

GRAPPLE: Executive Summary



The Generic Responsive Adaptive Personalized Learning Environment (GRAPPLE) project aims at delivering to learners a technology-enhanced learning environment that guides them through a life-long learning experience, automatically adapting to personal preferences, prior knowledge, skills and competences, learning goals and the personal or social context in which the learning takes place. The same environment can be used/accessed at home, in school, at work or on the move (using mobile/handheld devices).

To achieve this goal GRAPPLE has created an infrastructure that combines Learning Management Systems (LMS), typically used by institutes and companies to “manage” the learning process, an Adaptive Learning Environment (GALE) that supports the learning itself, and a User Modelling Framework (GUMF) that collects information about the learners from all possible sources and thereby helps the personalization offered by GALE. The adaptation is defined by course authors by means of a graphical authoring tool (GAT).

To show the generic nature of the GRAPPLE approach the project has:

- defined and implemented the connection of five different LMS to the GRAPPLE infrastructure: CLIX and learneXact which are proprietary system from resp. IMC (Saarbrücken, Germany) and eXact Learning Solutions (Sestri Levante, Italy), and three open source LMS: Moodle, Sakai and Claroline; for all of them a single sign-on facility was created based on Shibboleth;
- defined and implemented a generic Even Bus (GEB) that enables the communication between GRAPPLE components through Web Services;
- used the authoring tool GAT and adaptation engine GALE to create and use numerous different example courses, including an on-line adaptive tutorial on all of the GRAPPLE technology;
- used GUMF to generate learner profiles based on the use of GRAPPLE components as well as public profiles on popular social networks;
- explored extensions of the infrastructure to provide visualization of learning progress and to offer adaptation in virtual reality and simulations.

GRAPPLE has organized numerous training events in academic and industrial settings, to introduce *adaptive learning* to authors of learning material and to familiarize authors with the GRAPPLE environment and tools. Apart from validation through actual use of GRAPPLE numerous publications have passed the scientific peer-review process of conferences and journals. This also served as dissemination, to make the academic research community fully aware of the GRAPPLE project and its potential as a basis for further research. The success of GRAPPLE comes not only from the use of its infrastructure as a whole but also by the uptake of different GRAPPLE components: adaptive courses that are based solely on GAT and GALE, new projects that are using GUMF for modelling users in other environments and LMS extensions that allow an LMS to communicate with external sources of learning material and user information. Experience with GRAPPLE has also resulted in better insight into the needs of educators (teachers) which will guide future research into authoring of adaptation and into improving support for different teaching/learning styles.

GRAPPLE: Publishable description



GRAPPLE: Bringing Adaptive Learning to Learning Management Systems

GRAPPLE¹ is an EU FP7 STREP project that ran from February 1, 2008 to January 31, 2011. Twelve academic² and three industrial³ partners collaborated to develop a generic adaptive learning environment (GALE) and integrate it with (five) different learning management systems (LMS) in order to enable adaptive life-long learning for learners in higher education and industry.

The current situation in Technology-Enhanced Learning is that LMSs are quite common in both higher education and industry as they facilitate the learning *process*, and especially the *management* of that process, including enrolment in courses, delivery of learning resources, submission (and grading) of assignment work, on-line tests and exams, etc. Adaptive Learning Environments have been researched and developed for over fifteen years but are not so popular, which we attribute to them supporting mostly the *learning*, with so far unclear benefits for the institutes or companies. GRAPPLE tries to stimulate the uptake of adaptive learning by integrating it into the LMS, thereby making it more readily available to everyone who uses an LMS.

In order to support life-long learning a direct integration of the ALE and LMS is not the right solution: people move between institutes, graduate and start working in industry where they undergo in-company training, and they may also engage in learning activities in their personal life. As adaptation requires that the system gets to know the learner as well as possible, the learner's "profile" should not be confined to a single LMS but move along with the learner. GRAPPLE therefore designed and built an architecture (shown in Figure 1) that consists of:

- LMS for managing the learning process, progress and support;
- GALE for the adaptive delivery of learning material;
- GUMF, a generic User Model Framework that maintains information about each learner as (s)he uses different LMS and GALE instances;
- a single sign-on facility (based on Shibboleth⁴) that ensures that all GRAPPLE components recognize the learner through a single identity.

¹ GRAPPLE stands for "Generic Responsive Adaptive Personalized Learning Environment".

² Eindhoven University of Technology, Open University Netherlands, University of Hannover (L3S Research), Free University Brussels, University of Warwick, University of Lugano, University of Graz, German Research lab on Artificial Intelligence (DFKI), Trinity College Dublin, Catholic University of Louvain, University of Cambridge and Delft University of Technology.

³ eXact Learning Solutions, Information Multimedia Communication (IMC) and ATOS Spain.

⁴ See <http://shibboleth.internet2.edu/>.

- GEB, a generic Event Bus that facilitates asynchronous information exchange between all GRAPPLE components.

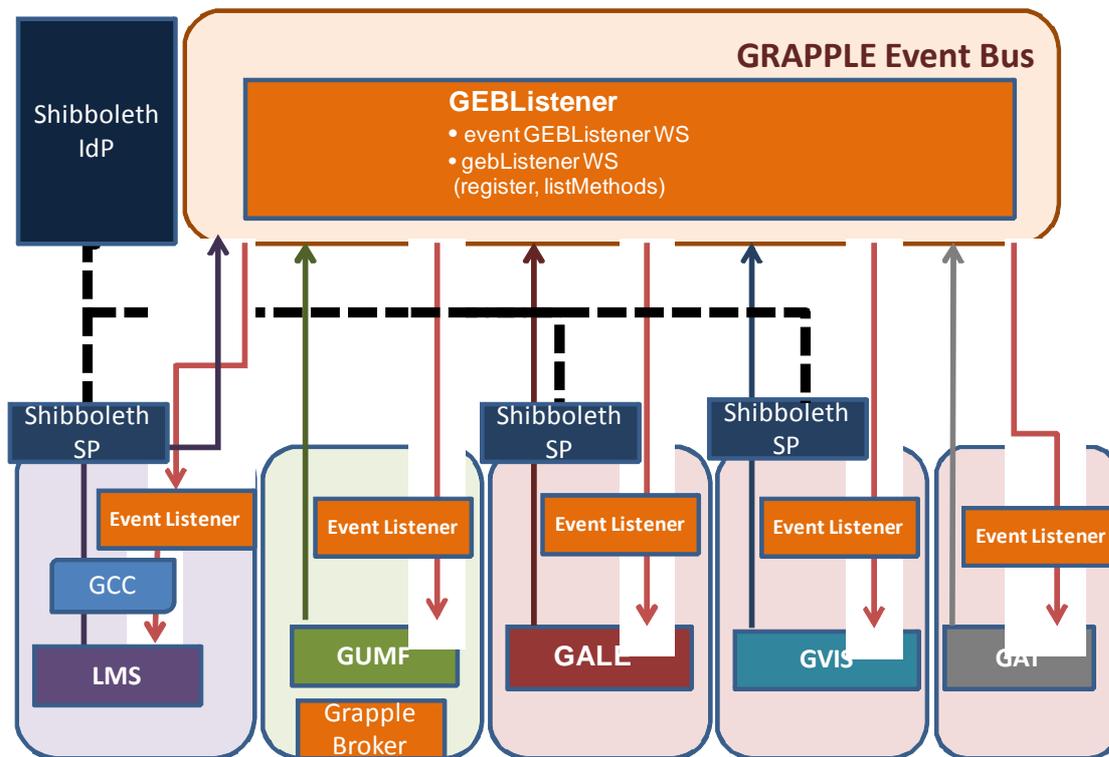


Figure 1: The GRAPPLE Architecture

The development and use of open source and open definition of interfaces and data formats ensures that GRAPPLE can easily be integrated with LMS that have not been used by the project.

The generic nature of the infrastructure has been exemplified by developing some extensions: visualization tools that help learners and teachers to get overviews of their learning progress (or that of their students), adaptation to courses that employ Virtual Reality and adaptation in learning through Simulations.

The basic learning paradigm that GRAPPLE supports and advocates is *learning through adaptive information exploration*. To this end it uses learning material in *adaptive hypermedia* form. In hypermedia, best known through its presence on the World Wide Web, the learner can explore learning material by following links between pages. Apart from pure “information pages” a page may also contain interactive elements that ask the learner to perform an exercise or task or may contain a (multiple-choice) test. The *exploration* is stimulated by offering a rich (dense) link structure. The abundance of choice may make it difficult for learners to construct their own sensible learning path through the learning material. This is where the *adaptation* comes in: GALE offers *guidance* by means of *link annotation* (showing whether a page is recommended or not), *navigation menus* or *guided tours*⁵. The guidance is based on *pedagogical relationships* such as *prerequisites*.

⁵ GALE offers many more possibilities for adaptation as it is a highly flexible and extensible adaptation engine.

In order to enable authors (teachers) to create the conceptual and pedagogical structures used in GRAPPLE applications an authoring tool set GAT (GRAPPLE Authoring Tool) was developed. When defining a course a structure of *concepts* and *concept relationships* is designed. An author can define arbitrarily named relationships between pairs of concepts, either generic relationships such as *parent* (to define a hierarchy), *is-a* or *has-a*, or course-specific relationships such as for instance *rotates-around* in a course about celestial objects such as stars, planets and moons. During a number of workshops on the use of prerequisites it was observed that authors felt the need to define pedagogical relationships between *sets* of concepts rather than single concepts. Studying a specific planet (like “Jupiter”) may be a prerequisite for studying all of its moons. In response to this authoring need a *Course Tool* was developed that allows sets of concepts in pedagogical relationships that typically have one or two sets but that can in fact have arbitrarily many sets. Another observation from these workshops (that only used pens and paper) was that some teachers had problems to understand and use the *learning through adaptive information exploration* paradigm. They were looking for ways to define sequences or workflows, which cannot be expressed through prerequisites alone.

Within the GRAPPLE project a number of training sessions were organized during which authors (teachers) were instructed on how to create learning material for GRAPPLE, following the information exploration approach, thereby using *prerequisites* as the main means of offering *guidance* to the learner. The training included instruction on how to use the GAT tool, and some instances of the training sessions used a GRAPPLE tutorial that is served through GALE, as adaptive hypermedia based on prerequisites. Interestingly, whereas trainees reported few issues or discomfort while using the GALE-based GRAPPLE tutorial for learning about GRAPPLE’s technology and approach to learning they found it difficult and uncomfortable to define their own structure of prerequisites and enter this into the system through the GAT tool.

As part of the research on extending GRAPPLE with learning through simulations an alternative approach was used, using a (not so different) authoring tool in which the workflow can be defined explicitly. Authors found this way of authoring relatively easy and comfortable. This experiment tells us that more research and also education will be needed in the future to help authors in becoming comfortable with the main GRAPPLE way of learning (through information exploration). Learners seem to be ready for this new approach to learning but authors/teachers apparently are not (yet).

GRAPPLE has not only opened up a new way of learning and support for life-long learning by separating the user (learner) model from the LMS, but it also raised new research questions for future projects: Which way of use of this generic technology “guarantees” improvements in learning outcome? How can learning be improved by using learner information obtained in one course in another (follow-up) course? How can the use of an adaptive course be fed back into the authoring process to improve future versions of a course?

Because of the modular approach to GRAPPLE the technology need not be adopted in its entirety by institutes and companies, but individual components can, and in fact are already being taken up by institutes not part of the consortium.