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ECAAD Modelling Tool based on ADOxx®

Introduction

The paper presents how meta-modelling concept and technology allowing creating custom meta-models for a modelling tool can be applied in the area of technology enhanced learning specifically in the design of learning activity sequences and assessment/appraisal methods summarized in the approach called “Evidence Centered Activity and Assessment Design” – ECAAD. The term “model” is understood as described in [Reimann, 2012] as semantically-rich, graphical representation of a real-world system-under-study, “ that on one hand provides means of externalization, visualization of knowledge of the domain user and on the other hand is interpretable by machines/programmatically.

The model-based approach as introduced below should support learners and teachers in their knowledge-intense planning, design and specification task for the 21st century, technology-rich classroom to allow for knowledge sharing, collaboration among domain experts and operationalization of the created artefacts.

The modelling approach is described in the following from technical perspective as researched and developed in course of the European Commission co-funded project NEXT-TELL project [NEXT-TELL, 2013, www.next-tell.eu] specifically focusing on the underlying meta-modelling concepts and technologies as a realization framework for highly flexible solutions in the area of ECAAD.

1. Objectives

The European Commission co-funded project NEXT-TELL defines models and the related task of modelling as a key building block to support the creation of the 21st century learning environments. The

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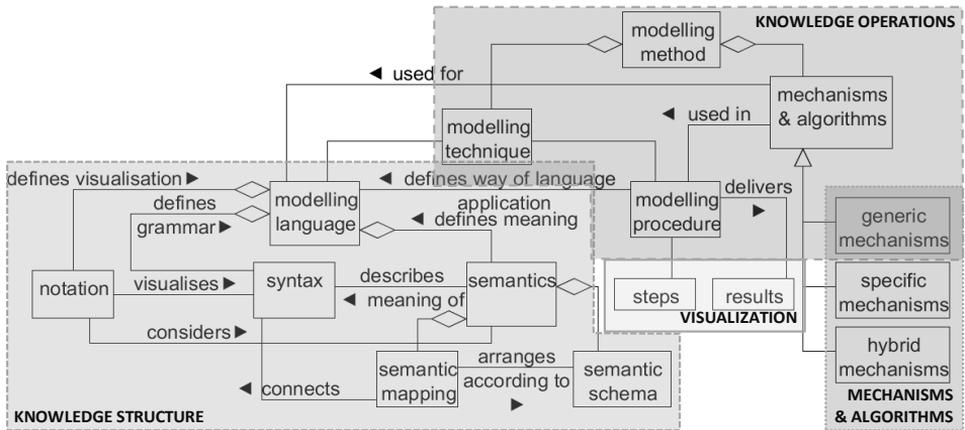
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teachers are supported in their planning tasks (individual activities/services and assessment methods) by a tool with scalable and adaptable approach. The learner uses a transparent platform to negotiate and interact with the teacher through learning plans derived from a competence development structures. For both stakeholders, the project proposes modelling and models as an application technology.

The objectives of this specific work-stream in NEXT-TELL is to develop a) a coherent modelling method as defined by [Karagiannis, Kühn, 2002] for “Evidence Centred Activity and Assessment Design (ECAAD)” including aspects such as a role-based interactions, algorithmic validation/operationalization and a defined result view as well as b) modelling tool support to move beyond simple model editing to full-fetched tooling [Utz, 2009], [Utz, 2012].

Figure 1. Modelling Method Specification Framework



Source: Own elaboration based on [Karagiannis, Kühn, 2002].

As defined in [Karagiannis, Kühn, 2002], the specification of the ECAAD method considers and builds upon the generic meta-modelling specification framework, consisting of a) the knowledge structure needed to model learning sequences and assessment methods (set of modelling constructs such as classes, relations, model types, attributes and properties), b) knowledge operations to support the different target groups in design and operationalization tasks (as the set of functionalities offered by the system building upon the knowledge structure), c)

definition of interface/extension aspects to support collaborative model design, sharing and contextualization of models (as the interaction level, user interface definition) and d) algorithms and mechanisms as a foundation.

2. Methodology

The research methodology applied in NEXT-TELL builds on experimentation and iteration including aspects from user-driven design and specification. The development process follows iterative approach including validation and trial phases - also by providing prototypes to domain experts in order to gather their feedback. The method and tool development approach is in line with the project plan that follows yearly major iterations plus minor scenario-based adaptations. Within each of these iterations the manner specified by [Karagiannis, Visic, 2011] is followed:

1. **Conceptualization:** in this phase specification and translation of requirements based on literature review and lessons learned into meta-modelling concepts, algorithms, interactions and visualization as defined in [Karagiannis, Kühn, 2002] take place.
2. **Implementation:** based on a previous phase the concrete development task on the ADOxx[®] meta-modelling platform as the selected implementation technology is done.
3. **Deployment:** last phase includes release management and packaging of functionality for different user groups and technologies. This phase has a content perspective (training and familiarization) and a technology perspective (package, release, migrate).

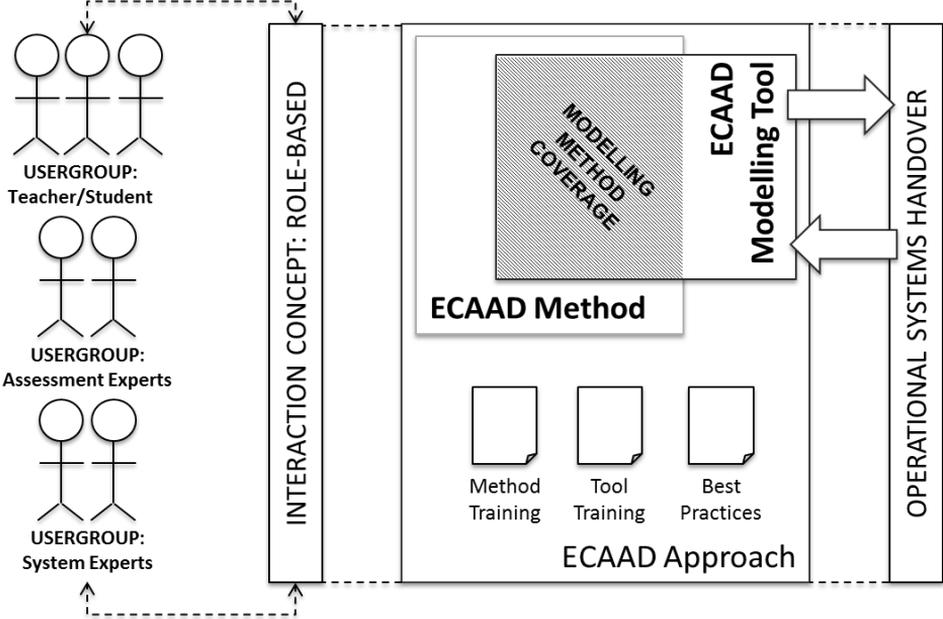
From a technology perspective, the ADOxx[®] platform has been selected as a baseline since it offers out-of-the-box features such as multi-language support, repository functionality, support for various client technologies, user rights management and additionally provides extension and update capabilities that permit add-on implementation and personalization of a tool.

3. Conceptual and Technology Results

The conceptual result of the mapping from requirements into a high level system and interaction architecture is presented in Figure 2. The characteristics of the system derived from this mapping are listed in the following paragraph building upon common characteristics of the whole NEXT-TELL system to be a) web-based, meaning accessible via standard

browser technology, b) open for integration and complying to a common information architecture (access to artefacts) and c) distributed from a deployment perspective (different deployment options, depending on the device used).

Figure 2. ECAAD Tool Components – conceptual



Source: Own elaboration.

On figure 2 the following components are presented:

1. Role-based access mechanisms: The functionality provided by the ECAAD modelling tool depends on the role assigned to a certain user. Each role and their interaction streams are specified and appropriate visualizations and functionalities are provided to user after authenticating to the system.
2. Modelling method as a subset of the ECAAD method: An important consideration is that the complete ECAAD method as defined in literature and the project results (see [NEXT-TELL, 2013] for details) consists of 9 steps, the implementation on tool level considers a subset of these steps and enables ICT support for specific functionality.
3. The artefacts defined in a modelling tool are either handled to human experts or to external systems that interpret them operationally. The handover from the design is based upon the internal representation of the models defined, the back-link through usage information and

feedback streams allows for continuous update and modification/adaptation.

4. Open Interfaces: all functionality provided is openly available for potentially related systems in the NEXT-TELL ecosystem and beyond. An open API allowing queries on model repository (read access) as well as changing it (write access) is available.

Based upon these characteristics, the modelling method is defined and specified, building on the modelling method specification framework as presented in Figure 1. The focus in this paper lies upon the knowledge structure of the second step of the overall ECAAD methodology as “Learning activity sequence and assessment method design”, specifically investigating in the results of the conceptualization phase.

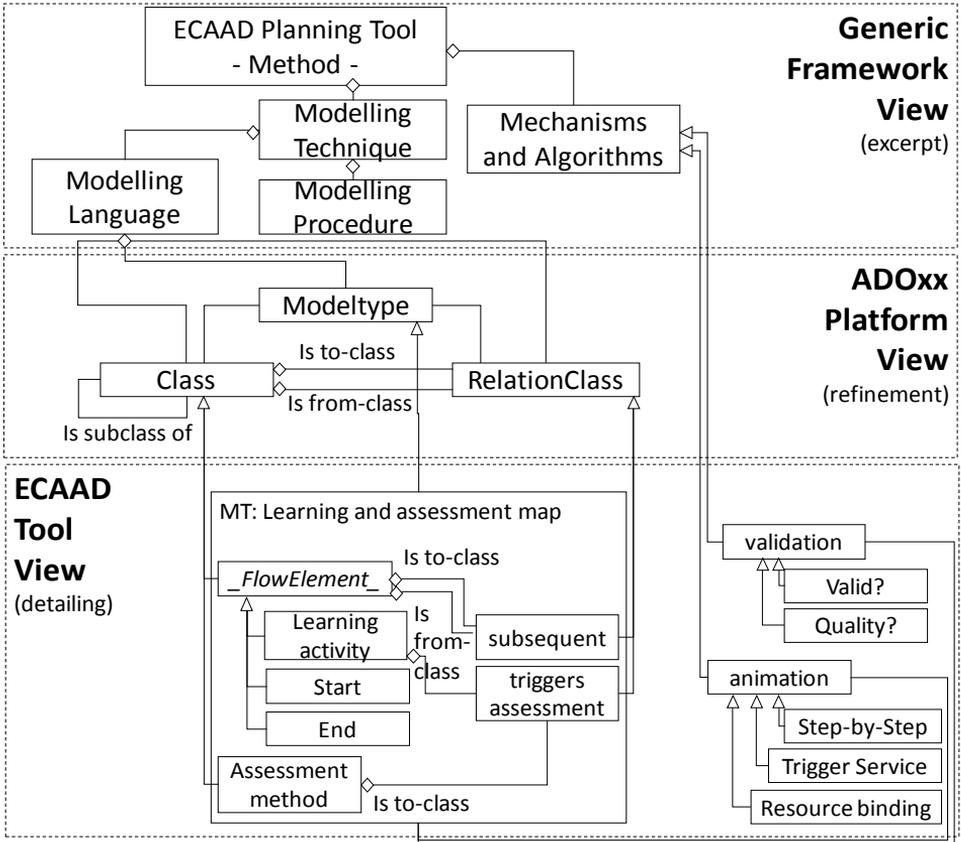
A detailed report on the results of the conceptualization on all 4 elements from Figure 1. and across the procedure model is available in deliverable 2.1 (first iteration) [NEXT-TELL, 2011], 2.3 (second iteration) [NEXT-TELL, 2012] and 2.5 (third iteration) [NEXT-TELL, 2013].

3.1. Conceptualization phase

During conceptualization a break-down from framework level to concrete implementation specification is performed. The conceptualization takes into consideration platform-specific semantics and available functionality and combines it with the specifics of the domain. Figure 3. provides an overview of the different levels analyzed during method development. The generic modelling method specification framework is refined using ADOxx[®] platform specifics (i.e. ADOxx interprets the concept “Modelling language” as a combination of “Model types”, “Classes” and “Relation Classes”) and further developed to concrete types of these concepts through generalization (i.e. an abstract class “_FlowElement_” is derived from the “Class” element in platform level to describe any characteristic of any class that has a sequencing logic such as a “Learning activity”).

Figure 3. shows the ECAAD meta-model for learning activities and assessment maps, relating functionality required and therefore imposed on it and its classes (i.e. “animation” of a model of this type builds on specific properties that need to a) be foreseen in the meta-model b) be provided by the modeller and c) are validated through platform algorithms based upon a query language and graph-theory as foundational elements).

Figure 3. ECAAD Conceptualization Overview



Source: Own elaboration.

3.2. Implementation phase

The implementation of the above concept builds on ADOxx® possibilities to engineer modelling methods using the built-in integrated development environment to continuously monitor possible implementation errors and warnings. The platform implements the so-called DORA concept (“Define-Once-Reuse-Anywhere”) reducing implementation overhead when developing meta-models and functionalities of similar kinds or with overlapping requirements. For the NEXT-TELL project concepts developed in the ECAAD domain become technically reusable within the related work packages for TISL (Teacher Inquiry Layer) and SPICE (Strategic Layer) since they all needed functionality allowing to show different viewpoints to different stakeholders/user types.

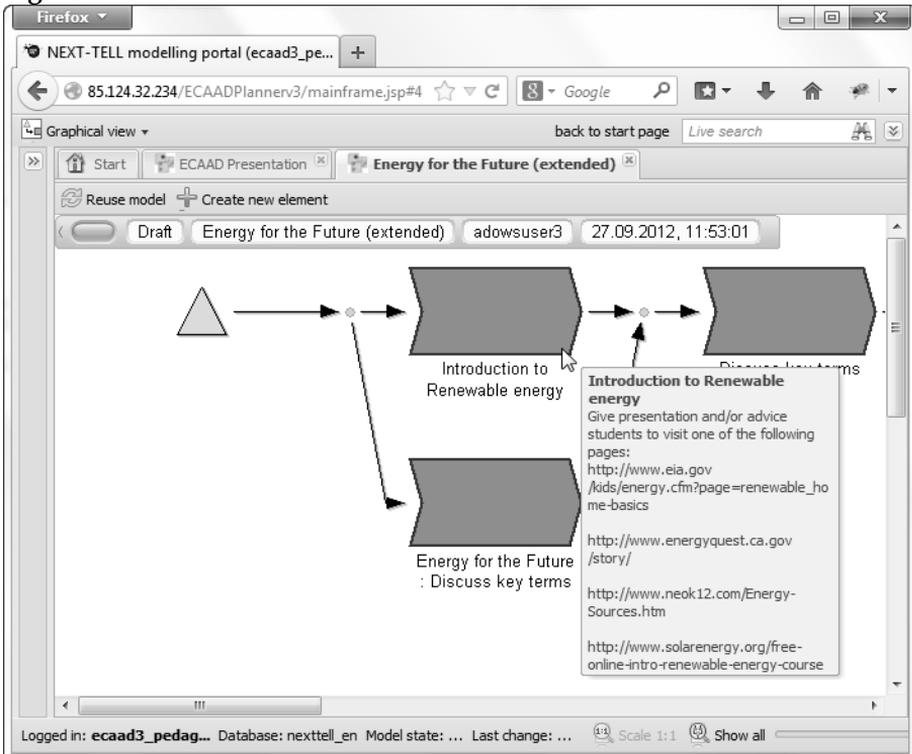
3.3. Deployment phase

The ECAAD modelling tool is deployed as an internet application through Java application and distribution technologies (JNLP) and a HTML/JavaScript based client for viewing and browsing content, supporting SOAP and REST based features from a technical perspective. All modelling tools are integrated in a common modelling portal the so-called “NEXT-TELL Modelling Workbench” that provides as an umbrella common functionality such as user authentication, authorization, repository management.

4. Application Results and Outlook

Validation and evaluation of the implementation results are performed in accordance with the project’s application scenarios in the area of STEM (Science, Technology, Engineering, and Mathematics) and TESL (Teaching English as a Second Language). Tests are performed by the respective project partners in different cultural settings (Germany, Norway, UK, Austria) in order to gather feedback from a broad user base.

Figure 4. ECAAD Web Client



Source: Own elaboration.

The repository of models developed during the course of the project is available online and currently holds around 300 models developed by end-users (teachers and supporting project partners). Figure 4 gives an example of a so-called “Knowledge State Map” from the subject mathematics and the related learning progression and assessment map in the background that is shared with the students in order to allow negotiating it.

The iterative approach on method and tool development results in a continuous modification and update of the tool deployed and used by different modelling projects within NEXT-TELL. The milestones defined and reached relate to the following aspects:

1. Authoring support for cbKST [Kickmeier-Rust *et al.*, 2011]-driven competence design implementing a knowledge structure for competence design, competence combination and respective algorithms to allow transitive validation and querying.
2. Sharing mechanisms of good/best-practices in activity and assessment design through easy to browse, searchable, “cloud-like” repository of patterns.
3. Analysis features in the repository. Thanks to the semantic richness of models developed, the repository is not only searchable as mentioned, but provides features for analyses and validation.
4. Operationalization of models: not only design and drawing of models is in focus, but the plans are “runnable” using a semi-formal description language that can be animated and executed.
5. Feedback for continuous model evolution: the feedback loop back to the design from operational execution is integrated.

Conclusion

The development of the first year concluded in August 2011 and for the second iteration on August 2012. Following an iterative approach, the next specification task already resulted in an update of requirements derived from the lessons learned/feedback from facilitators and end users of ECAAD tools. The main aspect in the first year related to a restructuring and modification of functionality presented in the tool to follow a persona and scenario based framework as defined above to reduce complexity on tool level. A second important conclusion from work with teachers in the first year can be summarized in the provocative statement that models are of interest and the importance of design and

planning is understood, but the modelling – as the actual task to produce models - is regarded as too cumbersome in a day to day operation. The expectation is that individual plans are developed building upon a library of patterns to be selected and customized/parameterized by the end-user at maximum which means that different ways of model creation (mining mechanism, monitoring, different interfaces) need to be explored to offer different approaches following a persona-approach in the project and thereafter.

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ECAAD Modelling Tool based on ADOxx® (Summary)

The work presented in this paper as a result of the European Commission's project NEXT-TELL shows how concepts from the domain of meta-modelling have been applied in the area of technology enhanced learning (TEL) to enable full-fledged tool support for activity and assessment design. The tool, based on the ADOxx® meta-modelling platform (www.adoxx.org), supports teachers and learners to externalize their plans, pedagogical approaches and reasoning using a graphical models. Proposed modelling approach uses a pre-defined but still flexible modelling language, enhanced by a set of mechanisms and algorithms to operationalize the design work. The focus for the enactment of models through mechanisms and algorithms lies upon the model itself rather than on a "generation" approach as applicable in other domains such as software engineering or workflow management.

During the development tasks, an open and iterative approach was selected to on one hand include user feedback in the implementation work but also make the results available in an open and reliable framework. The Open Models Initiative (www.openmodels.at) by the University of Vienna has been selected to enable a continuous evolution of the model content on one hand (model library/repository of artefacts created) and also the modelling method for ECAAD defined as set of construction principles and approach for these models.

Keywords

meta-modelling, ECAAD, ADOxx