The Evolution of E-Learning Platforms from Content to Activity Based Learning

The Case of Learn@WU

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***Abstract*— Over the last decades e-learning platforms evolved from tools for distributing materials and providing quiz-based assessments to complex software systems that enable didactically enriched learning experiences. This paper describes the metamorphosis of the Learn@WU system, one of the most intensely used e-learning platforms. The platform is in use since 2001, when it was designed for learning content management, complemented by community management functions over the years. One of the major usages in the beginning was the support of blended learning in large classes up to 1000 students and the provision of self-assessment in the initial phase of the study programs. From the start, the platform supported all beginner courses of all subjects without much instructional design, to give students complete freedom for self-directed learning. Today, the platform contains more than 160,000 learning materials used in the 4,000 courses offered each year. However, studies showed indications that most students prefer to use the self-assessments in order to memorize questions instead of deep learning of content, i.e. by carelessly submitting results for many exercises to receive the correct solutions provided as a feedback from the system. As a consequence, the success rates in self-assessments did not serve as good predictors for knowledge and exam success. It was also found that spaced learning and overall learning time have a positive influence on final exam results [1]. Based on these findings, the objectives for the further development of the platform included efforts to increase the validity of the self-assessment data and to better support instructional designs. The new implementation allows to assign different learning activities to resources and to organize activities in thematic modules in order to support, e.g., flipped-classroom designs. This focus on learning activities was achieved through the implementation of learning design functionality and the possibility to connect resources to several so-called 'content flows', which are short workflow sequences that specify series of user interactions with the resource within a certain context. They define, for instance, if a resource has a training or self-assessment purpose (which are different learning activities), in order to improve the validity of knowledge assessment. After one month of productive use of the new features, more than 8,000 learning activities have been created in more than 100 courses of the university, which indicates good acceptance rates. According to our knowledge, Learn@WU is the first large-scale e-learning platform which has adopted a workflow-based approach for realizing differentiated learning activities. (*Abstract*)**

Keywords*— Learning Management System, Data-Driven Development, Learning Activities, Content Flows, Learning Progress, Learning Workflows

I. Introduction

The first generation of e-learning platforms mainly comprised learning management systems (LMS) that have a strong focus on creating and standardizing learning content, on distributing materials to learners and on providing functionalities for self-assessment exercises and examination purposes (cf. [2]). Driven by various factors like the increasing number of students in higher education settings, the need for competency and outcome-oriented teaching (cf. Bologna Process), novel insights from research, and other influences, new requirements to e-learning technologies arose and led to an evolution of LMSs to complex, scalable software systems that enable didactically enriched learning experiences based on activities and individual learning paths.

A. Introduction to Learn@WU

This paper describes the metamorphosis of Learn@WU, one of the most intensely used e-learning platforms. The platform is in use since 2001, when it was designed as a learning content management platform. Over the years it developed first to a learning community management platform and is now focusing on supporting richer sets of learning workflows and learning analytics. In the first years, one of the major usages was the support of blended learning in large classes (up to 1,000 students) and the provision of self-assessments in the initial phase of the study programs. Hereby, the platform supported all beginner courses of all subjects without much instructional support, to let both the teachers and the students much freedom about how to use the content (self-directed learning). Today, the platform contains more than 160,000 learning materials. In the peak times of the study year, more than 4 million page views are performed from over 17,000 users logging in per day.

Despite this success and the broad acceptance of the platform among the various stakeholders of the university, the design of the platform revealed also some drawbacks. While the system gives freedom about how to use the content for learning, it offers only limited possibilities for structuring the learning resources for teachers who would like to provide some guidance for students. Instead, resources are grouped by resource type (e.g., exercises, downloads, etc.) tempting the students to only solve multiple-choice-exercises and not learning other content. Applications such as the forum or the assignment module are broadly used by teachers and students. However, also the forum and assignments entries stand for themselves and are not structured or integrated with the learning materials.

B. Analysis of Usage Data

In the field of Learning Analytics [3], a set of studies has been conducted about Learn@WU over the years to analyze the learning behavior of students, for instance to identify seasonal effects in LMS usage [4] and to investigate dependencies between LMS usage patterns and learning results [1, 5]. Among others, the following insights were gained.

1) Memorizing of questions instead of content learning

From the beginning, usage data has been suggesting that an intense use of the Learn@WU platform is an indicator for exam success [5, 6]. However, there have been indications that students tend to memorizing questions rather than learning the provided content. For instance, Alberer et al. [6] found that students have success rates of over 70% in the self-assessment exercises and fail in the final exam, and that students solve exam questions which are copied from the learning repository correctly while they fail in slightly modified questions. As a consequence, the success rates in self-assessments are not good predictors for knowledge and exam success.

2) Spaced Learning and Learning Time

Another finding is that spaced learning and overall learning time might have a positive influence on final exam results [5]. This study shows that those students who were active on more days before the exam and had more and longer sessions, achieved better grades in the exam. This dependency was strongest for the groups of best and bad learners [1, 5].

3) Repeating

The repeated solving of exercises does not correlate strongly with grades. It was found that the best results are achieved when the items are practiced once or twice only [1]. As a consequence, the possibility to solve large amounts of exercise questions several times for exam preparation is not a good learning practice.

4) Validity of analytics data

These findings stand to some extent in contrast to the literature. For instance, literature [7] suggests that repeating is a good learning practice. Repeating is necessary but not sufficient, especially when transfer of knowledge is desired. Furthermore, it gets apparent that the high number of page views particularly during exam preparation is not a predictor for exam success. Also, through Learning Analytics, only online activities can be tracked, although we know from interviews that students spend more than 60% of their learning time with offline activities [1]. Thus, the findings described above indicate that some analytics data from the existing Learn@WU system have a limited validity to predict student success. These insights influenced the redesign of the LMS.

II. Related Literature

Besides the empirical findings, literature suggests approaches directed towards activity-based instead of resource-based concepts. Among others, the Learning Design concept, Computer-Supported Collaboration Scripts (CSCL scripts), the IMS Simple Sequencing specification and the Learning Activity Management System LAMS were considered.

The field of Learning Design is described by Dalziel [8] as “the creation, sharing and implementation of sequences of teaching and learning activities that include both content and collaboration” and as a “reaction against other ‘content centric’ views of e-learning”. The aim is to support students to be effective, efficient and motivated learners, and to help teachers or learning designers in general to design qualitative units of learning by applying specific design rules [9]. While one area of research in Learning Design focuses on the development of a technical language for describing teaching and learning activities and implementing it in software, another area aims at describing pedagogical methods [8].

The IMS Learning Design specification, for instance, is a meta-language for describing learning designs in the style of a stage-play, consisting of roles, objectives, activities and an environment [10]. It allows, among others, to describe many pedagogical models, to coordinate multi-learner and single-learner scenarios, and to reuse and transfer learning designs or parts of learning designs [11].

LAMS builds on this specification, although in a simplified way because the IMS Learning Design standard is deemed to be too complex for the majority of teachers [8]. The LAMS environment allows teachers to author sequences of learning activities, and to modify and reuse these sequences in different disciplines, by changing only the content but not the activity structure [12].

Another approach which aims at describing learning activity sequences are CSCL scripts [13]. These scripts are intended to “facilitate collaborative learning by specifying activities in collaborative settings, eventually sequencing these activities and assigning the activities to individual learners” [13]. Activities play a central role in CSCL scripts, including, for instance, elaboration, explanation, argumentation and question asking [14]. Kobbe et al. [14] aim at a framework consisting of just a few components, namely the participants, the activities they conduct, roles, resources they use and groups. The so-called script mechanisms help to define the task distribution, the group formation and the sequencing of interactions, for instance over time.

Besides these more technical approaches to describe learning designs, Laurillard focuses on describing pedagogical methods. The Learning Designer is a software application developed with the aim to support learning design thinking and to make the pedagogic structure of a learning design explicit [15]. Each learning activity defined in the Learning Designer can be assigned a pedagogic descriptor such as “acquisition”, “inquiry”, “discussion”, “practice” and “production”. Furthermore, the approach allows to specify whether the activity is intended for individual or group work, and how much time is recommended for the activity. This allows the creation of statistics about how much time students are engaged in different forms of learning [15].

Summing up, there is a number of approaches which aim at integrating Learning Design in LMSs. However, they still lack integrated Learning Design functionality, and "the core technical features of an authoring system and a 'workflow engine' for managing the flow of students through a sequence of activities is yet to be added to LMSs" [8].

Another gap can be identified in the lack of pedagogic properties of activities within learning designs, according to Dalziel [8]. The approach of the Learning Designer [15] described above is seen as promising attempt to apply pedagogic descriptors to activities and to analyze learning design sequences in terms of these descriptors, however with potential to refine and expand the approach [8].

III. Aims and Objectives

The approach described in this paper intends to close some of these gaps and to drive activity based learning concepts further. In particular, one of the objectives for the redesign of the learning components of the platform was increased validity of the (self) assessment data that can be used to provide better support of instructional designs and other learning analytics features in the future.

A set of design principles was established for the redesign, taking account of the literature and data-driven findings.

A. Shift from learning content to learning activities

One of the core aims was to provide learning activities instead of pure content objects. Learning activities are intended to provide specific assignments with different objectives to students. The same resource can be used in multiple learning activities.

B. Design a workflow-based activity system

Another central aim was to manage the conduction of activities and sequences of activities by students through workflows. A learning activity in our definition is a resource combined with a workflow that has a didactical scope. Workflows can define single and complex learning activities (sequences of learning activities).

C. Represent both online and offline activities

Since we interested to support blended learning, a further goal was to find a way to represent both online and offline activities in the LMS. One example are activities which students solve offline but confirm online (e.g., "read chapter 5 and confirm it afterwards").

D. Structure activities and provide navigation modes

Furthermore, the aim was to provide modes for structuring learning activities, for instance by lessons, themes, or chapters. Teachers should have as much freedom as possible to structure their activities according to their learning design. Appropriate navigation modes should be provided for students to work through the activities.

E. Allow the creation of re-usable collections of activities to represent pedagogical scenarios

The system should allow the creation and management of pedagogical scenarios, for instance flipped classroom concepts or jigsaw-scenarios. These scenarios should be collections of activities with defined objectives, assigned to different roles. The collections should be re-usable and modifiable.

F. Improve the validity of Learning Analytics

Another aim was to improve the validity of Learning Analytics data. The workflow implementation should allow to trace at which point activities are possibly dropped, which activities cause most problems to students, in which order students work through pedagogical scenarios, and much more.

G. Support spaced learning

The implementation of the aims described above should establish a basis for supporting spaced learning, for instance through the structured provision of learning activities, through the explication of assignments through the learning activities, and through advanced progress statistics for students.

IV. Technical Approach

Among others, the new implementation allows to assign different learning activities to learning resources and to organize activities in thematic modules or modules with pedagogic designs. This focus on learning activities was achieved through the possibility to connect learning resources to modular workflows, which specify series of user interactions with the resource within a certain context.

This workflow-based approach was developed with the OpenACS component XoWiki Content Flow package [16], an extension of the XoWiki Framework [17]. Wiki pages or, more generically, content objects, can be provided with workflows and thus a series of states and actions defines which content is presented to the user in which workflow state, and which actions are possible in that state [18]. The workflow execution of the Content Flow package follows the State design pattern [19]. A learning activity is thus a resource plus an attached workflow which defines what a teacher or learner can do with this resource in a given context. A set of such modular workflows were defined for the creators (typically teachers) and administrators (often teaching assistants) of learning activities, as well as for the learners. Both the workflow definitions and the workflow instances are saved in a content repository and can be collaboratively developed in wiki-style from a browser. This makes it also possible to reset the learning workflow instances to prior states.

Figure 1 shows an example of a content flow; where different workflows are connected to a simple resource, for instance a multiple-choice-question. The item management workflow (Figure 1, left) describes the steps to be undertaken by the teacher to create, edit and publish the learning activity. It is straightforward to define e.g. additional workflow stages which are dedicated for quality management.

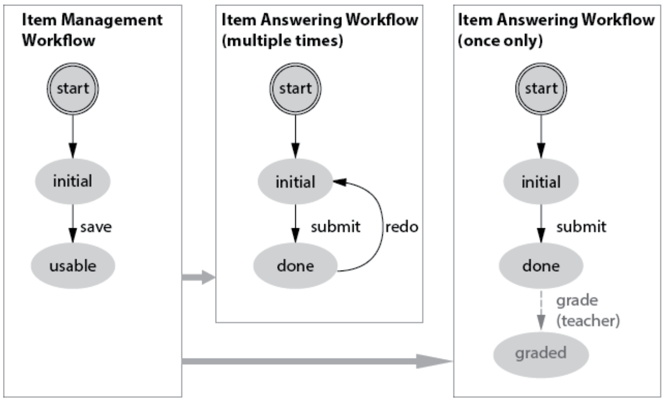

Fig. 1. Multiple-choice question that is connected to three different workflows

Depending on the parameters chosen during the creation, different workflows for submission by the students are applied to the question, leading to different learning activities, i.e. to a many-time activity for self-assessment purposes of students (Figure 1, middle) or to a one-time activity that optionally can be graded by the teacher (Figure 1, right).

V. Implementated Learning Activity Workflows

Based on the learning design concepts and content flow principles described above, the implementation so far comprises a set of simple and combined activities, and various tools for students and teachers to support teaching and learning.

A. Definition of simple activities and related parameters

The set learning resources to be used in the learning activities consists, so far, of assessment items (open question, multiple-choice question, gap match question), text pages and files. They be selected through a context-sensitive menubar (Figure 2). The creation form (Figure 3) offers a set of parameters, which define details about the workflow.

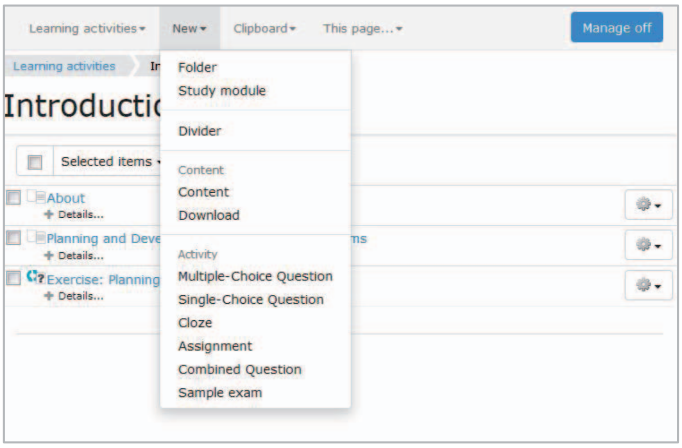

Fig. 2. Creation of learning activities through the interactive menubar

The workflow defines whether the attached resource can be solved multiple times or once only, whether the resource is required or optional, whether it will be graded or not. These (example) workflow parameters offer a high level of flexibility in the design of learning activities. Although the properties “one/multiple times”, “required/optional”, and “graded/not graded” are more abstract than the pedagogic properties described in [15] or [8], they allow multiple combinations and may obtain, through this combination, pedagogic value.

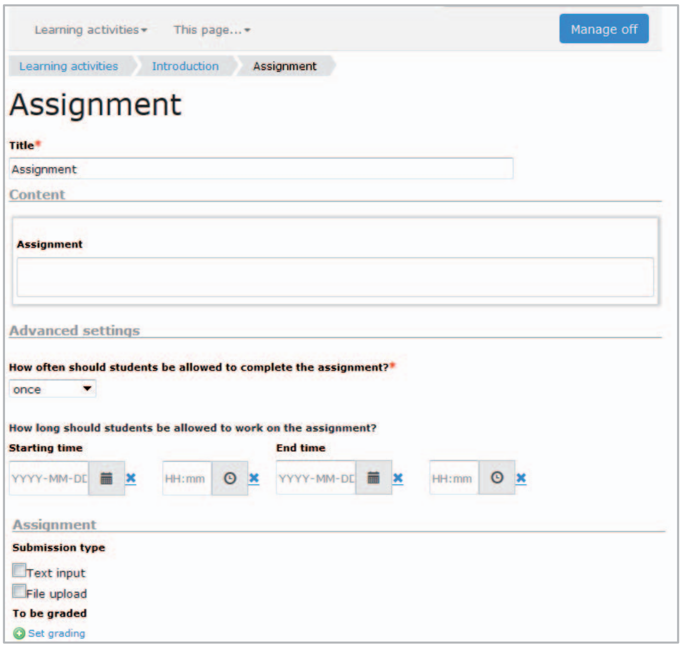

Fig. 3. Example form for creating an assignment. Various parameters can be defined, such as solving once or multiple times, with or without grading, etc.

For instance, if an exercise can be solved only once it has more of a self-assessment character than if it can be solved multiple times which has a practicing character. An open question which can be solved once and will be graded has an assessment purpose, while an open question which is assigned to a group of students has a collaborative discussion purpose. Since the properties of a resource can be changed, a high level of flexibility in the pedagogic design and re-usability of content objects can be achieved.

B. Definition of complex activities

Single resources can be collected and organized in various types of folders. In its simplest form, the folder acts as a container for learning activities. Similar to the items described above (cf. simple activities), workflows and properties can be assigned to folders, thus enabling a variety of concepts. With respect to the IMS Simple Sequencing standard, an example would be to attach a workflow which allows to navigate through the activities in the folder in a sequential way. Moreover, navigation controls and conditional rules such as navigating in a strict order or freely can be attached.

However, the workflow concept combined with folders goes much further. A folder might become an intelligent textbook that remembers the progress of a student or for an example an exam. In the latter case the workflow defines the time window in which the questions of the exam have to be solved, and allows the grading – automated with multiple-choice questions or manual with open assignments – of the exam. Figure 4 gives an example of an exam definition that in our case consists of a set of multiple-choice questions. In the first step, the teacher creates the exam (Figure 4, left) and defines the questions and the time window for completing the exam.

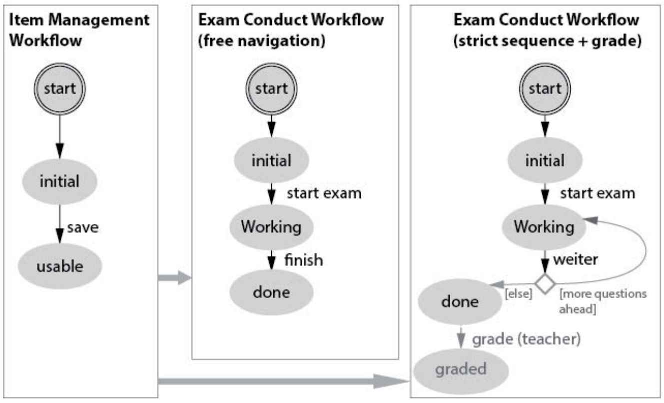

Fig. 4. Exam workflows to create an exam (left), conduct the exam as a student by navigating freely to the exam items (middle), and alternative where only strict sequence is allowed in the exam conduct, with optional grading (right).

Different workflows for conducting the exam are possible, for instance a workflow where students go through the questions in a free order (Figure 4 middle) or a workflow where students have to navigate the exam items in a strict sequence and is graded afterwards (Figure 4 right).

Such smart folders can be also used for scripted sequences of activities, such as a jigsaw module, could be realized in a similar way, with the extension that the roles of the participants of the workflow would change throughout the flow of activities.

Also a flipped-classroom concept was implemented with smart folders. In our case, the flipped-classroom-folder is a container which is connected to a lesson time-stamp in a semi-automated way. The learning activities created for each lesson (and thus the flipped-classroom-folders) can be assigned to temporal categories such as "to be conducted before the lesson", "to be conducted during the lesson", "to be conducted after the lesson", and they are activated through the LMS on time. The students are informed about new activities through an activity list displayed at the portal page summarizing the student activities of a certain learning subject (Figure 5).

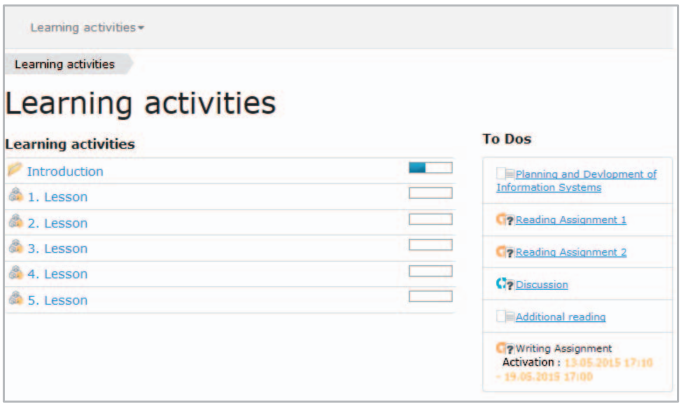

Fig. 5. Landing page of application in student view. To Do's, activated by the flipped-classroom-module, are on the right.

Thus, a folder may not only act as container of learning activities or as container for simple sequencing, but rather can also map a pedagogic pattern.

C. *Workflow status and progress of students*

The workflow based approach allows the students to be always informed about the individual progress the various workflows in which they participate. Figure 6 shows an example for how the progress is presented to students via the so-called activity navigator. Folders are organized in a hierarchical order, containing the learning resources. The blue progress bar shows the quantitative progress percentage of the student in the learning module. The red and green icons give an indication of the success factor of solving individual activities. The icons in front of the activity names show which kind of resource and which kind of workflow the activity is made of, for instance a question mark for a multiple-choice question and a blue circle for an exercising activity. Assignments with grading are marked as well.

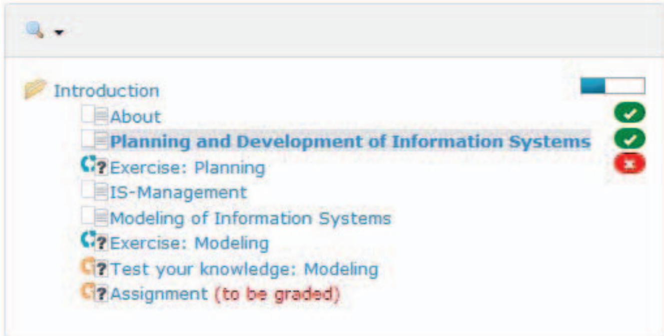

Fig. 6. Navigator of learning activities with individual progress indication in student view.

D. *Learning Analytics*

Regarding the aims and objectives, the workflow-based approach increases the validity of self-assessment data. Since different workflows are connected to learning resources, it can be distinguished in the analysis of data whether assignments are made for practicing, repetition, reviewing, etc. Since each workflow consists of a series of states, it can be tracked whether a student has started, completed or dropped an activity. The data collected about the workflows provide better ways for visualizing a student's performance in a course and monitoring the progress of a class, even in courses with large cohorts of students. So far, simple elements for giving feedback to students are available already (see above), while teaching analytics functionality is subject to the upcoming release.

E. *Re-Usability of activities*

Re-usability of activities and content can be achieved in different ways. First of all, templates for complex activities (e.g., learning sequences or modules) are provided, so that teachers can create them in a comfortable way, i.e. supported by help texts or even online tutorials. Secondly, it is also possible to copy existing activities with clipboard functionality. Thirdly, old resources of former courses can be imported and converted into activities through an import wizard. Finally it is also possible to create links to an existing activity, so that users can directly jump to it either form a text-based attribute (internal link) or from a folder (symbolic link). Symbolic links even allow integrating activities from other courses (e.g., courses held in parallel to one), which enables activities beyond the scope of one course.

F. Dissemination and acceptance rates

The new functionalities were rolled out in a stepwise approach over the last four semesters. An increasing group of voluntary teachers was instructed and supported to use the new features in their courses.

After two months of university-wide use of the new features within the Learn@WU platform, more than 11,000 learning activities have been created so far in more than 130 courses of the university, which indicates good acceptance rates.

VI. SUMMARY AND CONCLUSIONS

This paper described the evolution of e-learning platforms by means of the e-learning platform Learn@WU. Driven by the analysis of usage data and literature, the platform was developed from an intensely used platform for content distribution and provision of self-assessment exercising to a system for managing and providing learning activities, offering the possibility to structure them thematically and pedagogically.

So far, a set of activities has been implemented in the platform, including activities for practicing and reviewing, reading assignments, open questions with the option to be graded, self-assessment exams, learning modules that have to be completed in a step-by-step or random approach, a flipped-classroom-module and others.

While the IMS Learning Design Standard only allows strict designs, which have to be carried out in a more or less linear way from beginning to end, the presented approach is more flexible. Although strict sequences are possible, one can also realize more open designs. Another advancement compared to, for instance, LAMS is the fact that the workflow structure allows state-depended actions.

The next steps will be to conduct extended data analysis of the usage of the new functionalities, including an evaluation of the validity of the new data. Furthermore, learning analytics features will be implemented in the platform in order to provide information about the learning activities to both students and teachers. Thirdly, the pedagogic patterns will be extended, inspired be concepts such as the CSCL scripts.

According to our knowledge, Learn@WU is the first large-scale e-learning platform, which has adopted a workflow-based approach for realizing learning activities.

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