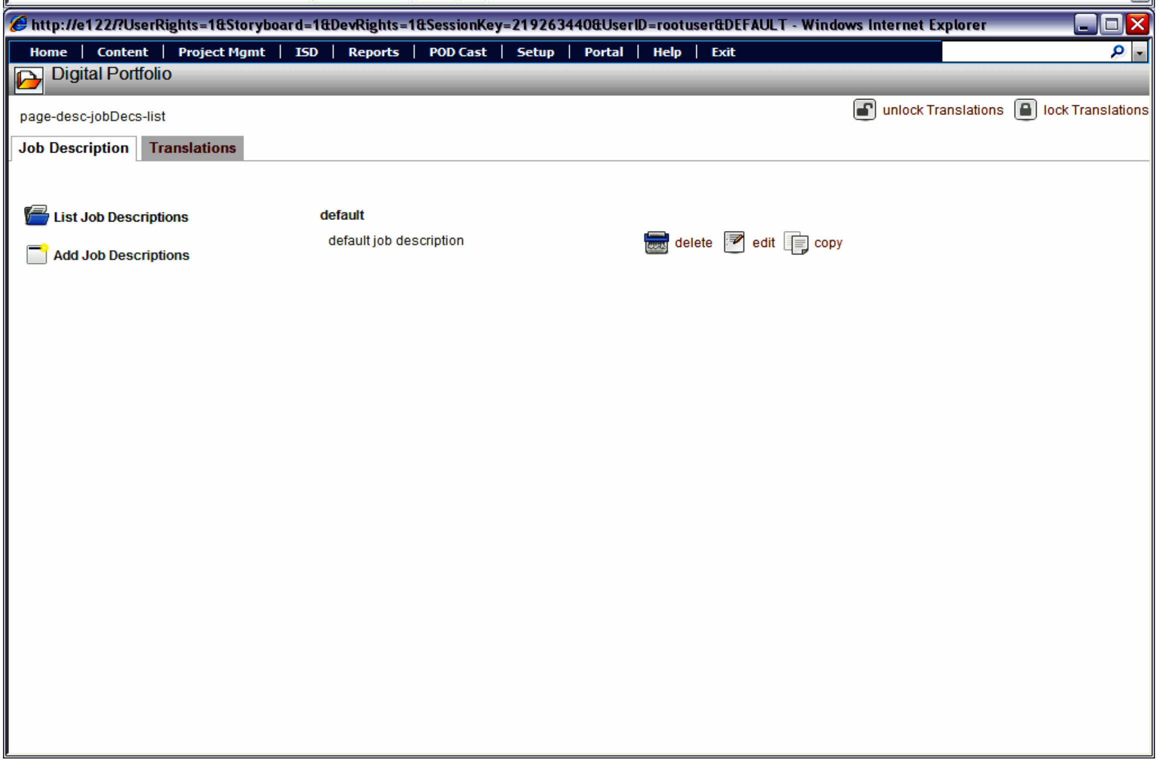
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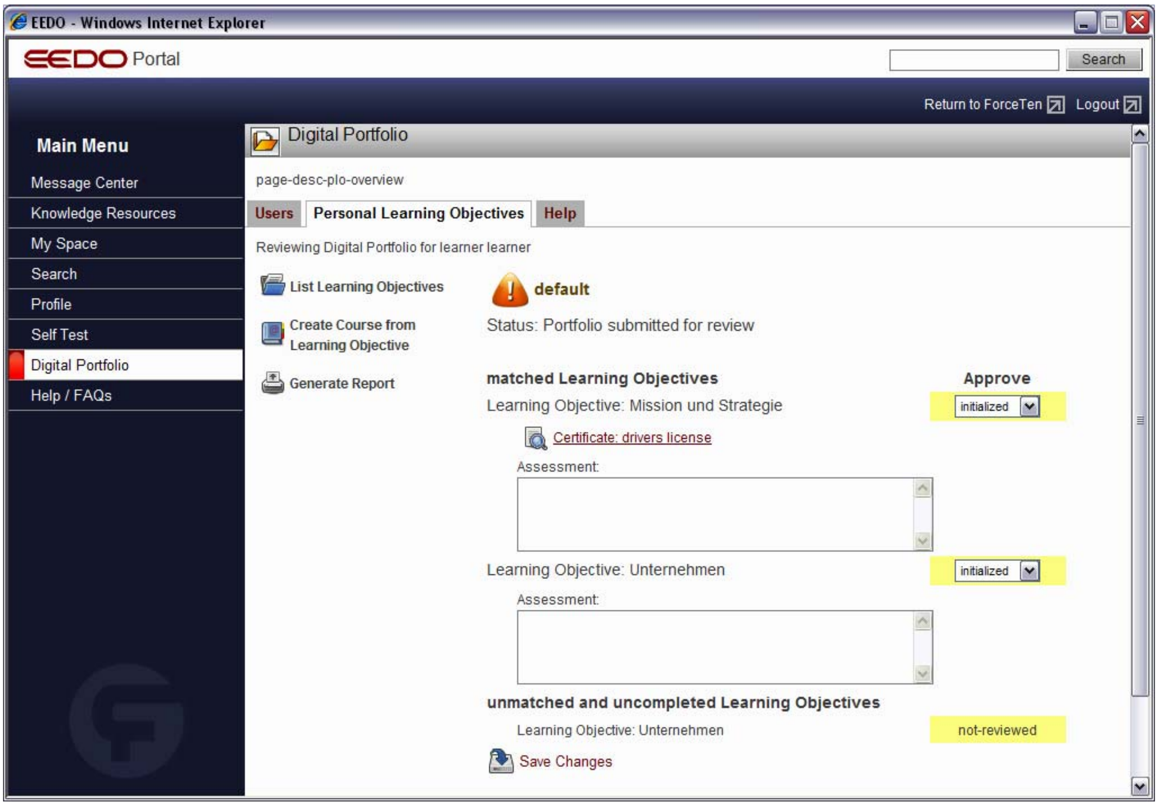
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Self Test
Digital Portfolio
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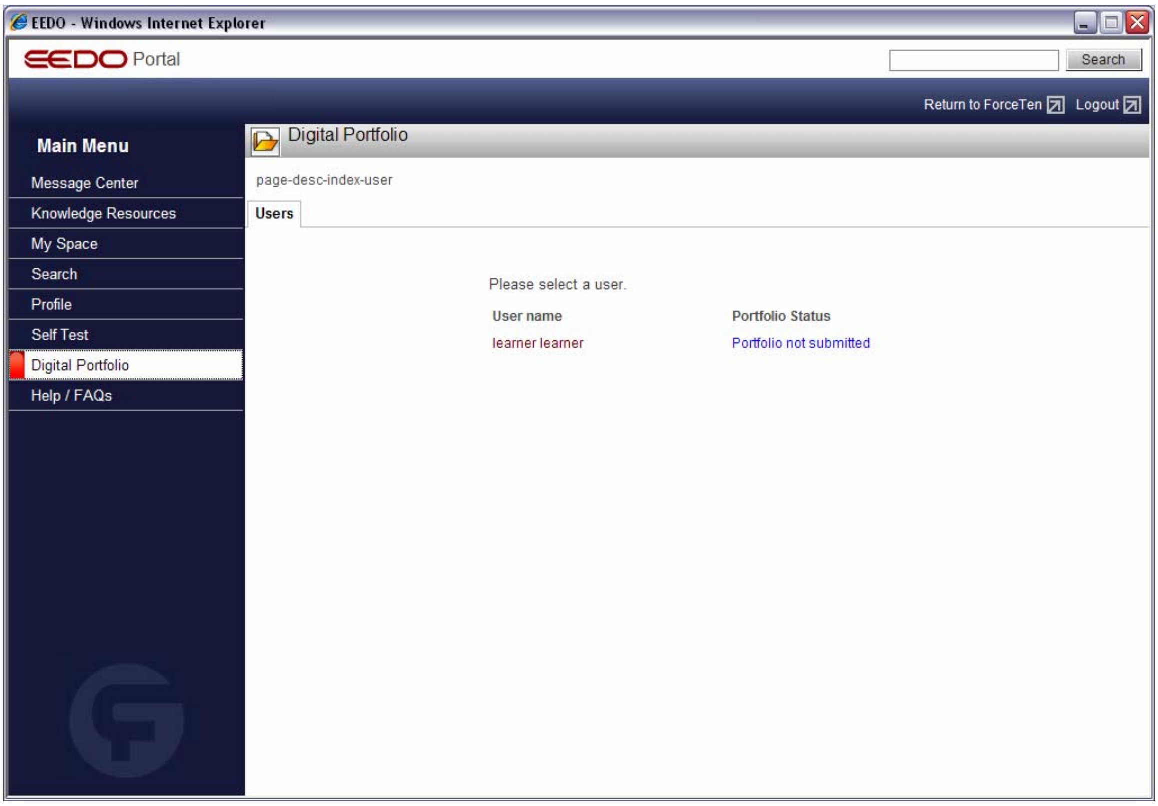
Digital Portfolio
page-desc-plo-overview
Users
Personal Learning Objectives
Help
Reviewing Digital Portfolio for learner learner
List Learning Objectives
Create Course from Learning Objective
Generate Report
default
Status: Portfolio submitted for review
matched Learning Objectives
Approve
Learning Objective: Mission und Strategie
initialized
Certificate: drivers license
Assessment:
Learning Objective: Unternehmen
initialized
Assessment:
unmatched and uncompleted Learning Objectives
Learning Objective: Unternehmen
not-reviewed
Save Changes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Help / FAQs
Digital Portfolio
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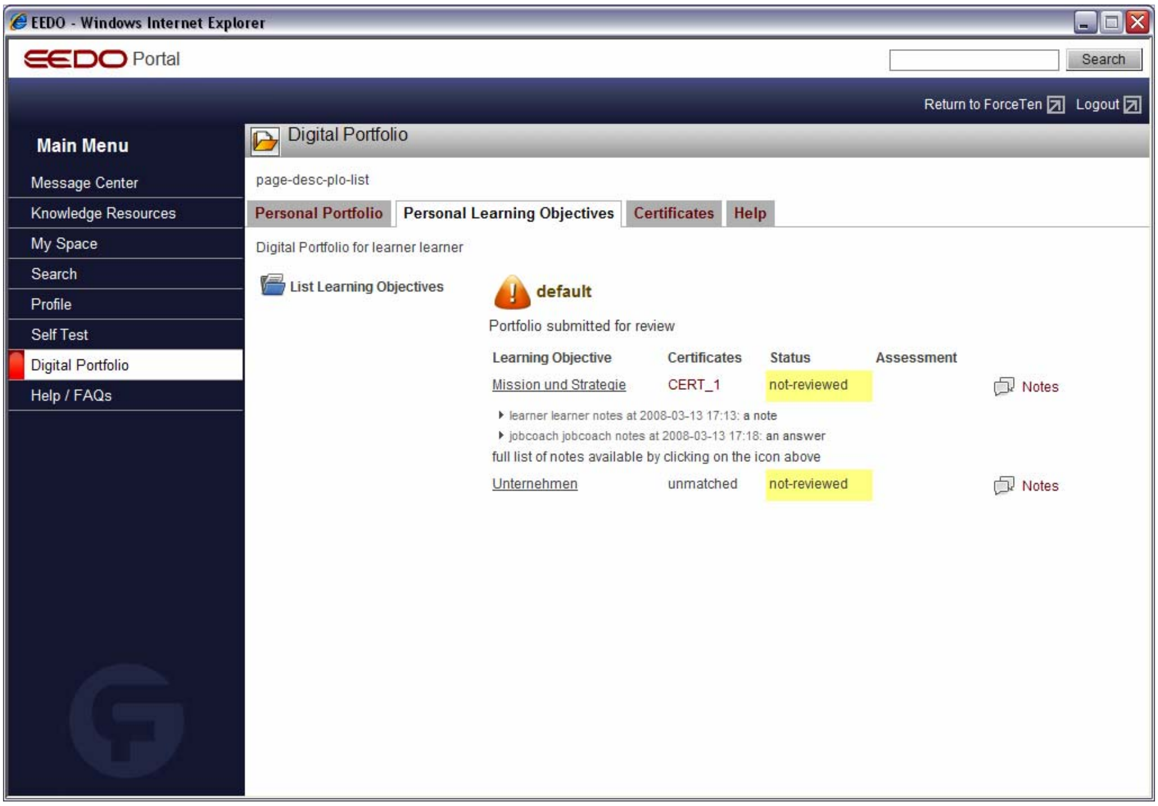
Users
Please select a user.
User name
Portfolio Status
learner learner
Portfolio not submitted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Personal Portfolio
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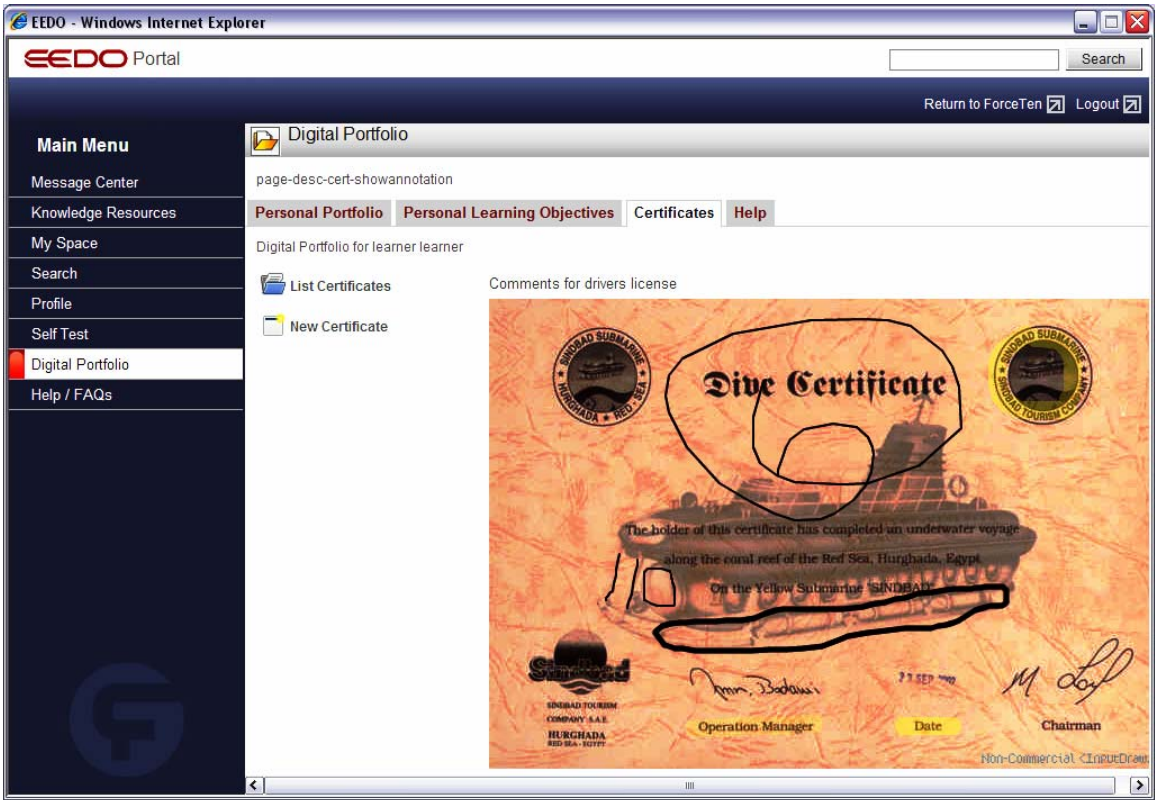
Help
Digital Portfolio for learner learner
List Learning Objectives
default
Portfolio submitted for review
Learning Objective
Certificates
Status
Assessment
Mission und Strategie
CERT_1
not-reviewed
Notes
learner learner notes at 2008-03-13 17:13: a note
jobcoach jobcoach notes at 2008-03-13 17:18: an answer
full list of notes available by clicking on the icon above
Unternehmen
unmatched
not-reviewed
Notes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Digital Portfolio
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Personal Portfolio
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List Certificates
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Comments for drivers license
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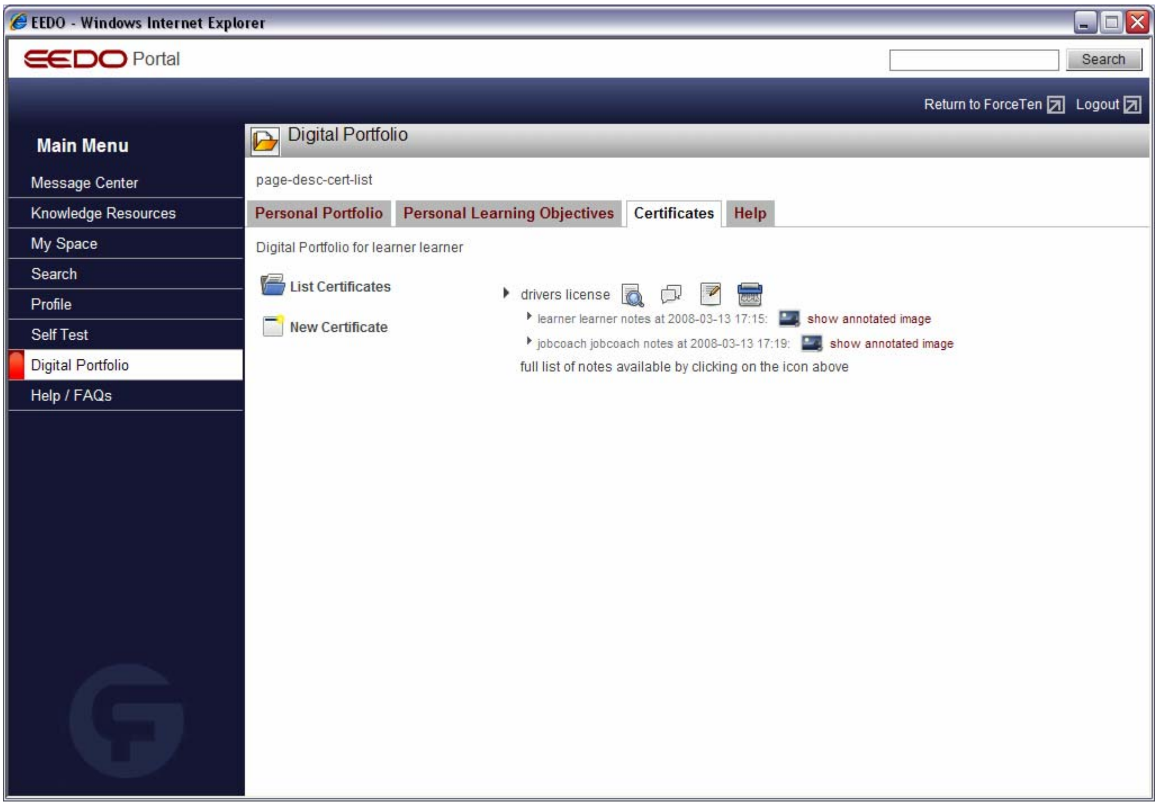
Operation Manager
Date
Chairman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Personal Learning Objectives
Certificates
Help
Digital Portfolio for learner learner
List Certificates
New Certificate
drivers license
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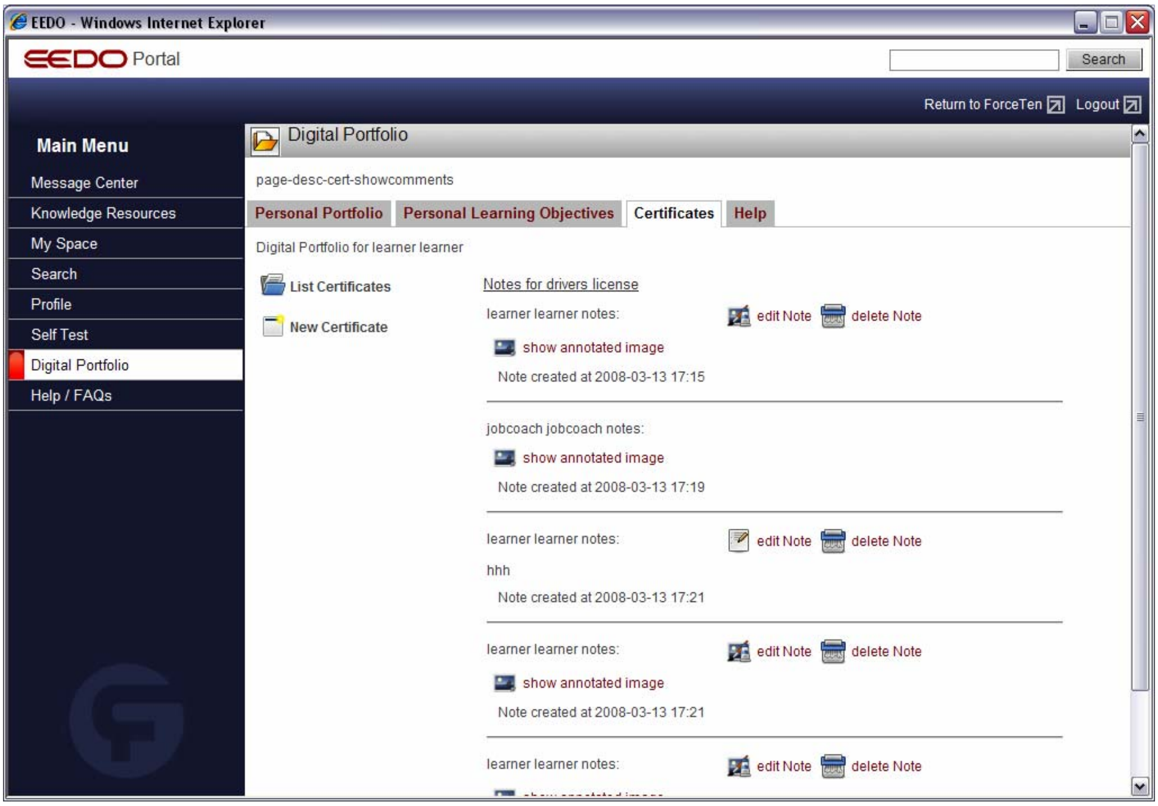
show annotated image
jobcoach jobcoach notes at 2008-03-13 17:19:
show annotated image
full list of notes available by clicking on the icon above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Personal Portfolio
Personal Learning Objectives
Certificates
Help
Digital Portfolio for learner learner
List Certificates
New Certificate
Notes for drivers license
learner learner notes:
edit Note
delete Note
show annotated image
Note created at 2008-03-13 17:15
jobcoach jobcoach notes:
show annotated image
Note created at 2008-03-13 17:19
learner learner notes:
edit Note
delete Note
hhh
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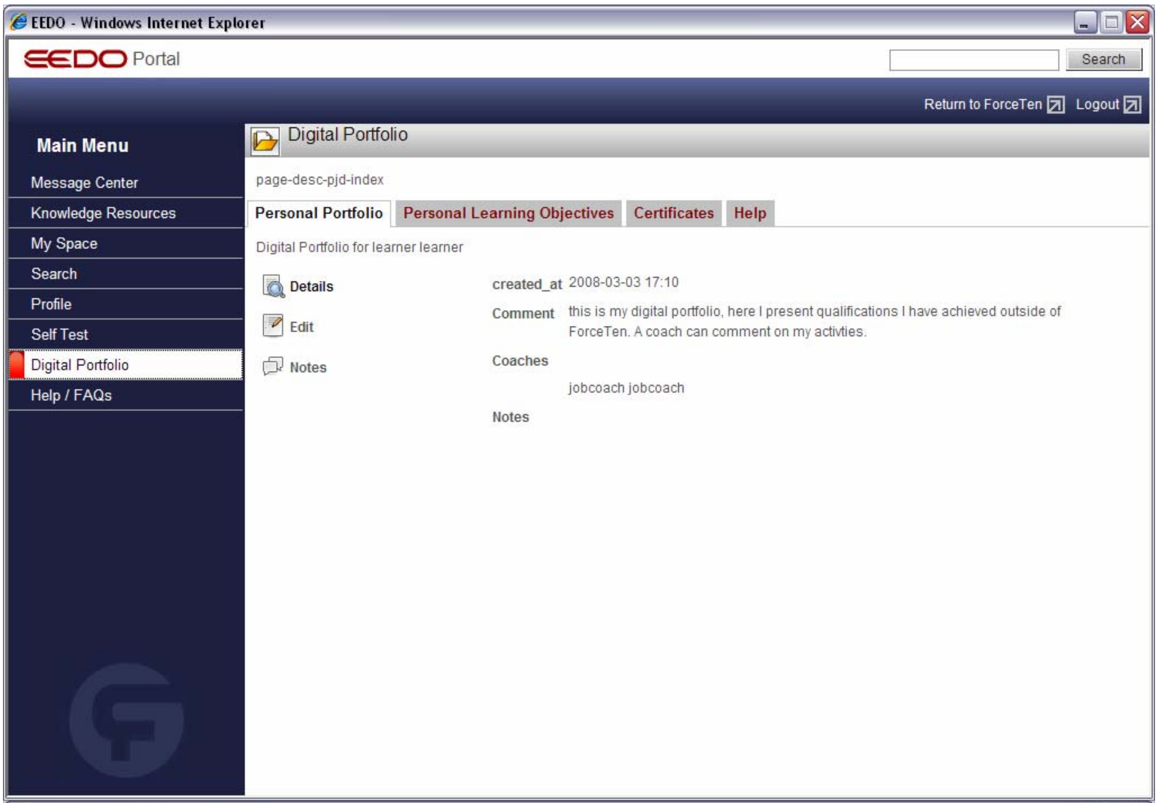
edit Note
delete Note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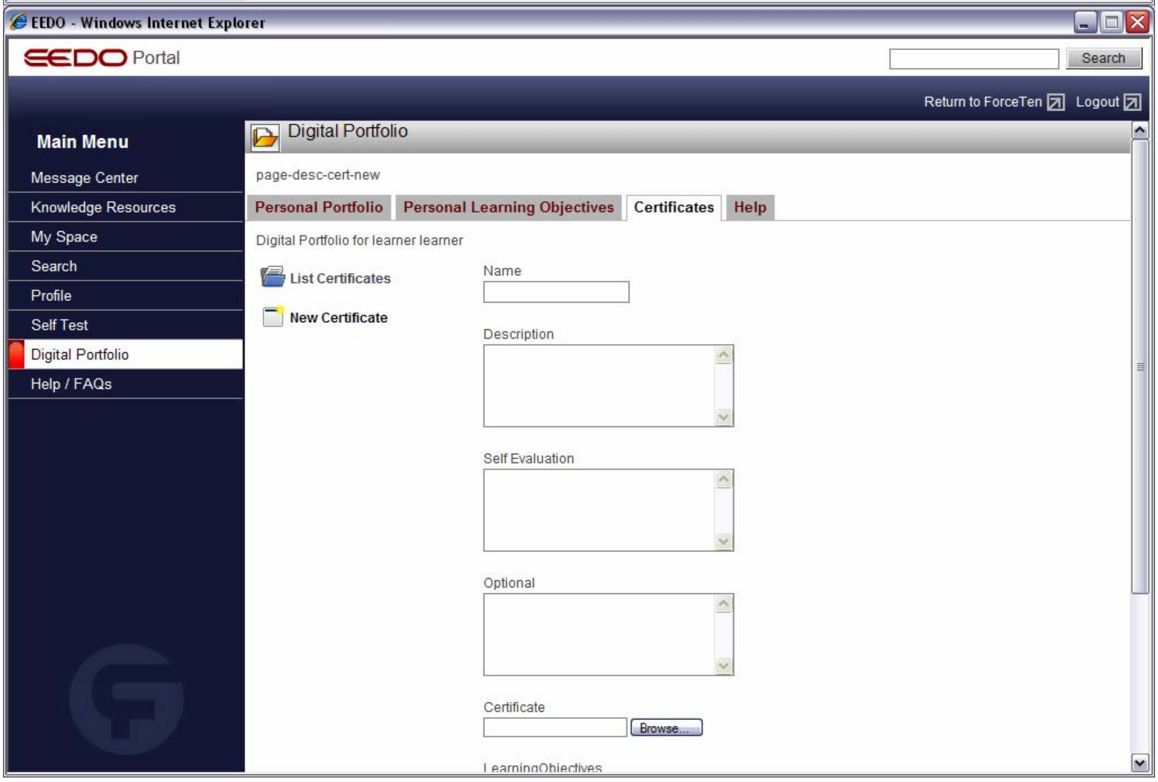
Coaches
jobcoach jobcoach
Notes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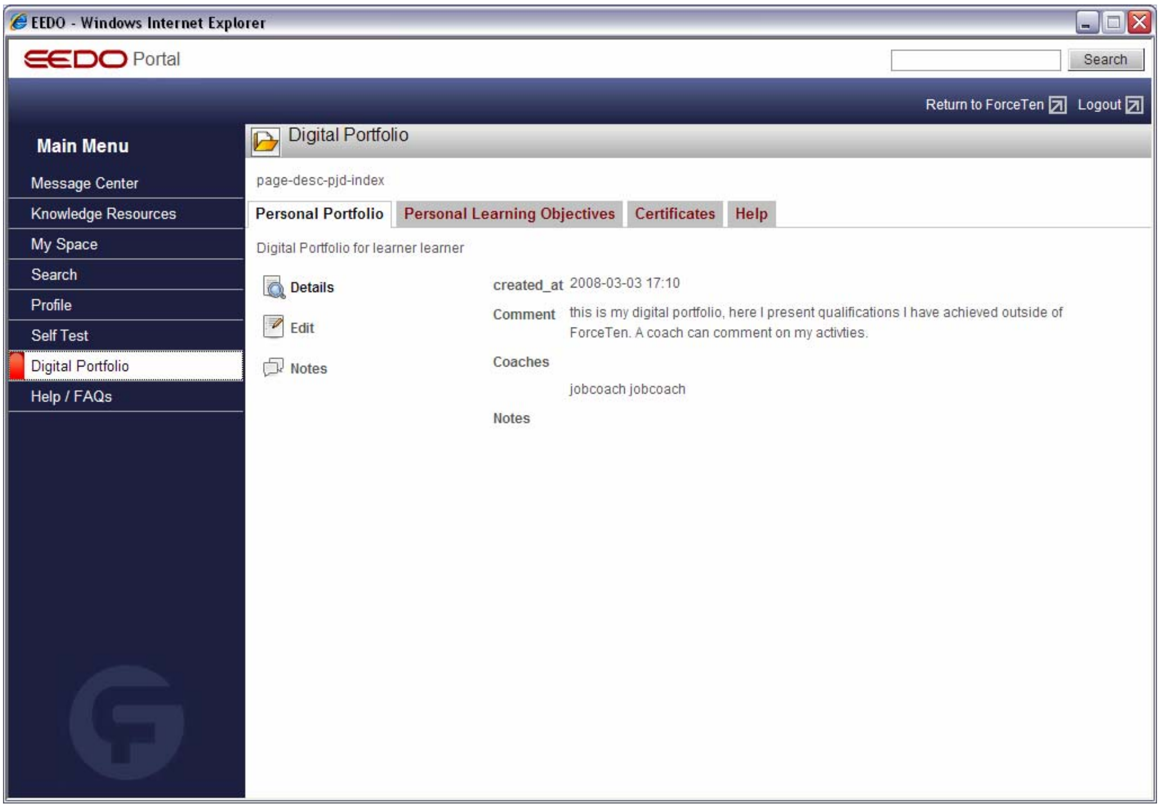
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Details
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created_at 2008-03-03 17:10
Comment this is my digital portfolio, here I present qualifications I have achieved outside of ForceTen. A coach can comment on my activties.
Coaches
jobcoach jobcoach
Notes

Appendix H – Literature Review

I-Trace Literature Review

Cognitive aspects of note-taking and annotation

Prepared by S. Shaw
Eedo Germany

August 2006

I-Trace Literature Review

Contents

1.0 Introduction.

The I-Trace initiative investigates the capabilities of an "intelligent" visual tracing algorithm, WebTrace, that allows for sophisticated comparisons of an ideal or expert identification of regions of an image with specific properties against another individual's identification (specifically, a learners' input). The software also allows for the simple use of visual tracing input, entered through a tablet PC, to annotate images of all kinds (maps, photographs, flow charts, schematics…..). The capabilities of the algorithm lend themselves to applications in learning in a variety of ways.

1) Provide a more sophisticated, more discriminating mode of interaction with images, to support deeper more robust learning, and to provide better evaluation of capabilities regarding visual discrimination tasks. At a most basic level, WebTrace offers a solution to a well-known problem in elearning concerning the use of "hot spots" as a form of interaction. In detailed graphics, they require too much precision from the user, or do not provide enough precision for developers. The use of hot spots also conditions the cognitive task of discriminating visually, since the defined regions provide some cues that could be omitted with WebTrace. WebTrace would eliminate what amounts to multiple choice guessing for visual discrimination, and cued recall. An existing literature on the role of annotation, and our knowledge of how visual discrimination tasks are mastered, suggests that replacing visual discrimination tasks based on conventional hot spots with WebTracing could lead to better retention and more robust learning. The ability to tie specific feedback to responses based on multiple criteria would also support more efficient and effective learning, than is possible with the use of simple hotspots as a mechanism for input, assessment and interaction. Basically, if visual discrimination tasks follow a pattern of successive iterations of generalization and then discrimination, then the capabilities of WebTrace should lend themselves more directly to the mastery of visual identification tasks than the use of simple evaluations and input based on highlighted regions or hotspots.

There are thus several ways to use WebTrace to implement sound instructional strategies for learning visual tasks: 1) provide the means for more sophisticated, free-form input on the part of the learner; 2) provide more detailed kinds of evaluation of user input against ideal or expert decisions (better, more precise informational feedback); 3) support progressive discrimination strategies (by relaxing or tightening constraints on user input); 4) provide more discriminating evaluation or testing to measure mastery.

2) More generally, apart from learning visual discrimination tasks, there is a very wide literature on the benefits of note-taking and annotation. This literature addresses the support note-taking offers for cognitive processes of selection, integration and organization and the effects on cognitive load, comprehension, retention and transfer. This literature includes analysis of individual differences in note-taking, effects of context and different types of notes (including visual representations such as, e.g., concept maps, information maps) and note-taking strategies, and the role of note-taking as a strategy to overcome disabilities. Recent literature also addresses note-taking in collaborative computer environments, and contrasts between traditional and computer-based media. The literature also addresses a variety of technologies for annotation, including tools for tagging content (essentially exposing a metadata scheme) or marking up text in a variety of ways. Any technology, such as WebTrace,

which can enhance and promote note-taking and annotative behaviours in on-line environments is likely to have significant benefits for learning.

3). From a developer standpoint, we would expect that sophisticated training for visual discrimination tasks can be created more efficiently with WebTrace. WebTrace should also provide a useful tool for annotating images in the design and development phases of instructional development, to support better interactions among instructors, subject matter experts, instructional designers and other specialistss. Many LCMS allow some form of rudimentary note-taking, supplemented with bookmarks and stored search results. However, this capability is generally limited. Some LCMS also provide annotation capabilities for developers and reviewers to annotate storyboards or pre-production courseware, to communicate requirements or suggestion for revisions. Typically, these are similar to the familiar low-end "Paint" application found with commercial software suites. These tools are not as transparent to the user, or as efficient a tool, as conventional pencil-on-paper and do not have wide-spread acceptance.

This literature review will cover a) what we currently know about the mechanisms involved in the learning and mastery of visual discrimination tasks, and b) what is generally known about the benefits of note-taking and annotation behaviours for learning. Implications for the use and benefits of WebTrace have been drawn above, and will be reinforced further.

2.0 Visual discrimination tasks

Visual discrimination takes place when people look for differences in two or more figures. It requires the abilities to differentiate objects based on their individual characteristics as well as to distinguish objects from their surrounding environment. Human ability to perceive distinctions is not only determined by the recognition methods employed by our visual system, but also improved during our interactions with the environment. Many scholars and educators believe that the improvement of visual abilities can be achieved through perceptual learning or discrimination learning - practising at discrimination tasks. As we notice, experts in different visually-oriented fields demonstrate exceptional visual abilities as compared with others. An experienced artist can tell subtle differences in the colour, shape, structure, and perspective of objects. Chess grandmasters can recall all of the pieces and positions of a mid-game chessboard after having seen the board for only a few seconds. The literature about visual perception and visual discrimination reveals how humans perceive and recognize objects and provides cues and evidence related to designing appropriate learning tasks to improve our visual abilities.

2.1 Two Hypothesises of Visual Learning

According to Pick (1965), there are two principal hypotheses about how humans learn recognition skills:

- *The Schema hypothesis* postulates that sensory input is matched to the internal representation of objects which are built and refined through experience.
- *The Differentiation Hypothesis,* on the other hand, emphasizes the importance of learning contrastive relations in order to distinguish among items.

A great deal of psychological evidence argues for a strong role of differentiation learning (e.g. Pick, 1965; Piater & Grupen, 2000). Although we don't know exactly what discriminative features should be employed in visual learning and how they are discovered, research has shown that these features are domain-related. In studies of chess experts (Chase & Simon, 1973; de Groot, 1978, cited by Kozbelt, 2001), for example, when the pieces are randomly arranged on the chessboard, a grandmaster's performance at a recall task decreases to a level comparable to that of chess novices.

The results suggest that expert performance is limited to situations involving familiar, domain-relevant patterns and expertise does not typically expand to encompass the visual modality generally. Studies exploring the recognition performance of artists and bird experts have found that the way experts perform recognition is qualitatively different than novices (Rosenblatt & Winner, 1988; Tanaka & Taylor, 1991; Kozbelt, 2001). Their work supports the view that experts are cognitively different from other people, especially when their scholastic abilities are taken into account. Experts have developed specialized features, facilitating rapid and reliable recognition in their domain of expertise. The implication of these findings is that the design of visual discrimination tasks needs to make the tacit recognition of an expert explicit and model the expert recognition process in order to help learners to develop a sense of domain-related distinctive features.

2.2 Visual Perception Process

Studies about visual search have made contributions to our understanding of visual perception process. In these studies, participants are presented with a display that may contain a target stimulus amongst a variable number of distractors. Their tasks are to make a target-present versus target-absent decision as rapidly and accurately as possible. Two major visual perception models are summarized by Muller and Krummenacher (2006). They are:

- *Parallel vs. Serial processing:* In the serial processing individual items in a display are searched successively, while in the parallel mode all items are searched simultaneously. The latter is considered more efficient than the former mode.
- *Pre-attentive processing vs. Attentional processing:* The pre-attentive processes are applied uniformly to all input signal and are parallel in nature. During these processes, humans perceive those elementary visual attributes such as colour, size, orientation. The attentional processes, in contrast, are more complex and only applied to a select part of the pre-attentive outputs.

The functional role of the pre-attentive processes has attracted researchers' interests. Two main functions of the pre-attentive processes in vision have been distinguished (Muller & Krummenacher, 2006):

- Registration of basic features – extracting basic attributes of input signals;
- Guidance of attention – guiding focal attentional processes to the most important information within the output of the pre-attentive stage.

According to some theories, the output of the preattentive stage consists of not only a set of spatiotopically organized feature maps that represent the location of each basic feature within the visual field (Treisman & Gelade, 1980; Wolfe, Cave, & Franzel, 1989) , but also more complex configurations such as 3-D form (Enns & Rensink, 1990) and topological properties (Chen & Zhou, 1997). The guidance of attention takes place in two different manners under two different conditions. When the defining features of the target objects are not predictable, humans selectively direct their attention in a bottom-up manner, detecting salient simple features that differ from the surrounding features (saliency cues). Under the conditions that the appearance of target objects can be predicted, our attention is allocated in a top-down manner, searching for task-dependent cues (Itti & Koch, 2001; Muller & Krummenacher, 2006). Many believe that there are interactions existing between two processes of controlled allocation of attention. And an appropriate balance is required to guarantee that the limited processing resources are devoted to the most informative visual input (Muller & Krummenacher, 2006).

2.3 Visual Attention and Memory

The functions of preattentive process reveal the important role played by ***visual attention*** in visual perception. Visual attention allows only a small part of incoming sensory information to reach the short-term memory and visual awareness (Desimone & Duncan, 1995; Itti & Koch, 2001). According to Itti and Koch (2001):

- Attention has orientating and scene analysis functions, allowing us to breakdown a visual discrimination task into "a rapid series of computationally less demanding, localized visual analysis problems";
- Attention generates attentional "feedback modulation of neural activity for visual features and at the location of selected targets". This feedback is essential for binding different visual attributes of an object, such as colour, and shape, into a "unitary percept";
- Attention is involved in triggering behaviours, such as recognition, planning, and motor control (pp195). In short, attentional selection has been shown to be necessary for object recognition.

Researchers have found that their participants develop strategies for processing information. They tend to focus on the relevant information for completing tasks (Haider & Frensch, 1996; Muir & Richardson, 2005). Muir and Richardson (2005) find that deaf people allocate their attention mostly to small detailed movements associated with facial expression and mouth shapes. They further infer that a video coding scheme that gives priority to the face of the signer may be applied to improve perception of video quality for sign language communication.

Empirical evidence shows that strategies to improve visual attention lead to the improvement of visual task performance (e.g., Pose, 1980; Solan, Sheely-Temblay & Fricarra, 2004). Poser (1980 cited in Kastner, 2004) notices that directing attention to a spatial location improves the accuracy and speed of subjects' responses to target stimuli that occur in that location. In a study exploring the perception of sign language and its application to visual communications for deaf people, Solan *et al* (2004) study the influence of visual attention therapy on reading comprehension. The computer-based visual attention therapy programs are designed to stimulate selective and sustained visual attention by stressing various aspects of arousal, activation and vigilance. Their results show that subjects who receive 12 one-hour sessions of therapy programs have significant improvement on their mean standard attention and reading comprehension scores compared with those who have not received any treatments.

There is no way to ignore the role of ***memory*** in visual perception tasks or separate it from that of visual attention. The "variable memory model" (Arami, Karwan, & Drury, 1984) assumes two key parameters of memory in visual search:

- Encoding - the location of attended items is encoded or not into memory;

- Recalling probability – the location of attended items is recalled when the attention is shifted.

Both long-term memory (LTM) and short term memory (STM) play their roles in the game. In their review, Woodeman and Chun (2006) summarize two types of interactions between perception and working memory that have been proposed by different visual search models (although not always supported by empirical evidence):

- Attended items are obligated to transfer to STM during each trail of visual search and create a perceptual representation;
- Such representation influences the perception process in a top-down manner so that items similar to those represented in STM are automatically selected for preferential processing.

Wodeman and Chun (2006) also find that many studies have shown that our memory for attended items during search is robust enough to last beyond the time of presentation. A representation of contextual objects, surfaces and locations can be built up and stored in LTM and facilitates the perceptual processing across visual trails (Castelhano & Henderson, 2002; Hollingworth, 2004). In addition, consistent semantic associations between target and distractor set also facilitate the target detection (Schmeider & Shiffrein, 1977; Chun & Jiang, 1997; Moores, Laiti & Chelazzi, 2003). The learning of contextual information - developing a memory representation of the repeated contexts of distractors, guides attention to embedded target items across visual trails (Chun & Jiang, 1997). However, sometimes, human fails to use the more efficient memory search algorithm which is stored in LTM (Wolfe, Klempen & Dahlen, 2000).

There is some empirical support for the postulation that artists might be cognitively different from others because they have better domain-related memory for visual materials (Rosenblatt & Winner, 1988; Winner & Casey, 1992). A good memory for pertinent information is relevant to the acquisition of expertise. We assume that means which facilitate the encoding and recalling process, as well as help learners build a domain-dependent memory representation similar to that of experts', may improve the performance in visual discrimination tasks.

3.0 Note-taking and Annotation

Note-taking and annotating are common strategies for recording and abbreviating information. Notes are short condensed written documents from oral or written source material. Annotations are summaries of or ideas about a document, usually written in margins.

While people annotate and create notes in everyday personal and professional contexts, educators are most interested in students' approaches. Students take notes while reading books, handouts and websites, while listening to lectures, labs and seminars, and while observing events. In all cases, taking notes involves comprehending, selecting and writing information. The exception is when students directly transcribe all oral information into notes, a practice sometimes common among younger students in lecture settings.

3.1 Properties of notes

Notes are a unique kind of writing activity. Notes are usually written for personal use, created to be reviewed within a moderate length of time, where small mistakes in writing and roughly sketched images are common. Notes are rarely created to be a permanent record; this is true of class notes. particularly.

Taking notes from oral versus written sources requires different strategies and resources because they differ in the cognitive effort required. Taking notes from oral information is more time-constrained than taking notes while reading. Time urgency is an important cognitive issue placing demands on working memory, cognitive load, and multiple tasks (Piolat et al., 2005, p.292). Time constraints affect the techniques used to take notes.

Students write notes as line-by-line text or in point form. Text is often arranged in short chunks to indicate organizational cues and conceptual relationships. Text is also commonly intertwined with graphics (Ward & Tatsukawa, 2003, p.962). While taking notes, students use abbreviating techniques, such as shortening words (e.g. *poss*. for possibly), not using vowels (e.g. *btwn* for between) and contracting suffixes (e.g. *recog*^{ed} for recognized). They will also change syntax to take notes more quickly (e.g. + or →) (Piolat et al., 2005, p.293). The practice of using any and all physical space on a sheet of paper for text and/or graphics is a defining attribute of notes (and annotations). This distinguishes notes from other documents like reports, articles, schedules, minutes, and recipes.

3.2 Tools and technologies

Many tools are available for taking notes on laptops, tablet PCs, Personal Digital Assistants, voice recorders, video recorders and, of course, pencil on paper. Common software used for taking notes include MS Word, MS OneNote, Visio, OmniGraffle, Palm Notepad and TextEditors such as Pico, TextWrangle, EditPlus, TextEdit and Notepad (Fox, 2005, p.17).

3.2.1 HCI issues

Digital documents are more legible, easier to search, edit and share. One recent study at the University of North Carolina found that students who take notes digitally said the most common benefit was legibility (Fox, 2005, p.20). Poor handwriting made it difficult to review one's own or other student's pen on paper notes. It also discouraged sharing these notes. Digital notes could be easily and neatly changed, merged with other notes and copied quickly. There was a general split among students about whether typing or writing was faster for taking notes.

Digital notes, however, lack formatting options for quickly creating figures, using syntax, subscripts or superscripts. Pen on paper allows for freehand movement needed for quick writing of symbols and drawing of graphics, for easy mixing of text and graphics, for open spatial positioning of information in order to create chunks. In the same North Carolina study, 69% of students stated they draw figures while taking notes (N=51), while only 26% of students draw figures electronically (N=35) (Fox, 2005, p.13). This may partly explain why students still commonly use pen on for taking notes even though digital note taking has many advantages.

From a human computer interface perspective, then, the ideal digital note-taking system should allow for easy entry of text and graphics at any desired position.

3.3 Note-taking strategies

Most students create their own strategies for taking notes, though there are many more effective or efficient approaches. Most note taking is unstructured as students take notes using whatever linear or graphic structure they choose, creating their own strategies for physical formatting and their own abbreviating procedures for truncating words and using syntax (Piolat et al, 2005, p.294). This is because most people are not taught how to take notes.

Structured note taking involves using a graphic organizer like an outline, matrix, or flowchart to take notes. Now it is more commonplace for students to be given handouts of class PowerPoint slides. This is a recent variation of structured note taking.

The Cornell system is a semi-structured approach for taking notes that involves creating a vertical margin on a sheet, where keywords are subsequently placed upon reviewing notes from soon after a lecture or meeting.

Stenography simply accelerates the process of writing, for either structured or unstructured note taking. Stenography involves simplified graphic traces and transcribing compared to writing the alphabet. It allows for taking notes more quickly than conventional writing but is rarely used because it involves learning a new process.

3.4 Effects on cognition and learning

Taking notes is a fairly complex cognitive activity that demands more cognitive effort than reading or learning and less than writing original text. This is because taking notes involves all these processes: reading, listening (for oral information sources), learning and writing. As listeners and readers, note takers need to understanding information. As learners note takers write information in order to (eventually) store them in long term memory. As writers, note takers select and record information in formats that differ from the original source (Piolat et al, p. 292). With the exception of direct transcribing of information, all note taking requires, then, understanding, selecting and recording information.

3.4.1 Cognitive load

Multiple cognitive processes are coordinated within a short period of time when taking notes: listening, cognitive processing, and writing. Listening depends on how quickly people speak. Research shows that average speaking speed is 2 to 3 words per second. Writing speed is about 0.2 to 0.3 words per second (Foulin in Piolat *et al*, 2005, p.297). Our mind is able to process, on average, seven ideas at any given time (Millar, 1956). This (seven plus or minus two) is the upper limit of the cognitive load that working memory can hold. Some information will necessarily be lost while taking notes given this disparity between the speaking speed of, say, a professor, and the cognitive load and writing speed of a student taking notes. Thus a note taker must select information as it cannot all be recorded.

Taking notes also allows for creating a stable external location to store information so that later we can process information at a conceivable pace. This is because our minds have a finite capacity to hold information in longer term memory. So notes are often thought of as external memory, a record of ideas because we are note able to hold them all in our minds (Kiewra, 1989).

3.4.2 Cognitive Processes of selection, integration and organization

Information is not only selected while taking notes but also integrated with prior knowledge. From an information processing approach to cognition, taking notes involves encoding new information, integrating it with schemata, organized structures of knowledge already in their memory. Schema provides context for students to decide if new information they hear, or see, should be noted and the structure to which new knowledge is added.

3.4.3 Retention

Notes help students learn, according to eighty years of research on the effectiveness of note-taking. Two processes have been usually investigated to measure the effectiveness of notes: recording notes (i.e, the process) and reviewing notes (i.e., re-reading the product). Encoding of information takes place during the process of writing notes while reviewing notes fosters storing information in long term memory (DiVesta and Gray, in Kobayshi, 2006).

In a meta-analysis of research on the effects of notes, Kobayshi (2006) found that taking notes had a large effect on student learning outcomes. Thirty-two studies were analyzed for the effect that writing and reviewing notes had on student learning outcomes compared with outcomes of students who did not take notes. The mean weighted effect sizes in the studies were .75 (mean unweighted ES=.77) for students who took and review notes compared to those who did not. Seventy-two studies were analyzed for the effect of writing and reviewing notes compared to students who did not write notes but were able to review materials before a test. In other words, they were reviewing original documents or someone else's notes. The mean weighted effect sizes in the studies were .77 (mean unweighted ES=.88) for students who took and review notes compared to those who only reviewed materials.

Taking and reviewing notes do, then, help students perform better in school. Indeed, there seems to be a generation effect for taking notes – students retain information better if they have generated them than if others have generated them (Piolat et al, 2005, p.296). Taking notes is itself a kind of mnemonic. It is not, however, clear if recording notes on its own helps learning outcomes.

Research indicates that this is a rather poor form of note-taking with only 30% of important ideas recorded for future use.

Summary

There is good evidence that note-taking as a practice significantly impacts learning and performance along dimensions of retention, comprehension and application of learning to problem-solving or higher order cognitive tasks. Effect sizes are relatively large, and the evidence is fairly consistent. The results apply for use of individual, traditional note-taking with paper-pencil. The effects are not present with any clear sense for use of keyboards to take electronic notes, or for collaborative note-taking and note-sharing. It seems clear that the power of note-taking and annotation is related to the fluid representational affordances and capabilities of the pen as an input device, and the transparency of the pen as a tool. This suggests enormous potential for pen-based learning technologies, given the most recent technical advances that have improved the quality and cost of pen-base digital interfaces.

Pen-based interfaces also offer the opportunity to improve on computer-based approaches to various interactive practice and learning tasks, such as acquiring skills in visual discrimination tasks. With regard to the latter the distinction between pre-attentive and attentional processing. Traditional approaches to teaching and practicing visual discrimination tasks within elearning environments typically exploits the use of "hot spots" to offer alternative choices. This approach converts the activity to a recognition type interaction rather than a recall task, and likely limits learning and retention as a consequence. From a theoretical perspective, the approach is likely to short-circuit the more complex discriminations that are required of the attentional phase of processing, again, limiting learning. The potential of interactions based on web-trace or other "intelligent" tools that can examine user input in the form of a trace or outline of a region of interest and then compare this for the degree of agreement or match with an expert's trace, based on selected parameters, is thus great in terms of facilitating the learning of complex, subtle visual discriminations, within an electronic environment.

Select Bibliography

Arani, T., Karwan, M. H., & Drury, C. G. (1984). A variable-memory model of visual search. *Human Factors*, 26, 631_639.

Adriano, C., Raposo, A., Ricarte, I. & Magalhães, L. (2000). Changing Interaction Paradigms in Annotation Environments. In P. Kommers & G. Richards (Eds.), *Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications 2000* (pp. 63-68). Chesapeake, VA: AACE.

Armbruster,B. Taking notes from lectures. Flippo, R.F. & Caverly, D.C. (Eds). (2000). *Handbook of college reading and study strategy research*. (pp. 175-199). Mahwah, NJ, US: Lawrence Erlbaum Associates, Publishers.

Boyle, J.R. & Weishaar,M. The effects of strategic notetaking on the recall and comprehension of lecture information for high school students with learning disabilities. *Learning-Disabilities-Research-and-Practice*. 2001 Aug; Vol 16(3): 133-141.

Bulterman, D. (2003). The Ambulant Annotator: Medical Multimedia Annotations on Tablet PCs. In G. Richards (Ed.), *Proceedings of World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education 2003* (pp. 2083-2086). Chesapeake, VA: AACE.

Castelhano, M. S., & Henderson, J. M. (2005). Incidental visual memory for objects in scenes. *Visual Cognition*, 12, 1017_1040.

Chen, L., & Zhou, W. (1997). Holes in illusory conjunctions. *Perception and Psychophysics*, 4 , 507_511.

Chun, M. M., & Jiang, Y. (1998). Contextual cueing: Implicit learning and memory of visual context guides spatial attention. *Cognitive Psychology*, 36(1), 28_71.

Crook, Charles. Deferring to resources: Collaborations around traditional vs computer-based notes. *Journal-of-Computer-Assisted-Learning*. 2002 Mar; Vol 18(1): 64-76.

Davis, R. (1999). Notepals: lightweight note sharing by the group, for the group. *Proceedings of the SIGCHIConference on Human Factors in Computing Systems: the CHI is the Limit*. Pittsburgh, PA. 15-20 May. New York, ACM Press, 338-345.

Desimone, R. & Duncan, J. (1995). Neural mechanisms of selective visual attention. *Annu. Rev. Neurosci*. 18, 193–222

Enns, J. T., & Rensink, R. A. (1990). Influence of scene-based properties in visual search. *Science*, 247, 721_723.

Faber, J.E., Morris, J.D. & Lieberman, M.G. The effect of note taking on ninth grade students' comprehension. *Reading-Psychology*. 2000 Jul-Sep; Vol 21(3): 257-270

Fahle, M. (2005. Perceptual learning: specificity versus generalization. *Current opinion in Neurobiology*, vol 15, 154-160.

Fox, J. (2005). *A survey of electronic note-taking behavior in information and library science students.* Unpublished Master's paper. Chapel Hill: University of North Carolina.

Hadwin, A., Kirby, J.R. & Woodhouse, R.A. Individual differences in notetaking, summarization and learning from lectures. *Alberta-Journal-of-Educational-Research*. 1999 Spr; Vol 45(1): 1-17.

Haider, H. & Frensch, P. A. (1996b). Information reduction during skill acquisition: The influence of task instruction. Journal of Experimental Psychology Applied. 5. 129-151.

Hollingworth, A. (2004). Constructing visual representations of natural scenes: The roles of short- and long-term visual memory. Journal of Experimental Psychology: *Human Performance and Perception*, 30, 519_557.

Itti, L.; Koch, C. (2001). Computational modelling of visual attention. *Nature Reviews Neuroscience*. Vol. 2/3, p194-203,

Kashihara, A., Sakamoto, M., Hasegawa, S. & Toyoda, J. (2001). Interactive History with Learning Affordance for Knowledge Construction in Web-based Learning. In P. Kommers & G. Richards (Eds.), *Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications 2001* (pp. 885-890). Chesapeake, VA: AACE.

Kastner, S. (2004). Attentional Response Modulation in the Human Visual System. In M.Posner(ed.) Cognitive neuroscience of attention. Guilford Press.

KayakiI, N. & Okada, R. (2003). A Preliminary Study on the Impact of Web Annotations in eLearning Environments. In G. Richards (Ed.), *Proceedings of World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education 2003* (pp. 249-252). Chesapeake, VA: AACE.

Kiewra, K.A. (1989). A review of note-taking: the encoding-storage paradigm and beyond. *Educational Psychology Review*, 1, 147-172.

Kiewra, K. et al. (1995). Effects of note-taking format and study technique on recall and relational performance. *Contemporary Educational Psychology*, vol 20, 172-187.

Kobayashi, K. (2006). Combined effects of note-taking, reviewing on learning and the enhancement through interventions: a metaanalytic review. *Education Psychology*, vol 2, no 3, pp 459-477.

Kozbelt, A (2001). Artists as experts in visual cognition. *Visual Cognition,* Vol. 8/6, p705.

Krottmaier, H. (2003). Enhanced Annotations. In C. Crawford et al. (Eds.), *Proceedings of Society for Information Technology and Teacher Education International Conference 2003* (pp. 991-993). Chesapeake, VA: AACE.

Kurhila, J., Miettinen, M., Nokelainen, P., Floréen, P. & Tirri, H. (2003). Joint Annotation and Knowledge Building in Collaborative E-Learning. In G. Richards (Ed.), *Proceedings of World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education 2003* (pp. 2249-2252). Chesapeake, VA: AACE.

Lakmazaheri, S. (2004). SideNote: A Web Annotation Tool for E-Learning in Graphics-Rich Disciplines. In G. Richards (Ed.), *Proceedings of World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education 2004* (pp. 2737-2742). Chesapeake, VA: AACE.

Lebow, D., Lick, D. & Hartman, H. (2004). Interactive Annotation for Teaching and Learning. In C. Crawford et al. (Eds.), *Proceedings of Society for Information Technology and Teacher Education International Conference 2004* (pp. 1781-1786). Chesapeake, VA: AACE.

Lebow, D., Lick, D. & Hartman, H. (2004). HyLighter and Interactive Annotation: New Technology to Develop Higher-Order Thinking Skills. *Inquiry: Critical Thinking Across the Disciplines*, Vol 23(1-2), Fal-Win 2003-2004. pp. 69-79

Lin, M., Lutters, W. & Kim, T. (2004). Understanding the micronote lifecycle: improving mobile support for informal note-taking. *Proceedings of the 2004 Conference on Human Factors in Computing Systems*. Vienna, Austri, 24-29 April. New York, ACM Press. 67-694.

Mason, H., Rebelsky, S. & Luebke, S. (1999). Annotating the World-Wide Web. In P. Kommers & G. Richards (Eds.), *Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications 1999* (pp. 409-414). Chesapeake, VA: AACE.

Moores, E., Laiti, L., & Chelazzi, L. (2003). Associative knowledge controls deployment of visual selective attention. *Nature Neuroscience*, 6 , 182_185.

Miura, K., Nomura, M., Saito, H., Saito, K. & Maeda, T. (2003). On Visualization of Learning Process and Its Application to Collaborative Learning in e-Learning Environment. In P. Kommers & G. Richards (Eds.), *Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications 2003* (pp. 892-893). Chesapeake, VA: AACE.

Müller, H.J.; Krummenacher, J. (2006). Visual search and selective attention. *Visual Cognition*, Vol. 14/4-8, p389-410.

O'Donnell, A.M, Dansereau, D. F. & Hall, R. H. Knowledge maps as scaffolds for cognitive processing. *Educational-Psychology-Review*. 2002 Mar; Vol 14(1): 71-86.

Peverly, S., Brobst, K., Graham,M. &; Shaw, R. College adults are not good at self-regulation: A study on the relationship of self-regulation, note taking, and test taking. *Journal-of-Educational-Psychology*. 2003 Jun; Vol 95(2): 335-346.

Piater, J. H., & Grupen, R. A. (2000). Distinctive Features Should Be Learned, *Lecture Notes in Computer Science*. Vol 1811, pp52

Pick, A. D. (1965). Improvement of visual and tactual form discrimination. Journal of Experimental Psychology. Vol 69, pp331-339.

Plass, J. (2004). Learner Preferences and Cognitive Abilities in Multimedia Learning. In P. Kommers & G. Richards (Eds.), *Proceedings of World Conference on Educational*

Multimedia, Hypermedia and Telecommunications 2004 (pp. 4255-4261). Chesapeake, VA: AACE

Ronchetti, M. (2002). Why web pages annotation tools are not killer applications? A new approach to an old problem. In G. Richards (Ed.), *Proceedings of World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education 2002* (pp. 837-841). Chesapeake, VA: AACE.

Rosenblatt , E., &Winner, E. (1988). Is superior visual memory a component of superior drawing
ability? In L. Obler & D. Fein (Eds.), *The exceptional brain: Neuropsychology of talent and*
special abilities. New York: Guilford. pp. 341–363.

Schneider, W., & Shiffrin, R. M. (1977). Controlled and automatic human information processing: I. Detection, search and attention. *Psychology Review*, 84, 1_66.

Sedig, K. & Liang, H. (2006). *Interactivity of Visual Mathematical Representations: Factors Affecting Learning and Cognitive Processes*. Journal of Interactive Learning Research. 17 (2), pp. 179-212. Chesapeake, VA: AACE.

Solan,H.A., Shelley-Tremblay,J., Ficarra, A.,Silverman,M. & Larson, S. (2004). Effect of attention therapy on reading comprehension. *Journal of Optometric Vision Development,* Vol 35, 2, pp87-96.

SlotteV. & Lonka, K. Review and process effects of spontaneous note-taking on text comprehension. *Contemporary-Educational-Psychology*. 1999 Jan; Vol 24(1): 1-20.

Tanaka, J.W. & Taylor, M. (1991) Object categories and expertise: is the basic level in the eye of the beholder? *Cognition Psychology*. 23, 457 -- 482

Trafton, T. G. & Tricektt, S.B, (2001). Note-taking for self-explanation and problem-solving. *Human-Computer Interaction* 16 (2001) 1-38.

Treisman, A., & Gelade, G. (1980). A feature-integration theory of attention. *Cognitive Psychology*, 12, 97_136.

Truong, K. & Abowd. G.D. (1999). Stupad: integrating student notes with class lectures. *Late-Breaking Results, SIGCHI Conference on Human Factors in Computing Systems: the CHI is the Limit*. Pittsburgh, PA. 15-20 May. New York, ACM Press, 208-209.

Van Meter, P., Yokoi, L. & Pressley, M. (1994). College students' theory of note-taking derived from their perceptions of note-taking. *Journal of Educational Psychology* 96. 323-338.

Ward, N. & Tatsukawa, H. (2003). A tool for taking class notes. *International Journal of Human Computer-Studies*, vol 59. 959-981.

Wallen, E.S. The effect of different types of hypertext annotations on vocabulary recall, text comprehension, and knowledge transfer in learning from scientific texts. Doctoral dissertation, U New Mexico, US, 2003.

Williams, R. & Effert, A. (2002). Notetaking in college classes: Student patterns and instructional strategies. *The Journal of General Education*, vol 51. 173-199.

Winner, E.,& Casey, M.B. (1992). Cognitive profiles of artists. In G. Cupchik&J. Laszlo (Eds.), *Emerging visions of the aesthetic process*). New York: Cambridge University Press. pp. 154–170

Wirth, M.A. (2003). E-notes: using electronic lecture notes to support active learning in computer science. *Inroads – the SICCSE Bulletin*, 35. 57-60.

Wolfe, J. M., Cave, K. R., & Franzel, S. L. (1989). Guided Search: An alternative to the feature integration model for visual search. *Journal of Experimental Psychology: Human Perception and Performance*, 15, 419_433.

Wolfe, J., Klempen, N. L., & Dahlen, K. (2000). Postattentive vision. *Journal of Experimental Psychology: Human Perception and Performance*, 26, 693_716.

Woodman, G. F.; Chun, M. M (2006). The role of working memory and long-term memory in visual search. *Visual Cognition*, Vol. 14 /4-8, p808-830.