VIDLATEL 2009

First International Workshop on Visual Design Languages and Applications for Technology Enhanced Learning

(http://elearn.pri.univie.ac.at/vidlatel)

in conjunction with **IEEE ICALT 2009**

July 17, 2009
Riga, Latvia

Preface

Many human activities are supported by the use of visual representations, which enable us to manage the complexity of real work problems by facilitating the use of our (commonly very limited) cognitive capabilities. Architects, musicians, surgeons or engineers use visual artifacts in their daily practice to plan, design and carry out their endeavors. Visuals can support imagination, creative thinking, communication, discussion, and organization of the work to be performed. Similarly, the difficult process of creation and provision of learning environments could be supported by the use of appropriate visual artifacts.

The achievement of learning is pursued by the performance of activities using learning objects, resources and tools. The ever increasing number of existing Technology-Enhanced Learning (TEL) tools and applications (e.g., Moodle, dotLRN, RELOAD, LAMS) provide academic staff with lots of useful functionalities to design their TEL environments. Past research has focused mostly on the computational aspects of TEL environments. There are a number of specifications that allow computational representation of processes and contents (e.g., SCORM, IMS-LD, IMS-CP, IMS-QTI) intended to facilitate reuse and interoperability of solutions. Nevertheless, these specifications provide only limited help and hints about how such learning environments can be developed by the average user (i.e., the instructor, the teacher).

Despite the need for sound and user-friendly instructional design approaches to TEL, there is still a lack of cooperation and integration between the fields of TEL and instructional design. The workshop is intended to explore this integration through the use of visual design artifacts (languages, notation systems, tools, applications). These can support and enhance the quality of TEL systems, facilitate sharing ideas, collaboration, reuse, and learning from experience.

The VIDLATEL workshop intends to bring together researchers and practitioners from relevant communities (instructional design, instructional development, educational multimedia, technology-enhanced learning, learning design, etc.) to share their knowledge, ideas, results, expertise and research about interdisciplinary approaches to visual design for TEL.

The call for papers solicited original papers about promising approaches and applications in several specific areas related to the overall workshop theme. The call for papers attracted 14 high-quality submissions from all around the globe. Each submission received at least two blind reviews by members of the program committee. All reviews were considered by all three workshop organizers to make a decision on each paper. Eventually, nine papers were selected for presentation at the workshop.

Manuel Caeiro, Michael Derntl, Luca Botturi
Workshop organizers

Main Issues to be Analysed

For the workshop, presenters are asked to focus their presentations on the following (non-exclusive) main issues around their approaches:

- What is the objective of your VIDL approach?
- What is the (theoretical) background of the approach?
- What are the benefits for:
    - Instructional designers / teachers?
    - Tool developers / providers?
    - Researchers?
- What are the next steps?
- What are ideas for future collaboration of workshop participants?

Organizing Committee

- Manuel Caeiro Rodriguez, University of Vigo, Spain (mcaeiro@det.uvigo.es)
- Michael Derntl, University of Vienna, Austria (michael.derntl@univie.ac.at)
- Luca Botturi, University of Lugano, Switzerland (luca.botturi@lu.unisi.ch)

Program Committee

- Luca Botturi, University of Lugano, Switzerland
- Daniel Burgos, ATOS Origin. Research & Innovation, Spain
- Manuel Caeiro Rodriguez, University of Vigo, Spain
- Michael Derntl, University of Vienna, Austria
- Martin Llamas Nistal, University of Vigo, Spain
- Susanne Neumann, University of Vienna, Austria
- Luis Anido Rifon, University of Vigo, Spain
- Todd Stubbs, Brigham Young University, USA

Date and Location

Date: 17 July 2009, 11 a.m.

Location: Building 2, room 208, Riga Technical University, Riga, Latvia

Tentative Program

Each workshop contribution is assigned 15 minutes for presentation plus 5 minutes for questions. We plan to include 5 contributions in the morning session and to continue the workshop after the lunch with 3 contributions. This is the tentative program:

11:00-11:20 **Workshop introduction**

11:20-11:40 **A graphical modeling language for computer-based learning scenarios**

11:40-12:00 **ScenEdit: a goal-oriented tool to design learning scenarios**

12:00-12:20 **Subjective representations of educational design systems**

12:20-12:40 **Improving the usability of an approach for visually supporting the creation of Personal Development Plans**

12:40-13:00 **Coordinating Curriculum Implementation Using Wiki-supported Graph Visualization**

Lunch

14:30-14:50 **Visualizing learning designs using IMS Learning Design: the position of the Graphical Learning Modeller**

14:50-15:10 **A Domain-Specific Modeling approach for supporting the development of Visual Instructional Design Languages and tools**

15:10-15:30 **Towards a Visual Language that Captures the Learning Experience on the Go**

15:30-16:00 **Discussion and Workshop closing**

Contributors

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Currently managing the R&D activities at SEBIT (An international e-education company with 200 employees which is fully owned by Turkish Telecom), M. Ali Türker has carried out his undergraduate and graduate studies in Middle East Technical University (METU) and later, PhD studies in Tampere University of Technology, all in Electrical and Electronics Engineering. He coordinated the technical aspects of the iClass integrated project, which was funded by the 6th Framework Programme for R&D in EU. This large scale, 54 months, technology enhanced learning project with 13 million EUR budget was carried out by 22 partners from 11 different countries and was finalized successfully in late 2008. M. Ali Türker has 48 articles in national and international publications, 2 US Patents and a PMP certificate. While he is a regular columnist at BT Haber weekly IT newspaper since 2003, he is also lecturing a graduate course on complex adaptive systems at METU Informatics Institute since 2004.

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Anne Lejeune is researcher at LIG laboratory, member of MeTAH Team, based in Grenoble (France). She is also teacher in computer science at IUT II (Institut Universitaire de Technologie), based in Grenoble. Her research concerns activity modelling in educational software, learning scenarios and authoring tools dedicated for teachers. In the context of the SCY European project, she was particularly interested in the specification of a high-level graphical representation of learning scenarios based on the Learning Activity Space (LAS) concept.

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Boubekeur Zendagui began his PhD in 2006 at the Computer Science Laboratory of Le Mans (LIUM). His research works are about the specification of observation needs in a re-engineering context of learnings scenarios-centered instructional design, in relation with both learning scenario and Educational Modeling Language. This cross-disciplinary subject leads him to deal with some various Technology-Enhanced Learning and Model Driven Engineering topics: instructional design, Educational Modelling Languages, Model-Driven-Engineering, Domain-Specific Modeling, observation needs, tracks analysis...

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Daniel K. Schneider is senior lecturer and researcher at TECFA, a research and teaching unit in the faculty of psychology and education, University of Geneva. Holding a PhD in political science, he has been working in educational technology since 1988 and participated in various innovative pedagogical and technological projects. He has been a prime mover towards the introduction of creative pedagogical strategies and ICT technologies. His current R&D interests focus on modular, flexible and open Internet architectures supporting rich and effective educational designs. Within TECFA's "blended" master program in educational technology, he teaches educational information & communication systems, virtual environments and research methodology

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Margus Pedaste is a senior researcher of educational technology at the University of Tartu in Estonia and director of the Pedagogicum of the University of Tartu. He has been involved in international research community related to computer based learning environments, problem solving, and inquiry learning. His main interest is to study the processes of computer-supported inquiry learning and problem solving. The recent research is on adapted support systems that are appropriate for increasing the effectiveness of students’ learning in technologically enhanced learning environments. At the same time he has been working as a regular teacher at school and for some years he has been the president of the Association of Estonian Biology Educators. In SCY project, he is involved in the questions related to pedagogical scenarios, learning activities and pedagogical plans, as well as in assessment of learning process in SCY Lab.

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Michael is a researcher at the Research Lab for Educational Technologies, University of Vienna, where he is also serving as vice-head, and lecturer at the Department of Knowledge and Business Engineering. He is currently engaged as postdoc researcher in the ICOPER project funded by the EU under the eContentplus programme, and with teaching courses in computer science and in media competence.

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Sonja is a project assistant at the Research Lab for Educational Technologies working on the project ActiveCC that deals with the implementation of the Faculty's e-learning strategy, and lecturer at the Department of Knowledge and Business Engineering. Her current research interests are conceptual modeling, design patterns for teaching and learning, curriculum design, competence facilitation in higher education, person-centered e-learning, action research and design-based research, blended communities, engineering education.

Accepted papers

The following papers were accepted by the program committee and registered by author(s) to be presented at the workshop in Riga:

- **Visualizing learning designs using IMS Learning Design: the position of the Graphical Learning Modeller**
  Susanne Neumann, Petra Oberhuemer, Michael Derntl
  Two research communities that need to work closer together are the community looking into the depiction or representation of learning designs and the community focusing on IMS Learning Design and its increased accessibility. A synopsis of some findings within these communities is given in order to then evaluate a graphical IMS Learning Design editor, the Graphical Learning Modeller.

- **A graphical modeling language for computer-based learning scenarios**
  Anne Lejeune, Muriel Ney, Armin Weinberger, Margus Pedaste, Lars Bollen, Tasos Hovardas, Ulrich Hoppe, Ton de Jong
  A crucial challenge for improving EMLs is to provide an intuitive notation to support educational practitioners to not only understand, but also describe a large number of flexible scenarios themselves. We present here the general outline of a graphical modeling language based on the concept of Learning Activity Space (LAS) and its related editor so-called SCY-SE. The design stage of learning computer-supported scenarios can be facilitated by the use of LAS arrangements as improved in the context of an interdisciplinary European project named SCY (Science Created by You).

- **ScenEdit: a goal-oriented tool to design learning scenarios**
  Valérie Emin, Jean-Philippe Pernin
  This paper presents ScenEdit authoring environment, a graphical tool dedicated to design pedagogical scenarios. The environment is based on ISiS goal-oriented model we have elaborated to structure the design of scenarios by teachers-designers and to favour sharing and reuse practices. We present here the main functionalities of the environment with an example of use.

- **Subjective representations of educational design systems**
  Daniel K. Schneider, Kalli Benetos, Jean-Philippe Pernin, Valérie Emin
  This paper explores the benefits of repertory grid technique (RGT) for research on educational design systems.

- **Improving the usability of an approach for visually supporting the creation of Personal Development Plans**
  Javier Melero, Davinia Hernández-Leo, Ernesto Arroyo, Josep Blat
  With the aim of visually supporting learners in the creation of their personal development plans, this paper describes the functionalities added to a preliminary approach for improving its usability and satisfying better the learners' needs taking into account the findings from a previous user study.

- **Coordinating Curriculum Implementation Using Wiki-supported Graph Visualization**
  Sonja Kabicher, Renate Motschnig-Pitrik
  Traditionally, curriculum specifications tend to be formal, static documents, not encouraging adaptation and evolution. In order to facilitate various activities in implementing a curriculum, such as coordinating content, meta-cognitive competences, student-centered learning outcomes, this work proposes to employ a structured, Wiki-supported space. Our experience with this approach showed an improved transparency and coordination of courses based on a structured overview, a multi-faceted specification and increased sharing among teaching staff.

- **A Domain-Specific Modeling approach for supporting the development of Visual Instructional Design Languages and tools**
  Pierre Laforcade, Boubekeur Zendagui
  In this paper the authors present, discuss and illustrate their Domain-Specific Modeling orientation for helping communities of instructional designers to specify Visual Instructional Design Languages and to develop dedicated user-friendly graphical editors.

- **Towards a Visual Language that Captures the Learning Experience on the Go**
  Mustafa Ali Türker, Tolgahan Dönmez
  This short paper describes “spatiotemporal aspect orientation” as a visual mediator. Aspects of the domain are captured in a contract and domain space is covered with activities. The flow of experience in time is oriented towards adaptation. The goal is to draw a living picture of the episode.

Visualizing learning designs using IMS Learning Design: the position of the Graphical Learning Modeller

Susanne Neumann[1], Petra Oberhuemer[1], Michael Derntl[2]
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Abstract

Two research communities that need to work closer together are the community looking into the depiction or representation of learning designs and the community focusing on IMS Learning Design and its increased accessibility. A synopsis of some findings within these communities is given in order to then evaluate a graphical IMS Learning Design editor, the Graphical Learning Modeller.

1. Learning Design Descriptions

Recent research has focused on the question how educators and instructional designers approach the task of planning instruction [1]. In this regard, two questions are of interest: 1) what are the necessary components to describe a learning design, and 2) how are visual representations capable of supporting the representation and design process.

An Australian group researched the way instructors approach the task of planning instruction [1]. The researchers found that they needed a common set of components in order to translate the often textual descriptions of learning designs into a recognizable schema that could be quickly scanned for its "ingredients" [2]. The so created description schema consisted of three essential elements, which are learning tasks, learning supports, and learning resources.

Independently of the findings of the Australian project, the specification IMS Learning Design (IMS LD) has proposed a language to describe learning designs in a standardized manner [3]. IMS LD recognizes, next to roles, learning and support activities as well as environments[1] as main components of a learning design. These components can be closely linked to the ones identified in the Australian project. We may thus consider that activities for learning, support for learning processes, and needed resources during the activities comprise core building blocks for the description of learning designs.

Goodyear [4] pointed out that the traditionally text-based representation of learning designs needs improvement to better support and propel educational design. Stubbs and Gibbons [5] have pointed out regarding instructional design that a large focus was placed on researching visual representations of learning content but only a small number of investigations were performed for visual representations that are used to further the design itself. It is thus worth looking into how graphical representations might support the process of planning instruction on top of providing a structured textual description of a learning design.

The Unified Modeling Language (UML) may be useful for depicting processes for instructional design, because UML diagrams are already being used in software engineering for design and development processes. However, instructional designers are unfamiliar with UML and sometimes have the feeling that its concepts are difficult to comprehend [6].

2. IMS LD tools as drivers for graphical support of instructional design?

As tools are being developed to edit and play IMS LD units of learning, the question is whether these tools can assist in graphically supporting the instructional design process. A look at the field of current IMS LD editor projects shows that graphical editing software are at the forefront of European developments.

One of the tools currently being developed is the Graphical Learning Modeller (GLM)[2], an IMS LD editor whose target audience are instructional designers

[1] Environments contain learning objects and learning services.

[2] http://sourceforge.net/projects/prolix-glm/

that have little to no prerequisite knowledge of IMS LD. The original role of the GLM was to establish a modeling environment for the quick design of learning design templates, which are free of learning content.

Fig. 1 shows a system for classifying tools that are used to create specification-conformant products [8]. The GLM is classified in the upper right quadrant of the matrix (cp. Fig. 1), since it is distant from the specification, does not cover the entire range of functions, and has the specific purpose of learning design template creation.

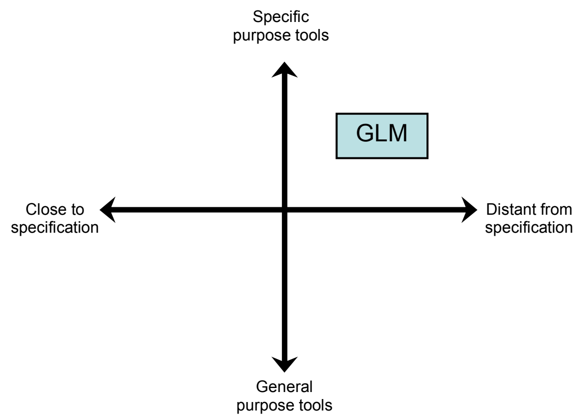

Fig. 1: Tool Classification Matrix [8]

The classification, however, does not show whether visual representations are used in the tool. Thus, the tools may or may not use a visual representation, no matter what quadrant the tool is classified in.

3. Suffice of GLM representations

If the request is made that a visual design editor for IMS LD should graphically represent the core components of a learning design (learning activities, learning support, and learning resources), then the GLM falls short of this request. The GLM visualizes two components—learning activities as well as support activities. Learning resources, which were not in the focus during the development, are not graphically depicted but represented in lists and icons in their relation to the activities. Is this visualization sufficient to support instructional design processes?

User tests have shown that when learning designers look at the designs that others have built in the GLM, they understand them. Designers have access to two representations in the GLM: The visual illustration of activities (high level overview) is accompanied by textual information, which offers detailed information [2]. This enables instructional designers to explore a learning design at different levels of detail. The GLM thus partially supports instructional design because other designers quickly grasp the essence of the described learning design.

4. Conclusion

The paper described the components of a learning design description. The question was then raised, how IMS LD graphical editing tools may aid the instructional design process. The GLM was evaluated as providing partial support in this regard.

Acknowledgements. This paper was written in the context of the research and development project PROLIX (http://prolixproject.org).

4. References

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[2] S. Agostinho, B. Harper, R. Oliver et al., "A Visual Learning Design Representation to Facilitate Dissemination and Reuse of Innovative Pedagogical Strategies in University Teaching," In L. Botturi & S. T. Stubbs (Eds.), *Handbook of Visual Languages for Instructional Design: Theories and Practices*, Information Science Reference, Hershey, 2008, pp. 380-393.

[3] IMS Global Learning Consortium, "IMS Learning Design Information Model," online: http://tinyurl.com/imsld-im, 2003.

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[5] S.T. Stubbs, A.S. Gibbons, "The Power of Design Drawing in Other Design Fields," In L. Botturi & S. T. Stubbs (Eds.), *Handbook of Visual Languages for Instructional Design: Theories and Practices*. Information Science Reference, Hershey, 2008, pp. 33-51.

[6] D. Griffiths, J. Blat, "The Role of Teachers in Editing and Authoring Units of Learning Using IMS Learning Design," *Advanced Technology for Learning*, vol. 2(4), 2005.

[7] L. Botturi, D. Burgos, M. Caeiro-Rodríguez et al., "Comparing Visual Instructional Design Languages: A Case Study," In L. Botturi & S. T. Stubbs (Eds.), *Handbook of Visual Languages for Instructional Design: Theories and Practices*. Information Science Reference, Hershey, 2008, pp. 315-343.

[8] D. Griffiths, J. Blat, R. Garcia, H. et al., "Learning Design Tools," In R. Koper & C. Tattersall (Eds.), *Learning Design: A Handbook on Modelling and Delivering Networked Education and Training*. Springer, Berlin, 2005, pp. 109-135.

A graphical modeling language for computer-based learning scenarios

Anne Lejeune[1], Muriel Ney[1], Armin Weinberger[2], Margus Pedaste[3], Lars Bollen[2], Tasos Hovardas[4], Ulrich Hoppe[5], Ton de Jong[2]
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Abstract

A crucial challenge for improving EMLs is to provide an intuitive notation to support educational practitioners to not only understand, but also describe a large number of flexible scenarios themselves. We present here the general outline of a graphical modeling language based on the concept of Learning Activity Space (LAS) and its related editor so-called SCY-SE. The design stage of learning computer-supported scenarios can be facilitated by the use of LAS arrangements as improved in the context of an interdisciplinary European project named SCY (Science Created by You).

1. A Graphical Modeling Language based on Learning Activity Spaces

A Learning Activity Space (LAS) [1] is defined as *a coherent and intuitive set of activities supported with specific tools and scaffolds. The input and output of a LAS are described in terms of a set of artifacts created by students (further called Emerging Learning Objects: ELOs* [2]*).*

We use the LAS concept as the basis of a graphical scenario modeling language intelligible for non-computer scientists and aiming at realizing some necessary flexibility while providing expressiveness and pedagogical relevance.

The design of learning environments can be built on a specified selection of learning activities, which constitute the respective LASs. The general outline of scenarios is thus defined by an arrangement of LASs and the various learning paths between them. Sequencing of the selected activities provided by each LAS is not prescribed in a linear fashion but instead by the ELOs learners produce while performing these activities. (Figure 1 shows a specific LAS with its potential activities, tools and input/output ELOs).

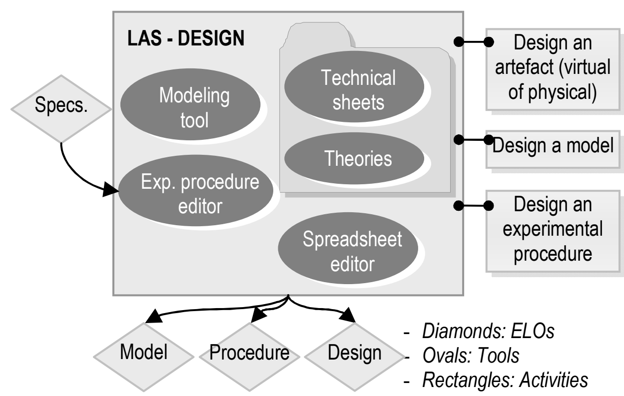

Figure 1: LAS Design.

Each activity requires an input ELO developed previously in another LAS by the learners or a given learning object pre-defined by the content developers. The activities in a LAS result in at least one output ELO, but in many cases there can be several of these. Additionally, the activities are supported by tools that may or may not have scaffolding characteristics, e.g., a simulation tool that – adapted to the learners' changing needs – provides clues for what variables to look for in the simulation.

For the SCY project (Science Created by You, FP7), thirteen LASs have been designed as the result of a large study focusing on science learning scenarios (i.e. *Analysis, Conceptualization, Construction, Debate, Design, Experiment, Evaluation, Information, Management, Orientation, Reflection, Regulation, and Reporting).*

In the specific outline of a scenario, a designer has to (1) choose a specific set of LAS from the 13 available LASs, and then (2) further specify each of them. In step (1), choosing the right set of LAS is guided by the identification of activities to be performed. In step (2), each LAS can be further specified with respect to its setting (learning arrangement, technology support, and location). Thus, each LAS can have different instantiations, i.e. single activities can be left out or added without changing the character of one LAS. The next step would be to adapt a so defined scenario to a concrete instance, adding specific content and a pedagogical plan.

2. Scenario and LAS editor: SCY-SE

Based on the conceptualization and the suggested graphical language for modelling educational scenario, the so-called SCY Scenario Editor (SCY-SE, figure 2) supports comfortable, graph-based and consistent creation of LASs and pedagogical scenarios, allowing practitioners and researchers to initially design exchange and compare new scenarios and LASs.

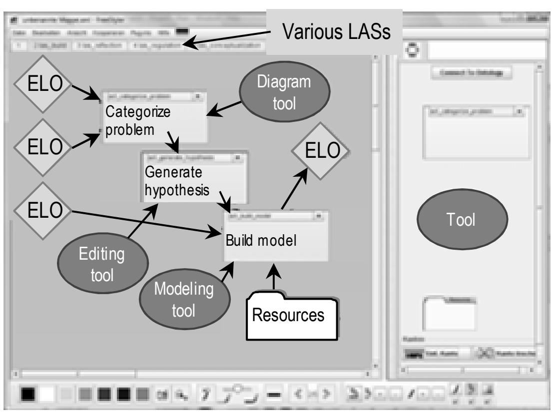

Figure 2: LAS View of the SCY-SE

SCY-SE is able to retrieve and infer information from an ontology that is being built in the context of the SCY project. In this ontology, a set of pre-defined template scenarios and LASs (as listed above) are stored along with their relations to activities, tools, ELO types, scaffolds, etc. Thus, SCY-SE assists the designer in adhering to constraints (e.g., an “interpret data” activity necessarily needs a tool to display data) and it is able to compare new or edited scenarios and LASs to existing ones. Similar scenarios or LASs may be joined or discussion between their authors may be initiated. SCY-SE provides two different views (with different objects and tools provided in a “palette”) for LAS specification (shown in Figure 2) and for the combination of LASs into an integrated scenario.

This application has been built as an extension of the FreeStyler multi-purpose modelling tool [3]. Its architecture integrates the Freestyler environment with the SCY ontology using a blackboard-based agent architecture. The blackboard serves as a repository and a shared memory and is implemented in terms of several tuple spaces [4]. Specific agents provide consistency checks and similarity computation for LAS and scenario specifications.

3. Conclusion

The notion of LAS enables a structured and expressive description of learning scenarios and at the same time it allows for a high variability in interrelating activities within and between LASs. The focus of the graphical modeling language is on learners’ expected productions while performing activities which are seen as keys for entering a specific LAS or for sequencing activities within it. By means of this graphical language and the SCY Scenario Editor (SCY SE) we seek to help non-computer-scientists to face the complexity of learning design.

4. References

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ScenEdit: a goal-oriented tool to design learning scenarios

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Abstract

This paper presents ScenEdit authoring environment, a graphical tool dedicated to design pedagogical scenarios. The environment is based on ISiS goal-oriented model we have elaborated to structure the design of scenarios by teachers-designers and to favour sharing and reuse practices. We present here the main functionalities of the environment with an example of use.

In collaboration with French National Institute for Pedagogical Research (INRP), we develop an authoring environment [1] dedicated to teachers who want to integrate digital technologies in the French secondary educational system. ScenEdit is based on ISiS, a goal-oriented model we have co-elaborated with experimented and inexperienced teachers. ISiS aims to capture the teachers' intentions and strategies in order to better understand scenarios written by others and to favour sharing and reuse practices. ISiS is not an alternative solution to Educational Modelling Languages [2], but completes them by offering high-level models, methods and tools for teachers-designers.

From this model, we have developed a graphical tool proposing three workspaces. The first *Context workspace* allows to define the two different types of context in which a learning unit is called to be executed. The *knowledge context* defines the targeted knowledge items (concepts, competencies, know-how, skills, conceptions or misconceptions, etc.) and the audience characteristics. The *situational context* is characterized by a set of variables such as resources that can be manipulated to support the activities (document, tools, services), locations where activities can take place, planning elements or number of learners, roles which can be distributed. The second *Components workspace* is dedicated to manage the three main components of ISiS model: (a) Intentions, (b) Strategies and (c) interactional Situations. For each type of component, the author may either create a new element or import and adapt an existing element from a library. The choice of a component depends on the characteristics defined in the *Context workspace*: an intention is considered as an operation to be realized by a certain type of actor occupying a role (previously defined in the *situational context*) on an item of knowledge (previously defined in the *knowledge context*). The third *Scenario Editor workspace* allows to structure the scenario by assembling elements previously defined in the *Components workspace* (cf figure 1).

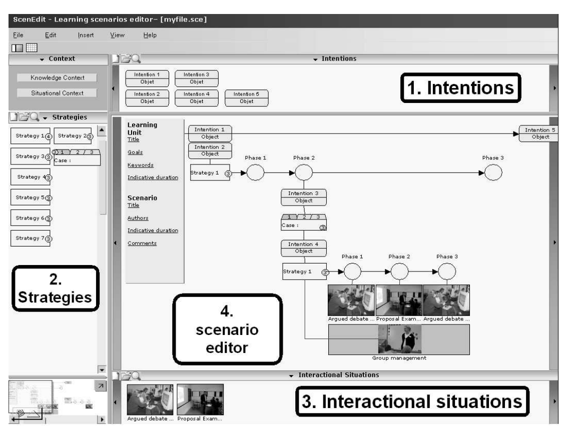

Figure 1. ScenEdit main screen

Figure 1 shows the main screen of the first prototype version. In peripheral areas (titled 1, 2a, 2b and 2c), the designer may create, edit or import the different components of its scenario (context, intentions, strategies, interactional situations). In central area (titled 3), components created in peripheral areas may be “dragged and dropped” and logically linked to compose a graphical representation of the scenario. This representation is a tree where horizontal dimension represents the time evolution and vertical dimension represents the hierarchy of ISiS concepts. Each type of component is shown with a different symbol: rounded rectangle for an intention, rectangle for a strategy, circle for a phase and picture for a situation.

We illustrate the use of the editor with an example based on a collaborative scenario [3] dedicated to the concept of power of a lamp in Physics in secondary school. This scenario has been designed by teachers with a main intention: to destabilize a frequently encountered misconception in electricity “the proximity of the generator has an influence on the intensity”. This first intention may be modelled as a triple (*operation*: “destabilize a misconception”, *knowledge item*: “the proximity of the generator has an influence on intensity”, *subject*: student).

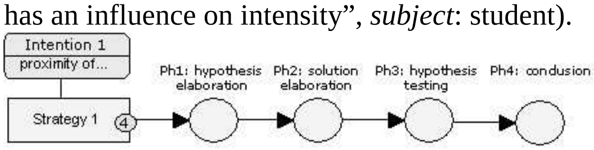

Figure 2. A first level of intentions

This intention (*Intention 1*) is implemented by a didactical strategy called “scientific investigation strategy” and composed of four phases: hypothesis elaboration, solution elaboration, hypothesis testing and conclusion , as shown on figure 2.

The fragment of scenario presented on figure 3 shows how to add a new pedagogical intention called “realize collaborative work” on the previously defined didactical phase “hypothesis elaboration”. This intention is implemented by *Strategy 2* called “elaborating a proposal by making a consensus using a forum”. The first phase of *Strategy 2* called “Make an individual proposal” is associated with the interactional situation called “Individual proposal on a wiki” which is composed of activities (detailed on another screen): reading the question and the guidelines, observing a document and writing the proposal on a wiki. The second phase called “Confront proposals. Obtain a consensus” is associated with the interactional situation called “Argued debate on a forum with consensus”. For this example, ISiS model, seems to be efficient: teachers report that this representation of the scenario is easier to understand, adapt, reuse and share than a narrative scenario or an UML-like activity diagram.

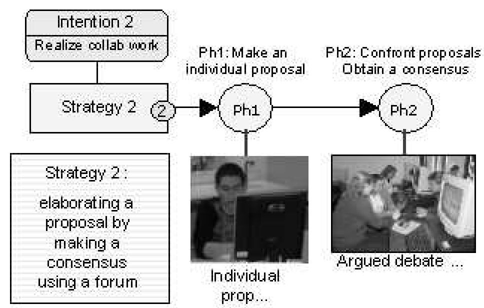

Figure 3. A second level of intentions

We currently experiment the first version of ScenEdit environment. This experimentation aims essentially to validate the visual representation of a scenario. A new online web-based version of ScenEdit will be enriched with databases filled with patterns of different levels (intentions, strategies, interactional situations) elaborated from best-practices found in literature or within communities of practice.

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Subjective representations of educational design systems

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Abstract

This paper explores the benefits of repertory grid technique (RGT) for research on educational design systems.

1. Introduction

Several authors define taxonomic dimensions for *educational design languages* and *educational modeling languages* [1] [2]. We suggest completing these with the analysis of subjective (idiographic) representations of various stakeholders in order to identify design issues that analytical methods cannot detect easily.

Repertory grid technique (RGT) was invented in the 1950's by Kelly [5] and is based on the assumption that people's view of objects with which they interact is made up of an idiographic (individual) collection of related similarity–difference dimensions, referred to as personal constructs. RGT has been used quite extensively in HCI, software engineering and management for various purposes, but we found very few publications related to educational technology.

RGT starts by the identification of a set of *elements* within a topic (e.g. a set of design languages) which are then rated with criteria termed *constructs.* Elements and constructs are usually elicited from the subject by a *triadic method*. Participants will first name a few elements they are familiar with, e.g. names of design systems. They will then compare triads, e.g. design A with designs B and C, and state in what aspect two are similar and the third is different. This procedure is repeated with other combinations until no more new constructs are elicited and until all elements can be discriminated in the construct space. This resulting grid of *m* elements in terms of *n* constructs can then be analyzed with various data analysis techniques, such as visual inspection, factor and cluster analysis.

2. RGT and educational design systems

We suggest four ways to use RGT in the area of educational design languages and systems.

(1) Research on visual design languages implicitly defines a parallel design situation with various competing approaches. Evaluation of each design artifact with RGT may produce rich and concrete data to guide future designs. Such a "similar systems" analysis has shown to be easy to conduct [3].

(2) Clearly defined design and modeling languages are not the only means to design pedagogical scenarios. We suggest throwing all kinds of design approaches together and seeing what construct systems emerge.

(3) After applying RGT to a large diverse population, we could produce a typology of different construct systems and identify essential features for design systems that are "revealing" for various types of stakeholders. Explicating such diverse constructs should help communication.

(4) RGT can be used to study how users perceive a single system, i.e. its various tools and features.

3. A feasibility example

To explore the interest and the feasibility of RGT to study perceptions of a *global "design systems" space*, we created repertory grids with a few people working in educational technology. After initial exploration, we adopted the following procedure. Participants first had to identify at least six design systems with varying features from a list [6]. Each system was then shortly demonstrated. RepGrid IV's built-in triadic elicitation script [7] was used to extract at least four constructs. Next, ratings for each aspect were adjusted. Construct names were also adjusted during this process, being usually made more general. Finally, "break match" warnings about non-discriminated elements or non-discriminating constructs were followed up if possible.

At the end, participants adjusted scores by looking at all elements for each construct.

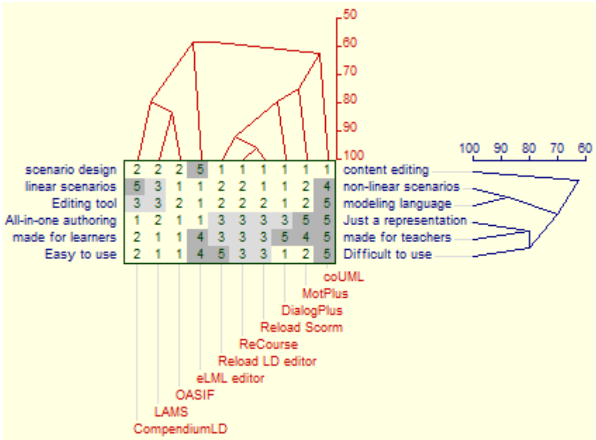

Figure 1: Two way cluster analysis of a small grid.

The two-way cluster of one participant's grid in fig. 1 shows that systems considered fall into very distinct categories. At a (low) 70% cut-off rate, we get 4 types: (1) eLML (a semantic content markup) and (2) coUML are isolated. We then find (3) a group of production tools, and (4) a group of learning design editors. Constructs that cluster together are *all-in-one authoring / just a representation* and *made for learners / teachers*. *Easy/difficult* to use is not far from this category. Then, we find *linear/non-linear scenarios* and *editing tool / modeling language* in a cluster. Finally, the *scenario design / content editing* construct is set apart from all others. A principal component's analysis that leads to similar results is not shown here.

4. Discussion and issues for further work

This exploration raised several issues. First, we noticed that many emerging constructs have to do with how a system can be used. Idiographic repertory grids therefore should be suitable for highlighting how practical considerations correlate with perceived characteristics and how various systems fit into a personal construct space.

The repertory grid technique (RGT) is best used when participants are able to identify representative elements and to rate them with their own criteria. This implies that participants need to be trained. In addition, we suggest creating vignettes describing each system and showing them to the participants.

We also need a reliable method to insure that the most important constructs will enter the grid. We found the trialogic procedure useful since it helps find "natural" and strong constructs. However, we suggest halting this procedure in the middle of the process. Participants will be shown results (e.g. the cluster analysis) and if they find two systems to be too close, a discriminating construct should be elicited, else one of the two elements should be removed. If two constructs are too close, a system that differentiates the two should be added.

We found comparing very different systems an interesting strategy but construct spaces quickly become complex. Data reduction will not produce "tight" clusters and variance explained by the two first factors will be below 50%. Such rich data is useful to the educational design researcher but we also should analyze very similar systems in order to identify focused constructs about a class of design systems.

We did not explore analysis across construct systems. Commonly used constructs of a larger set of participants can be identified through content analysis. A sample of 15-25 persons should generate constructs that are representative of the universe of meaning [4]. Another avenue is to explore group elicitation techniques [7]. Finally, we suggest comparing idiographic constructs obtained through a fixed nomothetic grid. Its constructs could be assembled from a synthesis of analytical and evaluation grids found in the literature. The elements should be a representative selection of various and somewhat known design systems.

In conclusion of this exploration, we put forward the conjecture that RGT could become a useful communication tool among design researchers and between researchers and expert users.

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Improving the usability of an approach for visually supporting the creation of Personal Development Plans

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Abstract

With the aim of visually supporting learners in the creation of their personal development plans, this paper describes the functionalities added to a preliminary approach for improving its usability and satisfying better the learners' needs taking into account the findings from a previous user study.

1. Introduction

Within the field of Visual Design Languages and Applications for Technology Enhanced Learning there has been significant research around supporting teachers when designing instruction [2]. However, there are not many efforts considering the role of learners in the creation of their own learning paths. In this paper we introduce an enhanced (version 2.0) graphical planning tool (GPT), developed in the context of the TENCompetence project [6], which supports learners in the visual design and creation of their Personal Development Plans (PDP).

The GPT version 1.0 was based on the approach of concept mapping [1, 3] and a metaphor of "bubbles" [5], where each bubble represents a learning activity. Learners could explore and plan the learning activities related to the competences of a certain competence profile (set of competences that define the requirements for a specific function or job) by dragging and dropping the bubbles. For instance, learners who want learn about driving, could use the GPT for planning the learning activities related to it (see [5] for further description of the scenario).

In order to evaluate the GPT 1.0, we carried out a user study [5] for analysing the understanding of the tool purpose, the suitability of the graphic elements shown in the interface, and the changes or additions that would improve the usability and functionality of the tool. The findings resulting from the user study were generally positive (participants found quite easy the use of the tool, they found that the tool facilitates the planning task, etc), despite some problems that learners had (using the scrollbar for seeing all the information, not being able to delete activities, difficulties for discerning the activities related to a competence, etc). The contribution of this paper represents a step forward for better satisfying the learners' needs in the creation of PDPs. Next section describes the functionality and visual approaches of the GPT 2.0 pointing out the changes accomplished (in GPT 1.0) as the result of the user study.

2. Enhanced Graphical Planning Tool

Table 1 summarizes the solutions for improving the tool's usability according to the most important findings of the user study presented in [5].

Table 1. Changes to enhance the approach

Problem in GPT 1.0	Solution in GPT 2.0	Label
Using of the scrollbar for seeing all the information of the interface.	Visualizing all the information in one page by resizing the tool according the browser's window.	[sol1]
Difficulties for discerning the activities related to a competence.	Doing a click on a competence, the activities related to it keep highlighted with the same color.	[sol2]
Bubbles come back at the original place every time the learner drops them.	Enabling to move away the bubbles without having to come back at the original place.	[sol3]
Difficulties for closing the tool-tip's (by doing a click on the related activity).	Adding a cross button to each tooltip for closing it.	[sol4]
Difficulties for understanding the "long-mid-short term" areas.	Adding a calendar for having and overview of the planned activities.	[sol5]
The unwished activities cannot be deleted.	Including a garbage bin for dropping the unwished activities.	[sol6]

The interface, organized in four areas, shows all the information in one screen, avoiding the use of the scrollbar [sol1]. At the top, there is the list containing the competences related to a competence profile. Depending on the topic area, each competence has a different colour (see Figure 1a), and doing a click on a

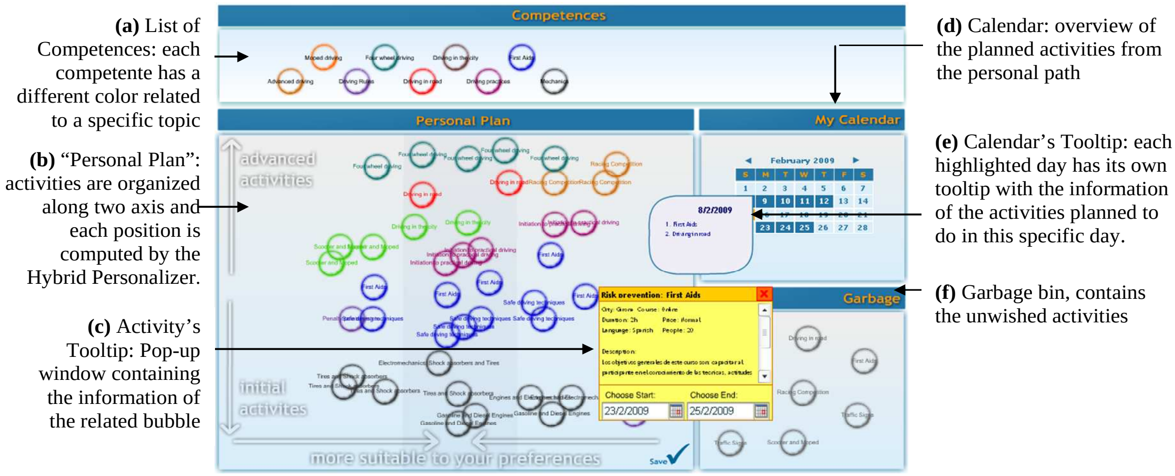

Figure 1. Screenshot of the enhanced tool for the graphical creation of PDPs

competence, the activities related to it change into the same colour of the competence (see Figure 1) [sol2]. The learning activities situated in the main area of the interface (Figure 1b), contains the personal plan computed using a service developed within the TENCompetence project called the Hybrid Personalizer [5]. It suggests to the learner a possible path which can be followed in order to acquire a specific competence profile. The path is organized among a vertical axis based on the activities' relations, and a horizontal axis which takes into account the learner's preferences. This main area (Figure 1b) can be used for exploring the suggested learning activities by dragging and dropping each bubble wherever the learner wants [sol3]. Each bubble has associated a "tooltip" (a small window that pops-up when a user clicks on the bubble, see Figure 1c) where learners can find a description of the learning activity, and specify both the start and end dates when they have planned to do the specific activity. For closing each tooltip, the learner should click on the red-cross [sol4].

A calendar, located at the top-right area (see Figure 1d), contains an overview of the planned activities [sol5]. Doing a click on a dark-blue colour day, a tooltip shows the information of the planned activities for that day (see Figure 1e). Besides, at bottom-right area, there is a garbage bin (see Figure 1f) which contains the learner's unwished bubbles [sol6].

3. Conclusion

This paper has presented the modifications performed in a preliminary approach for visually supporting learners in the creation of personal learning plans. These modifications are based on the findings from a user study carried out for evaluating this tool, and seek for improving its usability and fitting better the learners' needs. The integration of this graphical approach in the TENCompetence infrastructure will provide us interesting opportunities to evaluate the tool in authentic lifelong learning scenarios for competence development.

Acknowledgments

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Coordinating Curriculum Implementation Using Wiki-supported Graph Visualization

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Abstract

Traditionally, curriculum specifications tend to be formal, static documents, not encouraging adaptation and evolution. In order to facilitate various activities in implementing a curriculum, such as coordinating content, meta-cognitive competences, student-centered learning outcomes, this work proposes to employ a structured, Wiki-supported space. Our experience with this approach showed an improved transparency and coordination of courses based on a structured overview, a multi-faceted specification and increased sharing among teaching staff.

1. Active Curriculum of Computer Science

The Active Curriculum of Computer Science (ActiveCC) is a strategic project of the Faculty of Computer Science at the University of Vienna. The main goal of the project is to facilitate transparency, coordination and sharing of knowledge among teaching staff in order to implement a well-coordinated and coherent new computer science bachelor curriculum. The visualization and multi-faceted specification of the curriculum as described in this work is one special "ingredient" of the ActiveCC project.

2. Visualization of the Curriculum

According to the structural specifications stated in the formal curriculum document we organized the curriculum's Wiki offered on the CEWebS (Cooperative Environment Web Services) platform [1] in three layers: the curriculum, module and course layer. The curriculum layer includes a graph visualization of the structure of the curriculum (as illustrated in Figure 1) as well as general information like the curriculum goals, qualification profile of graduates, academic degree of graduates, etc.

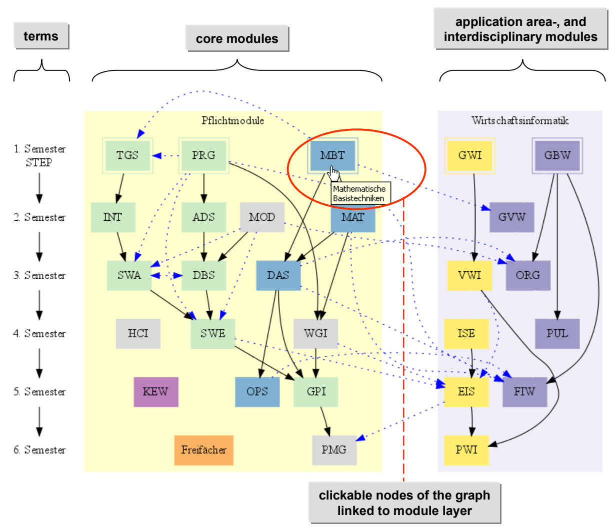

Figure 1: Visualization of curriculum structure

The graph shown in Figure 1 illustrates the modules of the curriculum and their dependencies. The organization of the graph relates to the suggested chronological order of the study. The position of a module within the graph complies with the semester in which its courses take place. For example, the courses of the module "MBT" (Basic Techniques in Mathematics) – which is positioned in the first row of the graph - are held in winter term and are suggested to be attended in the first semester by the students. The color scheme communicates the affiliation of the module to a particular module group. For example, green modules are members of the information technology module group, blue modules are considered as structural science modules, interdisciplinary modules are labeled in yellow, and violet modules represent application area modules. The arrows among the modules are dependencies that are subdivided into those stated in the formal curriculum document (black arrows) and those related to the modules/courses content (blue dotted arrows). The content related dependencies were identified by teaching staff during interviews. A more detailed description of the content-related dependencies is given on the module layer (illustrated in Figure 2).

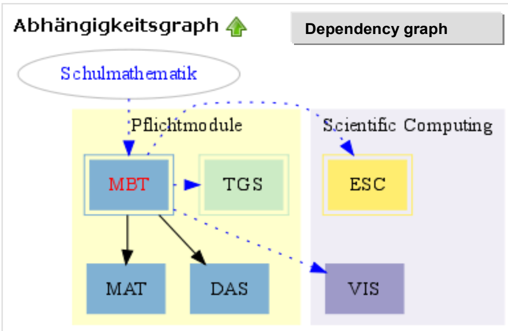

Figure 2: A module's dependency graph

The module layer contains module descriptions that are based on a description template. Items of the template are for example the module title, module coordinator, subject-specific and generic learning goals, content, methods, assessment mode and links to the module's courses. Further items are a dependency graph which illustrates direct dependencies of the module with other modules (Figure 2) as well as a description of dependencies in terms of prerequisites and dependent modules. The content-related prerequisites are described by a list of content items of other modules that are based on the educator's perceived necessity to be taught before, or in some cases simultaneously, to the course(s) of the module.

At the course layer, courses of the modules are described in Wiki pages by means of a description template that includes the items course's title, type, credits, content, methods, assessment mode and literature. Methods of the course are textually explained and visualized by coUML activity diagram graphs [2]; see an example in Figure 3.

3. Participatory Curriculum Design

In interviews that referred to curriculum, module and course issues we asked our teaching staff (N=55, n=32) to describe their perception of ActiveCC's usefulness. Results of the content analysis show that educators see benefits in:

- The visualization of the curriculum as a graph as it gives an overview of the curriculums structure and shows the position of the module within the curriculum. The illustration of dependencies among modules helps educators to get an overview of the links between their module and other modules of the curriculum. Thus, the role of the module in the curriculum becomes more transparent.
- The transparency of other modules' and courses' content as this information helps them to plan their own courses, to coordinate content with other modules in order to avoid unintended content redundancies or the absence of important topics. On the basis of the module and course descriptions content-related dependencies could be easily identified by the educators.

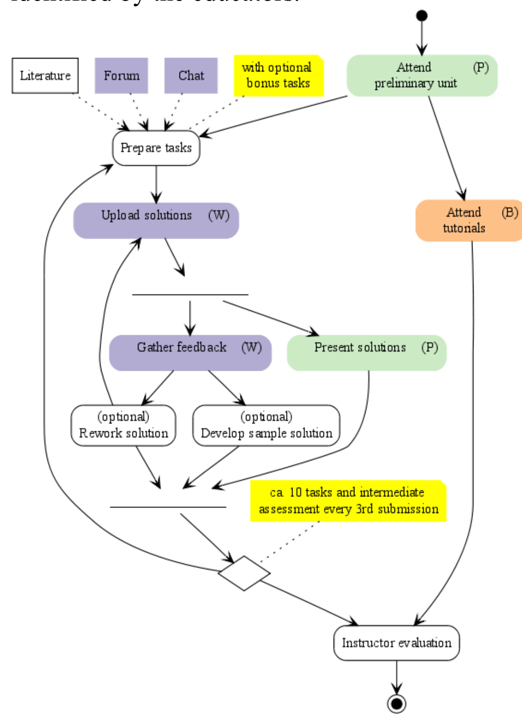

Figure 3: A course's activity diagram graph

By showing our teaching staff the curriculum visualizations and module and course descriptions many content-related dependencies as well as a course that did not fit with its position in the curriculum could be identified. Additionally, coordination and exchange among teaching staff was initiated and facilitated.

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A Domain−Specific Modeling approach for supporting the development of Visual Instructional Design Languages and tools

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Abstract

In this paper we present, discuss and illustrate our Domain-Specific Modeling orientation for helping communities of instructional designers to specify Visual Instructional Design Languages and to develop dedicated user-friendly graphical editors.

1. Context

Since the CPM language proposition [1], a visual language for defining and specifying Problem-Based Learning situations that has been tooled thanks to a dedicated *Unified Modeling Language* profile and a customization of the Objecteering CASE-tool, we have followed as a red-line a *Model-Driven Engineering* (MDE) approach for dealing with *Visual Instructional Design Languages* (VIDL) [2] and user-friendly graphical editors [3]. Finally our past experiences about graphical representations of learning scenarios and scenario transformations between different *Educational Modeling Languages* (EML) [4], lead us to the more focused *Domain-Specific Modeling* (DSM) orientation [5].

The DSM [6] is a software engineering methodology for designing and developing systems that involves the systematic use of graphic DSM-Languages to represent the various facets of a system. Several technical approaches and tools coexist, all proposing metamodeling techniques for expressing domain-specific vocabularies (abstract syntaxes), and proposing facilities to construct various notations (concrete syntaxes). These tools generate powerful and user-friendly dedicated editors for DSM languages.

2. DSM approach of VIDL

We proposed in [5] three categories for learning scenarios and languages from a separation of concerns reflecting different communities of practices.

Practitioners-centered VIDLs/Scenarios: the vocabulary is the one shared by a pluridisciplinary design team. They aim at easing the definition of learning scenarios, acting as a design guide and a support of thinking.

Abstract VIDLs/Scenarios: the vocabulary aims to be independent from any Learning Management System (LMS) and to be at a sufficient level of abstraction in order to support the pedagogical diversity while promoting exchange and interoperability of scenarios.

LMS-centered VIDLs/Scenarios: the vocabulary is specific to a dedicated LMS or other Technology Enhanced Learning (TEL) systems in order to act as a guide for the manual configuration of the technical systems by humans as well as for automatic configuration by machines when possible.

These categories share fuzzy frontiers between each other. We do not think instructional design processes handling learning scenarios must systematically follow all these categories. We do not propose a systematic way to transform scenarios from one to another. On the contrary we think that designers must be free to decide which EML/VIDL is useful according to their objectives and target public (human or machine interpretation). In our mind we would like to help the emergence of communities of practices about VIDLs. We think that it is more important to provide instructional designers with techniques and tools for helping them in elaborating VIDLs and dedicated tools than proposing yet another specific VIDL or editor.

Within a DSM approach, such VIDLs have to provide productive models (not contemplative) that will rely on a double-notation (graphical/textual) in order to be both human-readable and machine-interpretable (no ambiguous semantics) to guide specific executions (simulations, predictions, etc.).

We encourage the explicitation of vocabularies via meta-modeling techniques because metamodels are productive artefacts that can be both used by machine to generate editors, realize scenarios transformations between VIDLs, etc., and by humans to compare the pedagogical expressiveness helping so the reuse, integration and transformation of scenarios/VIDLs.

The key-point of this DSM approach concerns the transformation from one type of scenario to another, to gain the objectives of the targeted category, when changed, or to exchange and reuse scenarios with other communities of practices that do not share the same learning domain, or to adapt to a different target public by changing the format of the learning scenarios.

3. Experiencing Eclipse DSM tools

Our proposition needs concrete DSM tools and techniques: tools for defining domain-oriented VIDL, tools/techniques for transforming learning scenarios. We chose to use a unified set of modeling frameworks, tooling, and standard implementations from the *Eclipse Modeling Projects*: EMF (main metamodel-oriented framework), GMF (graphical framework) and ATL (model-to-model transformation framework).

These tools have been experimented within several projects of different scopes for two of the three categories: a VIDL and an editor specific to a TEL system (the *LEA* system) have been proposed as well as practitioners-centered VIDLs and editors.

We illustrate in figure 1 the use of these tools for a very basic VIDL/editor about a UML UseCase-like learning modeling for the specification of performing relations between roles and learning activities at a high-level of abstraction, and precedence/following relations between learning activities in a learning phase. According to the EMF/GMF engineering process, we have successively designed the domain model (metamodel on left of figure 1), the graphical definition model, the tooling definition model, and the mapping definition model. After a code generation step, a specific editor is generated. Scenarios realized with this editor are both human-readable (right of figure 1) and concretely serialized in a machine-interpretable format (XMI).

4. Issues

Although the DSM Eclipse tools have been successfully used to guide and generate 100% of final graphical editors, such tools still require a certain amount of technical skill. Also, the metamodeling technique require some experience. Indeed, specifying a metamodel is not a trivial activity. We still have to study the limits of expressiveness of this technique.

More complex user-friendly learning editors (with for example multiple views – structural at different levels, pedagogical, social, etc. – for a same learning situation) can be built on top of editors generated by DSM tools but software engineers will have to develop expertise of such frameworks. Finally, learning scenarios transformations have to be experimented in order to bridge the gap between VIDLs communities of practices built thanks to this DSM approach.

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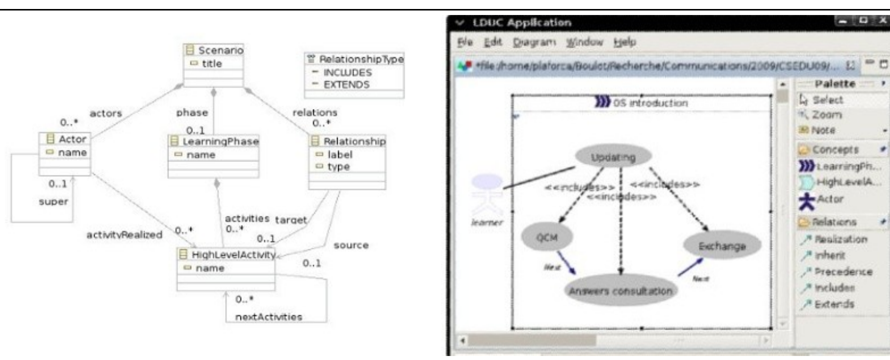

Figure 1. example of graphical learning scenario (right) specified thanks to a dedicated editor 100% generated by Eclipse DSM tools from a specific metamodel (left).

Towards a Visual Language that Captures the Learning Experience on the Go

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Abstract

From autonomous learning perspective, learning objectives are goals, learning activities are opportunities and evaluation tests are reflection instruments. The learning design is a rough chart of a learning path, which is meant to change on the go. In this context a visual language is a promising mediator between the conforming and accurate knowledge of the domain and the experience of the domain by the learner. Such a mediator is needed in real-time for the awareness of the exploitation versus the exploration of the domain and in a holist sense to serve as extrasomatic memory during and after the learning episode. This short paper describes "spatiotemporal aspect orientation" as a visual mediator. Aspects of the domain are captured in a contract and domain space is covered with activities. The flow of experience in time is oriented towards adaptation. The goal is to draw a living picture of the episode.

1. Introduction

Learning is an evolutionary process and vice versa. This year, the annual AAAS (the association which publishes the journal *Science* that reaches 10 million individuals) meeting held on 15th Feb. in Chicago, USA, was to highlight the 200th anniversary of Charles Darwin's birth. It comes as no surprise that a symposium called "*Inquiry or Direct? Research-Based Practices in Science Education"* was organized in this meeting, where Dr. William Cobern from Western Michigan Uni. reported (based on several years of research on middle school science education) that, inquiry based instruction yields only marginal improvement in understanding science content compared to direct instruction, given the instruction is good either way! Why can the learners not understand better, though they were more involved in the learning process? The thesis in this paper is that "a visual language can mediate between the conforming and accurate knowledge of the domain and the experience of the domain by the learner so that the learning episode would be more effective and satisfactory." S*patiotemporal Aspect Orientation* (SAO), as described below, is proposed to be such a mediator.

2. Representing an Evolutionary Process

In an experiment committed at the Wellcome Trust Centre for Neuroimaging at University College London, brain activities were captured using fMRI scans while participants chose unfamiliar options with the hope of higher reward [1]. The activity was found mainly at a primitive area of the brain called ventral striatum, suggesting that the process can be advantageous and shared by many animals. In fact this area closely relates to dopamine release control which is the neurotransmitter that causes the feeling of arousal and exaltation. Moreover it is the same arousal mechanism that drives "selective attention" signifying that it is critical to brain-environment interplay.

Promising higher awards, *exploration* is arousing. On the other hand, attractive for sure gains, *exploitation* is intuitive and computational.

The choice of exploration vs exploitation involves the prefrontal cortex [2] which holds our self-within-world (identity) model. It is the part that differentiates ours from the brains of the closest species.

Findings through exploration become exploitables (adaptation) by means of two cognitive mechanisms: *assimilation* (simplifying new but somewhat familiar observations to fit in existing schemata) and *accommodation* (disruptive change in schemata) [3].

In representing the *spatial* (among options) and *temporal* (in flow) change in evolution (development), not only explorative and exploitative actions, but also the adaptation should be visually described.

3. Entitlement in an Evolutionary Process

Arguably the only difference between learning and evolution could be the teleological (purpose seeking) nature of learning. However, focusing on goals (or objectives) in representing a learning episode may easily miss the critical events (reflection opportunities) during the process. Therefore, it is preferable to focus on *entitlement*. Signified with a *contract* that would be *endorsed* by the tutor, goal striving comes as an urge with the feeling of entitlement [4]. Such contracts also help built the trust relation between the learner and the tutor, strengthening the belief that effort will yield the contracted reward.

Entitlement fuels pragmatic, practical intelligence which governs the self-regulation of learning. Contrary to analytical or consolidating intelligence needed for assimilation and accommodation, practical intelligence is effortless and volitional.

4. Spatiotemporal Aspect Orientation

Although there are visual languages such as the Petri-Net based notation STRPN [5] for depicting (modeling) *spatiotemporal* flow in multimedia programming, they are not designed to represent evolutionary developmental processes. Besides, a visual language should provide more cognitive affordance than its translation into a propositional representation [6]. In our case, this affordance is for effective and satisfactory learning. Based on the previous discussion this is possible by i) the entitlement felt through contracts that outline the aspects and separate the concerns [7] ii) the awareness of acts of exploration and acts of exploitation oriented towards fulfilling the contract iii) the adaptation flow (turning explorations into exploitables). In Figure 1, *spatial* (among content options) and *temporal* (in flow) development during a learning episode is visually represented in a way that delineates these items.

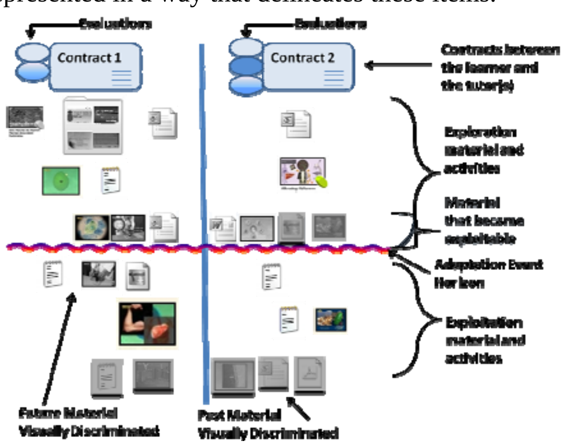

Figure 1. An instance in a study episode, expressed with a draft visual language, depicting the SAO

Notice that the visual design in Figure 1 is expressive rather than representative. The expression asserts that towards fulfilling a particular contract of an aspect, certain explorative activities brought rewards (assimilated or accommodated realization) and hence they themselves or similar activities can be exploitables in the future. At any instant during the episode, such causal expressions (assuming they are true) should increase the cognitive affordance, because they nudge towards future exploitations which would potentially bring higher rewards. To evaluate the increase in affordance, Cognitive Dimensions of Notations framework is regarded suitable [8].

5. Conclusion

Proper visualisation of the learning process through a study episode can capture what makes a particular episode satisfactory and effective. This serves not only as an extrasomatic memory for the learner, but also enables the dissemination of good instructional practice. The future work on SAO informs dashboard or advance organizer designs for online learning, promoting visceral behavior towards more rewarding learning choices.

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