Integrating E-Learning into Work Processes in Industrial Settings: A Case Study

Seid Maglajlic
RailNetEurope
1010 Vienna, Austria
Seid.Maglajlic@rne.at

Denis Helic
Graz Institute of Technology
Austria
dhelic@tugraz.at

Abstract

Nowadays, one of the key prerequisites for staying competitive in many business fields is efficient knowledge management in an organization. In particular, efficiency and integration of knowledge transfer activities into day-to-day organizational business processes is being of the primary importance. As recent research suggests only learning that is fully integrated with workers' current business activities can lead to improvements in productivity and process optimization. Consequently, such integrative approach to learning at workplace reduces workers training costs.

For evaluation purposes, in this paper we will use an experimental method of integrating learning at workplace with an international timetable coordination system called Pathfinder which is currently used for enhancement of international railway transportation business processes in Europe. Based on the evaluation results guidelines for integrative approach to learning at workplace will be created.

1. Introduction

The system Pathfinder [1] is suited for international path request and railway timetable coordination management. As such, the system is used by more than five hundred users and approximately 100 railway undertaking (RU) and railway infrastructure management (IM) organisations in more than 20 European countries. Pathfinder is a web application used as communication platform for the optimization of the international train path coordination which can be accessed via the internet by a web browser. The main features of Pathfinder are:

- Coordination of international paths for any timetable period including the coordination of the path feasibility studies
- Displaying of so called “catalogue paths” – the paths that are already prepared and offered for participation in international path by infrastructure managers (IMs).
- Workflow solution for international timetable coordination process:
  - The coordination process between railway undertakings
  - The coordination process between railway undertakings and infrastructure managers
  - The coordination process between infrastructure managers
- Train composition data for passenger and freight trains
- Message system for the on-line users
- Data export in PDF, XML, MS Excel
- Usage of international location reference database which is provided by UIC (International Union of Railways) for the time being

The coordination of international path requests and path offers is done between railway undertakings (in future text referred RUs) and infrastructure managers (in further text referred as IMs). The tool Pathfinder supports the workflows which are specific for each of these two organisations in a separate process layer. Therefore, the users of the tool are divided to the groups of so called “RU-users” and “IM-users”.

The system Pathfinder [1] is suited for international path request and railway timetable coordination management. As such, the system is used by more than five hundred users and approximately 100 railway undertaking (RU) and railway infrastructure management (IM) organisations in more than 20 European countries. Pathfinder is a web application used as communication platform for the optimization of the international train path coordination which can be accessed via the internet by a web browser. The main features of Pathfinder are:

- Coordination of international paths for any timetable period including the coordination of the path feasibility studies
- Displaying of so called “catalogue paths” – the paths that are already prepared and offered for participation in international path by infrastructure managers (IMs).
- Workflow solution for international timetable coordination process:
  - The coordination process between railway undertakings
  - The coordination process between railway undertakings and infrastructure managers
  - The coordination process between infrastructure managers
- Train composition data for passenger and freight trains
- Message system for the on-line users
- Data export in PDF, XML, MS Excel
- Usage of international location reference database which is provided by UIC (International Union of Railways) for the time being

The coordination of international path requests and path offers is done between railway undertakings (in future text referred RUs) and infrastructure managers (in further text referred as IMs). The tool Pathfinder supports the workflows which are specific for each of these two organisations in a separate process layer. Therefore, the users of the tool are divided to the groups of so called “RU-users” and “IM-users”.

The coordination of international path requests and path offers is done between railway undertakings (in future text referred RUs) and infrastructure managers (in further text referred as IMs). The tool Pathfinder supports the workflows which are specific for each of these two organisations in a separate process layer. Therefore, the users of the tool are divided to the groups of so called “RU-users” and “IM-users”.
Hence, Pathfinder system supports the railway specific international timetabling process [2]. The main issue of timetabling process is path request handling. The requests for using of railway tracks (capacity of the infrastructure) are issued by RUs that harmonize with their international partners on the operational level. IMs are responsible for handling the requests and offering of the free capacity regarding to the request. The requests can be handled differently depending on the time period of the year when they are issued. The timetabling agreement between RUs and IMs differs between the regular requests that are issued early enough by RUs to be processed by IMs and late / ad-hoc requests that are made just before the start of the timetable period or during the timetable year, just a few days before the train has to run. Therefore, the four process types for path requesting and one process type for synchronization of IMs’ pre-constructed paths are supported in Pathfinder:

- New path request (the process type for requests issued more than eight months before the train run)
- Late path request (the process type for requests issued less than eight months but more than two months before the train run)
- Ad-hoc path request (the process type for the requests made shortly before the train run, during the particular timetable period)
- Path study (the process type for the feasibility study of path requests, often used for long term planning)
- Catalogue path (the process type used only by IMs for harmonization and offering of pre-constructed paths: the capacity management add-on for long-term planning)

Obviously, the tool Pathfinder reflects the complex process of international timetable coordination. Therefore, the usage of the tool requires knowledge about the process itself as well as about the functions of the tool. Moreover, since the tool was initially built to support a business-specific workflow, the users have to be guided how to combine their knowledge in the business and the system functions in the best possible way. Quite clearly, for this purpose the training of the users is necessary. At the beginning of the Pathfinder project, the owner of the system, the European association of infrastructure managers, RailNetEurope [3], has organized trainings in a centralized manner, with the usage of a reference manual, typical training facilities and a trainer with 20 “students” at most. However, since the number of users is rapidly growing (about 100 new users per year), it is almost impossible to cover the all the users with this classic training methodology. Consequently, it was necessary to extend the project Pathfinder with eLearning platform which could offer the following possibilities:

- Possibility to organize the learning content in lessons, learning units and courses
- Possibility to categorize the users due to the organizational affiliation, geographical location (country) and knowledge level
- Possibility to organize virtual classrooms for the particular courses due to the user grouping
- Possibility of assigning a tutor for the user group
- Possibility to track the knowledge acquiring progress of the user (both for users and tutors)
- Possibility of question/test modeling and evaluation
- Context-sensitive search of the content, documents and user lists

Since there are already plenty of eLearning systems available, it was necessary to analyze and compare several systems. In the subsequent chapters, we will show the results of the evaluation of the systems. Furthermore, the utilization of the chosen eLearning system is also described, as well as the logical and functional structure of the eLearning material.

2. Selection of eLearning System

In this chapter, we will focus on the evaluation of the various eLearning systems. In order to evaluate the systems efficiently, the eLearning tools were checked for the fulfillment of the requirements given in the following two tables:

<table>
<thead>
<tr>
<th>Req. ID</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>FR1</td>
<td>Supervisory trainer needs a possibility for customizing of the courseware, and also to have a possibility for versioning (each version of courseware must be available in the system in order to be able to switch back and forward in different courseware versions)</td>
</tr>
<tr>
<td>FR2</td>
<td>Each user needs own learning space for personalizing of lessons</td>
</tr>
<tr>
<td>FR3</td>
<td>Each learning object needs to be assessable (i.e. the system has to provide a possibility for knowledge testing).</td>
</tr>
<tr>
<td>FR4</td>
<td>The assessment results have to be available for supervisory trainer in the system in a form of report.</td>
</tr>
<tr>
<td>FR5</td>
<td>The eLearning system has to be able to support internationalization (multilingual), since Pathfinder system is internationalized (multilingual) already.</td>
</tr>
</tbody>
</table>
FR6: The content has to be easy accessible, with direct links or full-text-search.

FR7: Hierarchical courseware

Table 1, Functional requirements

<table>
<thead>
<tr>
<th>Req. ID</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>TR1</td>
<td>Web-based system available over the internet</td>
</tr>
<tr>
<td>TR2</td>
<td>Upload up to 10MB images and up to 100 MB other files (ppt presentations, MS Office Word documents, PDF documents)</td>
</tr>
<tr>
<td>TR3</td>
<td>Answer-time for application should not exceed 8 seconds</td>
</tr>
<tr>
<td>TR4</td>
<td>The system has to be able to handle 20 concurrent requests</td>
</tr>
<tr>
<td>TR5</td>
<td>The system must have the ability to be extended in a rather easy way</td>
</tr>
</tbody>
</table>

Table 2, Technical requirements

An additional requirement which is not shown in the tables, but which was crucial for consideration of a tool was to be cost-free product: license free or open-source based.

The following systems have been analyzed:
- eFront [4]
- aTutor [5]
- dokeos [6]
- OLAT [7]
- Claroline [8]

We will just briefly point out the each tool for their fulfillment of the requirements. eFront was weak in FR5 since there were only 2 languages supported in the user interface in spite of the multilingual functions provided in the system. FR6 has also not a full support since the product is built in frames and the search results are not well usable. Regarding TR5 there is also a remark: the application programming interface (API) for extensibility of the product is not provided.

aTutor misses a few very important requirements: FR2: it does not support “lesson” concept, the knowledge acquiring process cannot be traced since there is no data about the learning progress and no report possibility. FR5 is not supported at all.

The system dokeos fits almost perfectly to the given requirements with only one functional requirement that could be improved: FR6: initially, only the content of the courses is can be searched, however, the system can be extended to support full text search.

OLAT has a disadvantage that the course content has to be provided as an external resource and the editing of the existing sources is rather difficult (FR2). Regarding FR6 there is also a remark: since there is an external link for each course, it is difficult to search and to show the search results in a structured way.

TR5: the system provides rather complex API which makes extensibility of the product more difficult than it should be.

Claroline system is very similar to dokeos, however, with one significant disadvantage: no multilingual support is provided. Due to this fact, the system cannot be used as the eLearning system for Pathfinder since the tool Pathfinder is fully multilingual, currently available in 17 languages.

After the final comparison of the research results about the eLearning systems, the tool dokeos has been chosen as the eLearning platform for Pathfinder. The fulfillment of the requirements is shown in the tables given below.

Table 3, Functional requirements fulfillment by dokeos

<table>
<thead>
<tr>
<th>Functional Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>FR1</td>
</tr>
<tr>
<td>FR2</td>
</tr>
<tr>
<td>FR3</td>
</tr>
<tr>
<td>FR4</td>
</tr>
<tr>
<td>FR5</td>
</tr>
<tr>
<td>FR6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Technical Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>TR1</td>
</tr>
<tr>
<td>TR2</td>
</tr>
<tr>
<td>TR3</td>
</tr>
<tr>
<td>TR4</td>
</tr>
<tr>
<td>TR5</td>
</tr>
</tbody>
</table>
Apache / MySQL / PHP and allows development of additional PHP modules.

**Table 3, Technical requirements fulfillment by dokeos**

In this research we have decided to use the term “learning progress” instead of “learning path”, since the path in railway terms represents the basic issue in the timetabling and is used in the official correspondence (e.g. “path request”). In order to be clear with the terminology, let us just briefly check the definition of the learning path and apply it further to the learning progress. The learning path can be defined as a sequence of learning activities performed by the learner while acquiring the knowledge through a learning unit [9]. On the other hand, the learning path serves actually for the tracking of the progress of the learner, therefore, the introduction of the synonym “learning progress” still covers the initial intention of learning path idea.

3. Implementation

The central function of the system Pathfinder is the workflow support. The workflow that is supported by Pathfinder corresponds to, as we have already mentioned above, the international railway timetabling coordination process. Quite clearly, the particular process description is an excellent introductory lesson about the pre-requirese to use the system Pathfinder. On the other hand, without knowing the basic functions about path request handling (opening, copying, changing/controlling the state and phase of the request, searching, setting the train parameters, etc.) that are offered by the tool Pathfinder in general, it would be impossible to participate in the workflow efficiently. Therefore, the next learning unit, after the introduction contains the general functions. Furthermore, Pathfinder also offers the support for different process types, as it is listed in the chapter 1. Each process type is also represented in the eLearning system with the corresponding lesson. Hence, we have the following learning units:

- Process description
- General features of the application
- Path study (path feasibility study)
- New path request
- Ad-hoc path request
- Late path request

Each learning unit is divided to the single lessons corresponding to the topics. Process description and the explanation of the general features are built in a rather straight-forward matter. On the other hand, the learning units concerning the business process types are carefully structured. The structure was built upon the experience from the live training sessions and support activities. Thus, each process step (actually, the subsequent workflow step) is represented by the lesson which contains the explanations:

- How to achieve the particular process step
- How to work in the process phase
- How to proceed to the next process step, i.e. how to finish the current workflow phase.

Hierarchically seen, the lessons are grouped in learning units and learning units are grouped to courses. Courses are suited to the different process layers we mentioned in the first chapter: process layers for workflow support of RU-users and IM-users. Therefore, there are two main courses which have the learning unit structure we defined in this chapter: RU-specific course and IM-specific course. Quite clearly, due to the separated process layers for different user types in Pathfinder, there are separated courses modeled in the eLearning system. However, it is important to note that, with this approach, the skills of the users are reflected in the eLearning model. More precisely, regardless of the competence of the particular worker that uses the eLearning system “General features”, “Path study” and/or “New path request” are surely the learning units that will be considered. However, since a timetabling expert knows the timetabling process very well, the process description should not be in his/her focus. On the other hand, the sales person (in this particular case, the person responsible for selling the free capacity of the infrastructure manager company) does not have the complete knowledge about the timetabling process in details which is needed for the proper usage of the tool. This implies that such a worker needs to be assigned to a course containing this learning unit in any case. Moreover, a sales person from an infrastructure department often gets a read-only access to the harmonization process of the RUs in order to make the best suitable offer for the path requested by RUs. As a consequence, the sales person belonging to IM-user group needs to be assigned also to the “Path request” description for RU-users in the eLearning system.

The next three figures depict this hierarchical course model: course -> learning unit (with learning progress) -> lesson.
On the left part of the figure, the courses specific for IMs and for RUs are shown. However, when the administrator, or the course tutor adds users to the system, the organizational background of the user tells which course should be offered to the user. More precisely, the user which belongs to a railway undertaking (RU) will only be enrolled to the course “Pathfinder 2.2.1 RU”, where the RU-specific process steps of Pathfinder are provided in the learning material.

On the left side of the Figure 3 the lessons are shown in the tree-view style. On the right side, the process layer of Pathfinder for “Ad-Hoc Request”-process type is shown, with the indication of the Phase where the process currently is. Please note that on the left side of the Figure 3 the process step “Path Elaboration” is selected, which corresponds to the process phase indication on the right side (in the right frame of the lesson). Surely, more detailed textual information is also contained in the lower part of the lesson – we have not shown it here due to simplicity reasons.

As we have mentioned in the requirements list, the assessment and test modeling was one important criterion for selection of the eLearning system. Fulfillment of this requirement is also strongly needed by the owner of the system, the organization RailNetEurope, since this organization has decided to provide Pathfinder knowledge certification possibility for one special reason: to educate the future trainers of Pathfinder in each RailNetEurope membering company of the association. This concept is called “Train-The-Trainer” and helps spreading out the knowledge about the tool Pathfinder and readiness to help users to work more efficiently in the international timetable coordination process. For this purpose, also the test modeling and assessment evaluation functionalities of the chosen eLearning system are intensively used.

The tests are modeled in the following way: they are divided to three groups of questions:
- Basic functions of Pathfinder (10 questions)
- Details about Pathfinder (15 questions)
- Timetabling process (9 theoretical questions)
If the user scores more than 75% of correctness, the user can be certified trainer of Pathfinder.

The following four figures show how the testing user interface in eLearning Platform looks like.
Hence, the fully functional eLearning platform has been provided for Pathfinder, containing all required functions: hierarchical courseware with knowledge acquirement tracking possibility, question/test modeling and assessment result reporting. Moreover, the administration interface of the system is also configured for organization virtual classrooms, classroom tutors, and groups depending on geographical and structural/organizational parameters such as country or company and the corresponding type.

4. Achievements

The eLearning platform for Pathfinder has been developed and configured initially in fall 2008. Currently, all Pathfinder users are automatically entered into the eLearning system through the Pathfinder support, i.e. each new user for whom a new Pathfinder account is created, is also enabled for usage of the eLearning system. Consequently, almost 900 users are registered for Pathfinder eLearning. The intention to enhance the Pathfinder training facilities and provide more intuitive help material than the “normal” application reference manual is successfully achieved. RailNetEurope, the owner of the system Pathfinder and supporter of this research has succeeded in certification of 20 “trainers” (the experienced users of Pathfinder who passed the appropriate examination to be able to transfer their knowledge to their colleagues, partners and customers) with a great help of the new eLearning platform. Consequently, the number of calls to RailNetEurope user support for Pathfinder (functional support for “distance help” for the users of the system) was reduced by 15%, due to the easier knowledge transfer from the “certified”, more experienced colleagues to their organizational affiliates and customers as well. Thus, the productivity in the international timetable coordination increased automatically. The positive difference in the productivity was noticed by measuring through monitoring of the business process (workflow) execution in the Pathfinder on the system level. Moreover, compared to the previous years of the usage of Pathfinder, in the year 2009, the blocking of the request processing which used to happen before due to the lack of knowledge of the users did not occur. Hence, the eLearning structure as it is depicted in the previous chapter was confirmed to be useful and clear for the Pathfinder users. Furthermore, the target methodology for eLearning for the tool Pathfinder consists of recognition of the skills of the eLearning user: depending on the skills recognized from the model, the eLearning content is offered.

5. Conclusion: topics for further research

To conclude this case study, we will briefly outline the possible ways to improve the eLearning methods not only for Pathfinder, but also for other industrial systems that integrate several hundred users across different organisations and geographical locations. For example, a context sensitive reference from the tool to the eLearning system could be constructed in order to deliver enough information from the tool to the
eLearning system regarding the skills of the particular user. With this information, the eLearning system could locate the user skills from the model, find the appropriate learning unit and offer the learning material to the user upon request.

On the other hand, since the eLearning system tracks the learning progress of each user, the one of the topics of the further research would be the organizing of the groups of eLearning users regarding to the learning progress or test results, i.e. to make it even easier for knowledge transfer not only from a certified user to other virtual classroom attendants but also to evaluate dynamically the learning path of the users belonging to the same virtual classroom and propose the “closest” colleague of the particular user who is searching for help.

Thus, as we have shown in this paper, the eLearning in industrial settings can improve the productivity of the business processes, especially if the skills and organizational affiliations of the users are carefully modelled in the eLearning system.

6. References


http://www.dokeos.com/ [19/01/2010]

