Design criteria for work-based learning: Merrill's First Principles of Instruction expanded

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Abstract

In multinational corporations, new models of learning are developing. A particular model with direct applications for challenges facing distributed workforces is one that combines the strengths of formal and informal learning while focusing on participants' work-based tasks. An operationalisation of this model in the context of the ongoing professional development of the engineers, geologists, and other technical specialists in a multinational oil company (Shell EP) is described. Important for the quality control and continual improvement of the implementation of the model is a set of criteria for the design and evaluation of courses reflecting its work-based learning approach. Merrill's First Principles of Instruction (2002) form a starting point for such a model, but need to be expanded to reflect the particular needs of the Shell EP context. This article presents the expansion of Merrill's First Principles as the *Merrill+ design and evaluation criteria* for courses with work-based activities for technical professionals and demonstrates how the criteria can be applied through a selection of some results of evaluations of more than 60 of the Shell EP courses using a course-scan methodology based on the Merrill+ criteria. Implications of use of the Merrill+ criteria for design and evaluation are discussed.

Introduction

Multinational corporations have a variety of motivations for the redesign of their courses. One typical motivation is cost reduction, through reducing or eliminating the costs of travel to fixed locations for course delivery. Another motivation is flexibility in

the times of learning events, so that participants can better integrate formal learning with their own work responsibilities. Informal learning—learning on the job through coaching and mentoring or learning via the interactions that occur in corporate communities of practice—can meet these requirements but lacks the mechanism to be stretched beyond one's particular task. Also, with informal learning it may be difficult to take time for reflection or to identify opportunities for direct comparisons of one's particular approach to solving a workplace problem with the approaches of others outside of one's workplace colleagues. Each of these limitations of informal learning can be strengths of formal, or course-based learning. However, informal learning has the strengths of being directly relevant to one's current work and of being tested in practice as the learning occurs. These characteristics are generally missing in traditional course-based learning in organisations. A mechanism to design learning that combines the strengths of formal and informal learning in order to optimise the benefits while constraining the limitations of each can form a powerful approach to corporate learning in a multinational corporation (Collis & Margaryan, 2003a,b).

One way to integrate formal and informal learning opportunities in the corporate context is by blending work-based activities within formal courses. Work-based activities are learning activities that are anchored in authentic practice and that are focused on developing learners' ability to solve the problems of their everyday professional job roles. Knowledge and skills acquired while carrying out the work-based activities are acquired in the situation and context in which they will be used later on rather than in an abstract context. In contrast to well-defined 'textbook' problems, work-based problems are complex and ill-defined, often require solutions for which there is no knowledge base and need to be solved in social settings, involving others for team working, and with coaching and scaffolding by an expert (Collis & Margaryan, 2003b).

While the arguments for blending the strengths of formal and informal learning through an emphasis on work-based learning activities within a learning event can be justified from theory, the procedures to design events that contain this blend are more difficult to specify. A set of criteria need to be identified that can guide the design process, and thus also the evaluation process in terms of course quality. This leads to one of the research questions addressed in this article: *What are criteria for guiding the design and evaluation of courses emphasising work-based activities and the blend of formal and informal learning?*

While there are many different frameworks and sets of principles for course design and evaluation in the literature (Achtemeier, Morris & Finnegan, 2003; Kirkpatrick, 1994; McInnis & Devlin, 2002; Merrill, 2002; Young, 1993), none fully represent the particular form of blended learning that integrates formal and informal learning through technology support of work-based activities for a number of reasons: either they assume that all instruction is face to face, or all of it 'online' or that participants are primarily responding to instructor-led instruction or content or to quasi-authentic environments prepared by the instructor or virtually presented through electronic environments. In addition, frameworks such as that of Kirkpatrick pay attention only to different types

of course impact rather than to the design variables that work together to improve the quality of the learning experience.

Whatever criteria are selected for design and evaluation process they need to be measurable in a valid, reliable, and scalable way so that observations can be made across courses as well as within even when the courses primarily take place in the participants' own workplaces. This leads to the second question addressed in this article: *How can these criteria be used in practice to code such workplace-oriented courses?* A specific context in which these questions are being investigated is described next.

The Shell EP example
An example of where such a blend of formal and informal learning is taking place is Shell International Exploration and Production (Shell EP) whose business activities include exploring, assessing and producing hydrocarbon reserves (http://www.shell.com). The Shell EP business has interests in exploration and production ventures in over 40 countries and employs over 25 000 people. The technical professionals in Shell EP represent the areas of wells engineering, field engineering, production engineering and petroleum engineering, and geosciences disciplines. Two particular issues facing Shell EP are ones that are also facing other companies worldwide. The first relates to maintaining technical excellence or other forms of competitive advantage in a rapidly changing environment where new technologies are creating increased challenges. The second is the demographic change that will be occurring among technical professionals in the next decade. Not only will highly experienced professionals be retiring, but those who replace them will represent a wider range of regional, cultural, and professional backgrounds than is now typical at the leadership levels. Two key problems relating to these general issues are that: (1) Little opportunity has been taken to provide time or support for the experienced seniors to work in face-to-face mentoring and coaching roles in order to pass on their knowledge and (2) Members of the same company, the seniors who are leaving and the juniors who will be moving into their places, are likely to live in different parts of the world with little opportunity for face-to-face interaction (for an analysis, see Collis, Margaryan & Kennedy, 2004).

The Learning & Leadership Development organisation of Shell EP is responding to these challenges through a new global learning strategy that emphasises the blend of formal and informal learning that takes place during work-based activities (Margaryan, Collis & Cooke, 2004). Work-based activities are assigned learning activities within a course, which are carried out partially or totally while the participants remain in their workplace. They are real workplace tasks, not artificial experiences; tasks that the participants will be doing as part of their work that incorporate both formal and informal learning aspects. Coaching occurs from the workplace supervisor and other appropriate persons, who may be technical subject-matter experts. Use is made of the in-house resources captured in knowledge-management systems such as document repositories and discussion forums (Van Unnik, 2004). Persons throughout the company contribute their advice and share their experiences with similar problems. These are all benefits of

informal learning. But when the work-based activities are carried out within a course context, the benefits of formal learning also are involved. There is an instructor and perhaps a team of experts who steer and guide the linkage of theory and practice and supplement the feedback given in the workplace with their own. The instructor team also helps the workplace coach in his or her feedback processes and extends and makes systematic the range of resources and contact persons available for knowledge sharing. In addition, all aspects of the learning process are supported via a Web-based environment (TeleTOP, developed at the University of Twente, see http://www.teletop.nl/teletop.nsf/home/en) that facilitates participant submissions, peer comments, and the sharing and reuse of experiences.

With approximately 100 learning events having been redesigned between 2001 and 2004 to reflect this blend of formal and informal learning at Shell EP, the need is clear to identify a set of criteria to serve as standards for the design, evaluation, and improvement of such learning events. Therefore, the general research identified for courses that blend formal and informal learning via work-based activities can be tailored for the Shell EP context: *What are criteria for guiding the design and evaluation of the Shell EP courses emphasising work-based activities and the blend of formal and informal learning, and how can these criteria be used in practice to provide feedback for the design process and to support course evaluation?* These specific questions are discussed in the next section.

Design and evaluation criteria for the Shell EP workplace-oriented courses: the Merrill+ model

A first step is to specify the criteria for the design and evaluation process in terms of a combination of key principles relevant in general to the design of quality instruction and key principles that reflect the Shell EP work-based activities context. For the key general principles, the recent synthesis of Merrill (2002) provides an appropriate foundation. From a meta-review of major instructional theories and models, he identified the following five key principles that form a core basis for designing instruction:

'Learning is facilitated when:
1. Learners are engaged in solving real-world problems.
2. Existing knowledge is activated as a foundation for new knowledge.
3. New knowledge is demonstrated to the learner.
4. New knowledge is applied.
5. New knowledge is integrated into the learner's world' (pp. 44–45).

He further notes that these are 'relationships that are always taken to be true under appropriate conditions, regardless of program or practice' (Merrill, 2002, p. 43). These relationships are shown in Figure 1.

These principles are valuable criteria for design and evaluation of workplace-oriented courses, but may need to be expanded in order to reflect the particular needs of a corporate learning context. For Shell EP, further needs relate to capturing and sharing
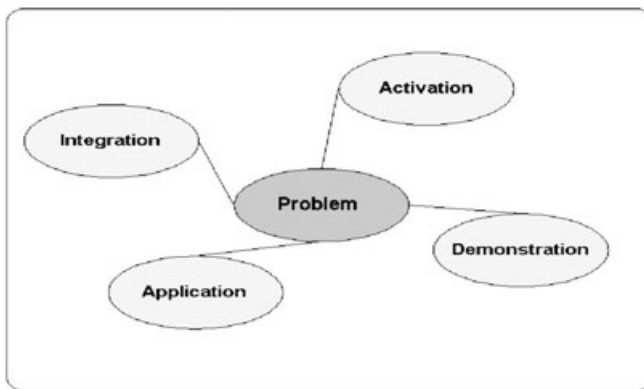
Figure 1: Merrill's First Principles of Instruction

knowledge existent in the company, involving the key stakeholders such as the learners' supervisors and workplace coaches/mentors as the learning partners, closing the existent competence gaps, and supporting collaboration and teamwork among geographically dispersed learners.

To address these needs, Merrill's First Principles of Instruction have been expanded with the following elements:

1. Collaboration among learners in a course and colleagues in the workplace.
2. Knowledge sharing and learning from others—not only peers in the course, but also experts and colleagues in the workplace, coaches/mentors, and others elsewhere in the organisation, through integrating in-house knowledge sharing networks within the courses.
3. Involving learners' supervisors, who are seen as the key stakeholders and workplace-learning partners (Bianco & Collis, 2003).
4. Reuse of knowledge and learning materials/artefacts that are already existent in learners' workplace.
5. Differentiation, or accommodating learners with diverse needs, including professional (experience), regional (necessitated by operating in geographically diverse environments such as desert, jungle, offshore), cognitive styles (preferred ways of processing new information), and ethnic (cultural) diversity.
6. Technology, particularly the web-based course support system (such as TeleTOP) that is seen as a key enabler for this type of courses, because it supports the integration and accessibility of all the above-mentioned elements.

The relationship of these criteria is shown in Figure 2.

These elements, combined with Merrill's First Principles of Instruction, form a set of criteria for design and evaluation of workplace-oriented courses.
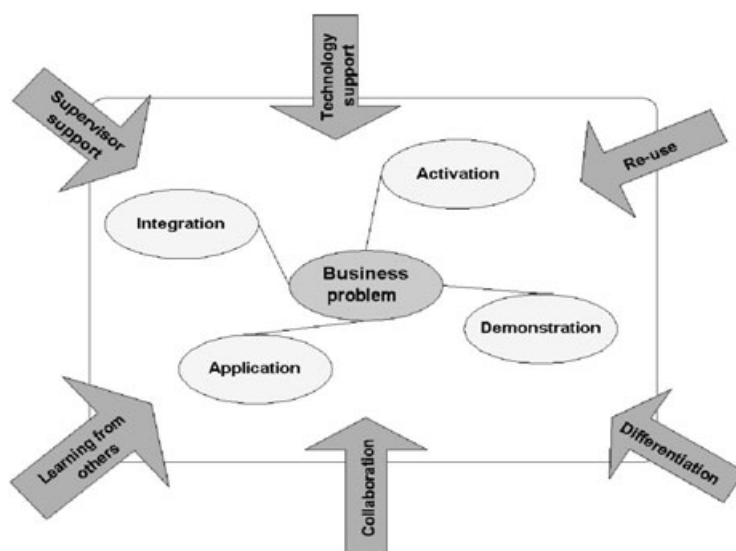
Figure 2: Merrill's First Principles expanded

The second part of our main question is: *How can these criteria be used in practice to code such workplace-oriented courses?* How this is being done at Shell EP is addressed in the next section.

Measuring the course design quality in practice using the Merrill+ criteria
In 2002–2004 the Merrill+ criteria have been used as a framework to evaluate the design quality of 68 workplace-oriented courses at Shell EP LLD, that combine formal and informal learning with the support of technology. On the basis of these criteria, an evaluation instrument and a coding procedure have been developed, that will be described in this section. Subsequently, some key findings of the analysis of 68 course cycles will be discussed.

Instrument
In order to code the workplace-oriented courses, an instrument and a procedure called the 'Course Scan' based on the Merrill+ criteria was developed and piloted in 2002–2003. With the Course Scan, the web-based environments of blended courses are studied in detail after the completion of the courses and coded on a set of items (n = 62) reflecting each of the elements shown in Figure 2. Except for general data about the course (level, subject area, and type of location blend, instructor and designer involved) which are coded as binary variables, the majority of the items are coded on a 1–5 Likert-type scale, where 1 indicated no evidence of the particular quality criteria, 5 indicated 'best-practice' evidence of the criteria, and the values 2, 3, and 4 indicated qualitative and sometimes quantitative increases. These 62 items were then reduced to 26 by grouping each set relating to a Merrill+ category and expressing the total score as a

variable between 1 and 5. A total 'Merrill+ score' was also calculated for each analysed course, by summing the weighted combination of items reflecting each of the Merrill+ criteria. As there are 11 elements, each coded on 1–5 scale, the overall Merrill+ score per course could range from 11 to 55. The instrument is attached in the Appendix.

Analysed courses
The Course Scan has been used to analyse 68 courses, of which 29 were distinct courses, and 39 were multiple cycles of these courses (the number of cycles per course ranges from 2–12). These courses were designed and delivered between June 2002 and June 2004, and were fully or partially carried out in the workplace, using the TeleTOP learning support system.

Results
Data obtained from the course scan were analysed in terms of the implementation of specific elements of the Merrill+ model. Since the purpose of this section is not to discuss the detailed results of the analysis of the Shell EP LLD courses, but rather to demonstrate what kind of data and analysis can be obtained by using the Course Scan, the results on only some of the Merrill+ criteria will be presented here.

The Merrill+ scores give an overview of the course quality as well as identify particular components that could be prioritised for further development. Table 1 shows the Merrill+ total scores for the 68 course events, as well as the individual mean scores of the 11 criteria shown in Figure 1.

As it was noted previously, the elements that scored 5 (the highest) are the ones that represent the best practice examples of implementation of that particular criterion. Thus, criteria scoring 3 are considered to be of a generally acceptable level, and criteria scoring 4—of an advanced level of implementation. The results in Table 1 show that courses on average scored acceptable or higher on such elements as relation of the

Table 1: Merrill+ total scores and individual scores for each criterion

Merrill+ Component (range 1–5 except for total score)	Mean (SD), n = 68
Merrill+ total score (11–55)	33.7 (4.9)
Business problem	3.9 (0.9)
Activation of prior knowledge	2.7 (0.8)
Demonstration	2.6 (0.9)
Application	4.1 (0.8)
Integration	3.4 (1.1)
Collaboration	3.8 (1.4)
Learning from others	2.6 (0.9)
Supervisor support	2.3 (0.9)
Technology support	3.1 (0.7)
Reuse	2.2 (0.8)
Differentiation	3.0 (1.0)

learning activities to a real workplace problem (3.9), application of learning in the workplace (4.1), instructional techniques enabling longer-term integration of learning into the learners' workplace (3.4), collaboration (3.8), design of technology support (3.1), and accommodation of diverse learning needs (3.0). It can also be seen that a number of areas in the courses need to be strengthened. These include instructional techniques for activation of prior experience (2.7), demonstration of what is to be learned (2.6), learning from others (2.6), reuse (2.2.), and supervisor support (2.2). Several examples of how the individual criteria can be used to highlight strengths as well as steer attention for further design follow.

One of the key clusters is collaboration during the course: among the participants within the course, as well as with the others—experts, colleagues, supervisor, and coach/mentor—in the workplace. It was found that while in the majority of the courses there are many activities designed for collaboration with the colleagues and experts outside the course, in about 50% of the courses there are no activities involving collaboration with the peers within the course. This is shown in Figure 3.

In addition, courses that involved multiple cycles were analysed in terms of the dynamics of the Merrill+ total scores among the cycles. As it can be seen in Figures 4 and 5, in some courses the quality of instructional design kept decreasing from a cycle to cycle, in some—decreased and then stabilised, and in others—increased with each subsequent cycle.

A reason for the decrease in course quality could be the lack of design maintenance and improvement after each cycle due to the current design and development process in
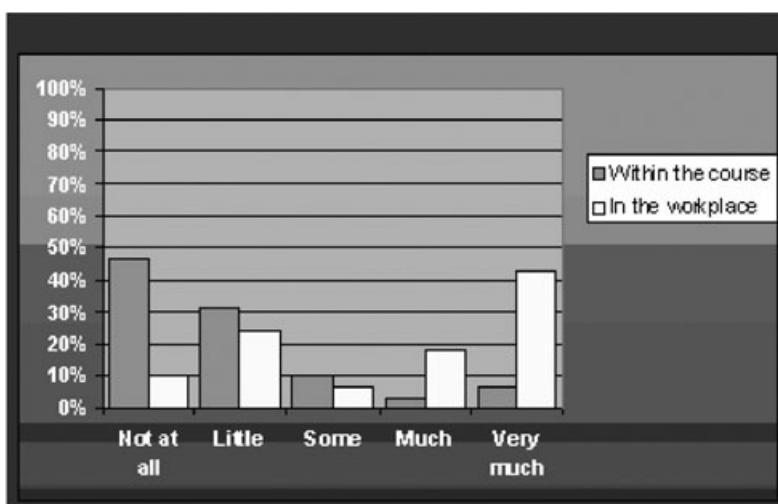
Figure 3: Amount of learning activities involving collaboration
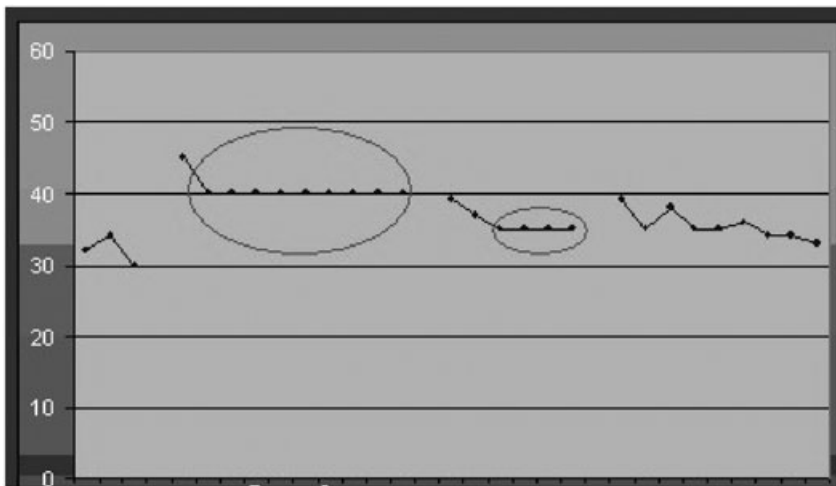
Figure 4: Dynamics within the multiple cycles: decrease of the quality of course design
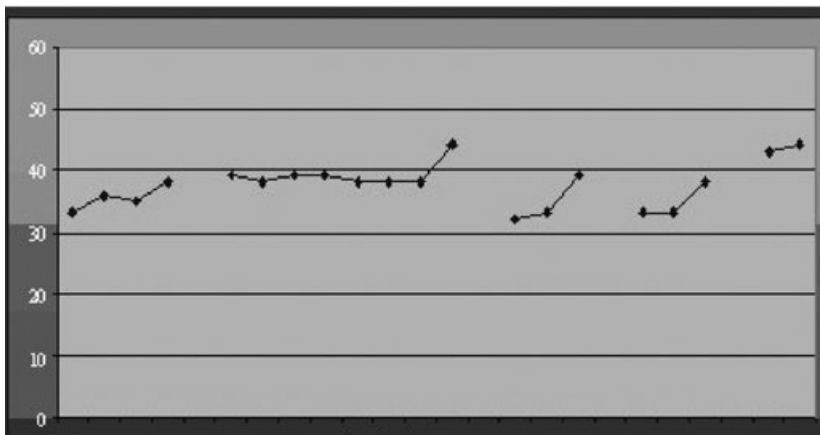
Figure 5: Dynamics within the multiple cycles: increase of the quality of course design

Shell EP LLD, whereby the course is handed over to the faculties after the first cycle(s) with gradual decrease in instructional designers' involvement in the subsequent cycles. Thus the data obtained from the course scan can be useful in demonstrating not only the quality of a single course at a given time but also in drawing the designers' and instructors' attention to fluctuations in course quality over time, as well as longer term implications of decisions related to design processes.

Conclusions and further research

The Merrill+ criteria have a number of implications for practice. They can serve as a framework for designing learning that combines the strength of formal and informal learning supported by technology, with formal learning integrated with learners' particular workplace needs and work tasks through work-based activities. This framework allows integration of coaching by the workplace supervisor or other subject-mater experts, in-house resources captured in company document repositories and communities of practice with support by a dedicated instructor who guides the linkage of theory and practice.

These criteria can also serve as an evaluation framework for quality control and improvement of the implementation of such models of learning oriented towards business needs and workplace tasks. The existing evaluation frameworks focus on different levels and types of impact, but tend to disregard instructional design of the learning, which is an important variable in the overall impact of a course. The Merrill+ criteria and the course scan instrument can be used in combination with other evaluation methods to broaden the scope and the depth of assessment of the impact of learning.

However, further research into the impact of the learning events redesigned according to Merrill+ criteria on integration of learning into workplace is needed. Although the Merrill's First Principles of Instruction that form the core of this set of criteria, as well as the other components of the extended framework relate to design principles and best practice underlying many theories and methods of learning, there is a need to identify empirical support for their actual impact in terms of improved workplace performance. Merrill (2002) noted: 'I assume, perhaps without sufficient justification, that if a principle is included in several instructional design theories, the principle has been found either through experience or empirical research to be valid... . Obviously, the support for this hypothesis [that there will be a decrement in learning and performance when a given instructional program or practice violates or fails to implement one or more of these principles] can only come from evaluation studies for a given instructional product or research studies comparing the use and misuse of these principles' (p. 44). Further research is needed to answer the question whether the courses redesigned using the Merrill+ criteria as a framework, lead to integration of new knowledge and skills into the learner's every day work and what the enablers and barriers for such integration are.

References

Achtemeier, S. D., Morris, L. V. & Finnegan, C. L. (2003, February). Considerations for developing evaluations of online courses. *Journal of Asynchronous Learning Networks 7*(1). Retrieved August 28, 2004, from http://www.sloan-c.org/publications/jaln/v7n1/index.asp

Bianco, M. & Collis, B. (2003). Blended learning in the workplace: tools and strategies for supervisor's involvement in the learning process. In *Proceedings of the Third International Conference of Researching Work and Learning* (Book IV, pp. 22–29). Tampere, Finland: University of Tampere.

Collis, B. & Margaryan, A. (2003a). CSCL and work-based activities in multicultural corporate settings. In M. R. Simonson (Ed.), *Proceedings of selected research and development paper presen-*

tations *AECT*, Vol. 2 (pp. 120–129). Ames, Iowa: Iowa State University, Technology Research and Evaluation Group.

Collis, B. & Margaryan, A. (2003b, 9 September). *Work-based activities and the technologies that support them: a bridge between formal and informal learning in the corporate context.* Presentation at the conference LearnIT: Information and Communication Technologies and the Transformation of Learning Practices, Gothenburg, Sweden.

Collis, B., Margaryan, A. & Kennedy, M. W. (2004, October 11). *Blending formal and informal learning offers new competence development opportunities.* Paper to be presented at the 11th ADIPEC (Abu Dhabi International Petroleum Exhibition and Conference), Abu Dhabi, United Arab Emirates.

Kirkpatrick, D. L. (1994). *Evaluating training programs: the four levels.* San Francisco, CA: Berrett-Koehler.

Margaryan, A., Collis, B. & Cooke, A. (2004). Activity-based blended learning. *Human Resource Development International 7*, 2, 265–274.

Merrill, D. (2002). First principles of instruction. *Educational Technology Research and Development 50*, 3, 43–59.

McInnis, J. R. & Devlin, M. (2002). *Assessing learning in Australian universities: ideas, strategies and resources for quality in student assessment.* Centre for the Study of Higher Education for the Australian Universities Teaching Committee. Retrieved July 2003, from http://www.cshe.unimelb.edu.au/assessinglearning/

Van Unnik, A. (2004, October 12). *Benefits of developing knowledge sharing communities.* Paper to be presented at the 11th Abu Dhabi International Petroleum Exhibition and Conference (ADIPEC), Abu Dhabi, United Arab Emirates.

Young, M. F. (1993). Instructional design for situated learning. *Educational Technology Research and Development 41*, 1, 43–58.

Appendix. Course Scan

GENERAL INFO

Course Code:	
Course Name:	
Course Director:	
SOU project leader:	
Present Date:	

WHICH OF THE FOLLOWING BEST DESCRIBES THE COURSE?

	Yes	No
Learning in the workplace followed by a classroom component	○	○
One or more classroom components preceded and/or followed by multiple workplace components	○	○
Learning only in the workplace without a classroom component	○	○

Other blend
(please describe):

BUSINESS NEED AND OBJECTIVES/STUDY RESOURCES AND ACTIVITIES

	None	A little	Some	Much	Very much
To what extent is the business need clearly stated?	○	○	○	○	○
To what extent are the course objectives relevant to the business need?	○	○	○	○	○
To what extent are the course objectives measurable?	○	○	○	○	○
To what extent are the study resources well organised?	○	○	○	○	○
To what extent are the study resources reused from the business?	○	○	○	○	○
To what extent do the activities in the course relate to the participants' real workplace problems?	○	○			
To what extent do the activities attempt to activate relevant prior knowledge or experience?	○	○	○	○	○
To what extent are the learners shown examples of what is to be learned rather than merely told information about what is to be learned?	○	○	○	○	○
To what extent do learners have an opportunity to practice and apply their newly acquired knowledge or skill?	○	○	○	○	○
To what extent are there techniques provided that encourage learners to integrate the new knowledge or skill into their everyday work?	○	○	○	○	○
To what extent do the activities provide opportunities for participants to learn from each other?	○	○	○	○	○
To what extent do the activities build upon each other?	○	○	○	○	○
To what extent do activities make use of the Shell resource (communities of practice or other)?	○	○	○	○	○
To what extent do the activities involve reuse of participants' submissions?	○	○	○	○	○
To what extent are there options for participants with various learning needs?	○	○	○	○	○

To what extent is the way in which feedback will be provided clearly explained to the participants?	○	○	○	○	○
To what extent is there sufficient information about completion requirements included?	○	○	○	○	○
To what extent were supervisors of the participants involved in the course?	○	○	○	○	○
To what extent do the activities involve collaboration with peers in the course?	○	○	○	○	○
To what extent do the activities involve collaboration with others outside the course?	○	○	○	○	○

WHAT TYPES OF ACTIVITIES ARE USED?

	Not used at all	Used once	Used twice	Used three times	Used four or more times)
Collecting information about a problem from own workplace, analysing and presenting the findings	○	○	○	○	○
Product development	○	○	○	○	○
Compare and contrast	○	○	○	○	○
Exercises (calculations related to a hypothetical problem)	○	○	○	○	○
Multiple-choice quizzes	○	○	○	○	○
Synchronous chat	○	○	○	○	○
Asynchronous Discussion	○	○	○	○	○
Self-analysis	○	○	○	○	○
Case Study	○	○	○	○	○
Problem solving	○	○	○	○	○
Reflection	○	○	○	○	○
Simulation	○	○	○	○	○
Studying conceptual material (viewgraphs, e-modules, textbook, lecture notes, etc.)	○	○	○	○	○

PARTICIPATION AND FEEDBACK

	None or N/A	1– 25%	26– 50%	51– 75%	76– 100%
Approximately how much individual feedback on learners' submissions is entered into the course site by the instructor?	○	○	○	○	○

	None or N/A	A little	Some	Much	Very much
Approximately how many of participants submitted all assignments?	○	○	○	○	○
Approximately how many of participants submitted at least half of the assignments?	○	○	○	○	○
How many of the questions submitted in Question & Answer are answered by the instructor?	○	○	○	○	○

WEB-SUPPORT DESIGN

	None or N/A	A little	Some	Much	Very much
To what extent are the News items short?	○	○	○	○	○
To what extent is there expiry dates set on the news items?					
To what extent is the course description clear?	○	○	○	○	○
To what extent is the Course Description section well structured?	○	○	○	○	○
To what extent is the look and feel of the Roster attractive?	○	○	○	○	○
To what extent is the length of the Roster appropriate?	○	○	○	○	○
To what extent is the Roster consistent?	○	○	○	○	○
To what extent are the course dates clear?	○	○	○	○	○
To what extent is the Archive well structured?	○	○	○	○	○
To what extent are there descriptions of the Archive items available?	○	○	○	○	○
To what extent are the Weblinks well structured?	○	○	○	○	○
To what extent are there descriptions of the links available?	○	○	○	○	○
To what extent is the Workspace well structured?	○	○	○	○	○
To what extent is the Discussion area well structured?	○	○	○	○	○
To what extent is the Discussion area used effectively?	○	○	○	○	○
To what extent is the Q&A area used effectively?	○	○	○	○	○