Culturally-based Adaptive Learning and Concept Analytics to Guide Educational Website Content Integration

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Abstract

In modern learning environments, the lecturer or educational designer is confronted with the multi-nationality of the students, which requires special considerations. That is, taking cultural aspects into account, having dynamic adaptation of the content to the current context, using adaptive learning paths, and integration of dynamical content analysis before delivery. We discuss the motivation for such adaptive systems via two scenarios and illustrate afterwards our design for a system to present learning content based on dynamically determined learning paths consistent with learner-profiles. This permits multi-cultural learning scenarios to be offered while respecting the cultural norms and ethics of learners without the need for special segregation of learners or learning content.

Keywords: cross-cultural education, adaptive learning paths, concept analysis, dynamic content selection.

Introduction

Many lecturers assume a homogenous group of participating students since, in general, everyone receives the same learning material. This tendency seems to be independent of whether the education is classroom or virtual learning environment based. Unfortunately, this homogeneity is rarely given in our flat world [Friedman, 2006] as students from all over the entire globe can enroll in the same class or study program, resulting in a potpourri of expectations and demands for the learning experience based on their perception of their surrounding and background [Bhattacharya et al., 2004].

The term culture refers to the "set of distinctive spiritual, material, intellectual and emotional features of society or a social group" [UNESCO, 2002] and defines "codes of manners, dress, language, religion, rituals, norms of behaviour such as law and morality" [Jary, 1991]; also [Geertz, 1973] or [Groeschel et al., 2000]. This definition shows a clear barrier in designing learning material. In view of the codes, we have to state that regarding language it is not acceptable to either encode the learning material in all languages or for a student being forced to learn another language, i.e. in a virtual e-Learning environment where the students are enrolled from various countries. In addition, certain learning material might not be suitable with respect to the cultural background of the learner. Note that barriers could be compared to the movie rating system, where the society of viewers is divided in groups according to age and suitable content. A discussion on further barriers and constraints such as retrieval, format or quality is given in [Reiners et al.,

2005] [Schüppel, 1997]. There is a broad research in the field of cross cultural education [Collis, 1997][Parhizgar, 1998][Hampden-Turner et al., 2000], multicultural learning material and technological solutions [Fluck, 2008][Wang, 2007] and discussion of the role of educators with respect to teach multicultural classes [Sowden, 2007][Middleton et al., 1999]. "Multiculturalism is an issue that is central to educators" [Slay, 2002] and needs to be considered with the "core of school curricula" [Stanley et al., 1994]. Nevertheless, we see the focus of this paper not in the argumentation about cultural issues – even though this is of great interested to us and the motivation for our concept – but rather in demonstrating the architecture to achieve a better integration of the individual learner in a learning scenario, i.e. the learning material selection and delivery. Furthermore, we consider our concept only as one component in an overall learning environment, which requires further pedagogical and technical parts like communication, content design or teaching methodologies; see for example [Collis, 1999][McLoughlin, 2001][Rogers et a., 2007][Sims et al., 2007][Young, 2008].

In a classroom setting, individualization is generally very limited as students participate at the same time in the same classroom and therefore receive the same presentation with the same slides and the same audio. Most universities require that students know the language for the classes in advance as live translations are not (yet) possible to be integrated efficiently. A further difficulty can result from the content chosen for the lecture as certain subjects might not be compliant with the cultural background of the students. On the other hand, the e-Learning scenario allows individualization of the learning material by adaptation to a given configuration and dynamic information gathered during the learning process by traversing objects with given subjects and concepts.

We believe that culture is highly related to language and therefore needs to be modeled as part of the e-Learning system. For the classroom scenario, we are limited to one language for the presentation, whereas integrated components like machine translation would allow on-the-fly translation of objects into the used language; with the limitations that the translation might not be perfect or completely correct [Gaspari, 2006]. The same applies to the e-Learning scenario. Nevertheless, another aspect is of importance: currently only material in the language of the search terms is found; we need cross-language searches on meta-data and concepts, so that additional material is found and used by the learner after being (machine) translated. Here, concepts are "abstract ideas or mental symbols, typically associated with a corresponding representation in a language or symbology" [Wikipedia, 2007].

The suggested concept supports the lecturer by dynamic real-time choice of suitable learning material or examples to demonstrate the latest learned objects, based on the predefined and constantly updated learner user-profile. Moreover, the system analyses the content and prevents visualization of objects being inappropriate to be shown in the classroom or as part of the virtual course. Note that the system goes beyond the selection of alternative objects but adapting the learning path with respect to previously performed choices and visited objects. The concept shown by [Reiners et al., 2007] is used and extended to allow further properties to influence the learning path adaptivity and, therewith, guarantee a cultural sensitivity where no one has to be confronted with inappropriate images, sounds, or text components.

This paper continues with two examples of learning scenarios which demonstrate possible cultural conflicts. In Section III, we introduce our learning material design for the multi-lingual adaptive learning path and then describe the integration of concept analysis to improve cultural awareness in the next section. The paper concludes with remarks on the ongoing research and thoughts about how to integrate the system and methodology with respect to achieve a high acceptance rate.

Examples of Cultural Conflicts

From a pedagogical perspective, the understanding of the learning material is improved if theory is supported by descriptive examples. The following two scenarios demonstrate that the selection of these examples might be critical in the matter that the content can be offensive to certain (social) groups and result in a negative learning experience.

The first scenario is about marketing and the hypothesis that "sex sells". Fig. 1 shows four examples where the product's nature is non-sexual but advertised by using sexual associations – nudity and even nudity in combination with religion and reference to God. These advertisements might be acceptable in some countries and cultures (and we are not intending to spark a discussion about discrimination and the role of women as sex objects), yet others would either forbid or even punish the display of such pictures. In the U.S., sexual associations and the showing of unclothed people is in daily use, whereas (full) nudity in public is not accepted. In accordance with the religion or cultural background of certain countries, the inhibition threshold might be different and even stricter.

Figure 1: Examples of advertisements with potential conflicts for the students' culture, morality, and ethics. The images might be provocative but demonstrate the major issue of this publication. Those non-adaptive and non-individualized e-learning materials are not appropriate in a multicultural context and require an innovative approach for receiving the right material. Sources of the images are the websites of the companies, printed journals, and websites collecting specialized content and subjects, mainly in the marketing field.

Another scenario presents the risk of outsourcing production to countries that do not prevent child labor, or have adequate and safe working conditions, or disregard Intellectual Property Rights (IPR). This could result in a negative impact to the reputation or loss of a company advantage. In the educational lecture setting, scenarios might involve countries of participating students who may be offended by the accusation as their understanding of culture, morality and ethics is di-

verse in the interpretation of IPR and cultural norms. For example, "some Chinese companies ... prefer to adopt a 'shortcut' route by launching products based (legally or illegally) on other people's technology rather than investing in the development of their own" [Moynihan et al., 2004], while "taking a more aggressive approach in safeguarding their IPR" [Moynihan et al., 2004]; see also [Facey, 2007] and [Williams, 2007]. Documented cases of similarity in product design are often mentioned in the car industry, for example with using similar logos for car brands (Toyota vs. Geely Group [Bloomberg, 2003], BMW vs. BYO [Williams, 2007]) or car designs; see [Bradsher, 2007] and [N.N. 2007].

Both scenarios point out that the selection of learning material can be crucial for the learning outcome and requires support from the learning environment. For the classroom, the examples have to be chosen such that they are appropriate for the majority of students and prevent conflicts with other user groups. In the e-Learning system case, the configuration of the learner profiles allows the dynamic selection of content. That is, for each group the examples for advertisement or outsourcing risk can be selected such that the content is on the edge of being allowed or banned, and, therefore, is able to be used. For the second scenario, the examples could be selected from the perspective of the learner using their country, local culture and justice system. Note that we could also decide to apply the culture and understanding of morality and ethics of the lecturer, university or country where the course is offered. Enrolled students must adapt and accept potentially offending learning material as it is even visible to students during daily life, e.g. advertisements, clothing and behaviour of people, television and consumer goods like alcohol and pork products.

For the implementation, we use individual configurations with elements describing the level of allowed nudity or sexual references, and the focus of countries used for scenarios in the examples. Levels could be in the range of none (no nudity or sexual reference) to strong (full nudity and sexually oriented content). For a classroom course, we could set the level according either to the culture of the country – assuming that learners must adapt – or to the minimum level of the participating learners. Note that the first setting would allow a larger flexibility in selecting examples, especially in countries like Germany, where nudity is not generally banned. For the second setting, the selection of learning material is limited to matching examples or needs to be censored using, e.g., cover-patches for areas unsuitable for display.

Design of Learning Material

The learning material is encoded using hierarchically structured objects of different granularity as shown in Fig. 2. Objects are differentiated by their aggregation level in media objects, learning elements, content modules, and thematic meta-structures, whereas the objects themselves are combined by objects of the same or lower level. With respect to reusability, the encoding of the objects should be harmonized and given in as few formats as possible, i.e. concerning the automatic analysis and extraction of information [Reiners et al., 2007].
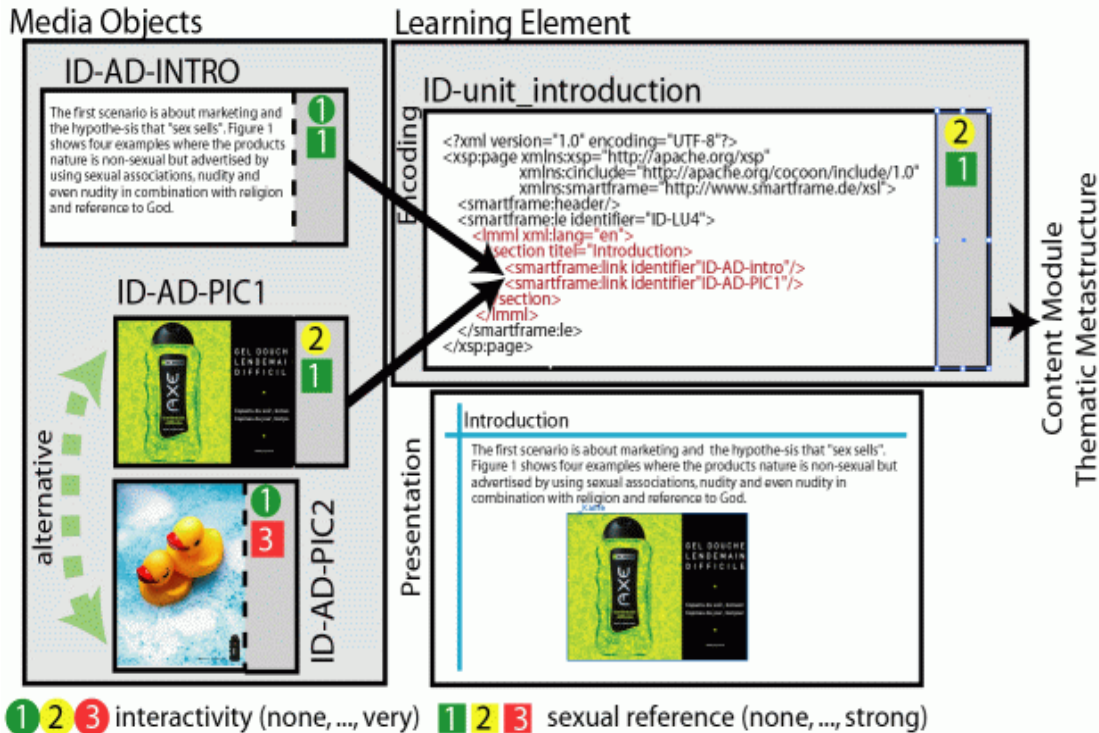
Figure 2: Object-based composition of learning material based on meta-data; based on [Reiners et al., 2007]

Connections describe the relation of objects. In Fig. 2, the objects ID-AD-PIC1 and ID-AD-PIC2 represent alternatives of the same content using, for example, a different media, formality or point of view. Here, we have two advertisements of the same product with different settings for the meta-data as one contains sexual references and is non-interactive while the other one is without sexual references and uses interactive elements to, for example, describe the product. The selection of objects is based on rules and the user configuration by either requiring a strict match or allowing for the best match.

Each object is described by meta-data using a standard like LOM (Learning Object Metadata), Dublin Core [Dublin Core Metadata Initiative, 2008] or MPEG-7 [Martinez, 2008] with the general understanding of meta-data being still the "authoritative, objective information consisting of facts that do not change" [Nilsson et al., 2002] describing the properties of the object, from a technical, formal, or educational perspective. This static view is seldom applicable as individuals cannot separate the content from its current context and personal background, configuration, and preferences. For example, [Alavi et al., 2002] uses connotative meta-data to keep "cultural codes that define the culture of a social group" and to prevent misinterpretation and erroneous usage of content objects. Despite the later on-the-fly verification, global and individual tag lists are used to represent the current understanding of its content and usage. For example, the user might assign individual tags like night, moon, scary, to an image, whereas another user would rather use the tag romantic instead of scary. The global tags are dynamically generated by an automatic analysis of the objects and the individual tags by, for example, concept analysis. They can be visualized for the user in so-called tag-clouds representing the importance of certain tags by increased size of the font or as keywords next to visualized objects for further references [Hassan-Montero et al., 2006].
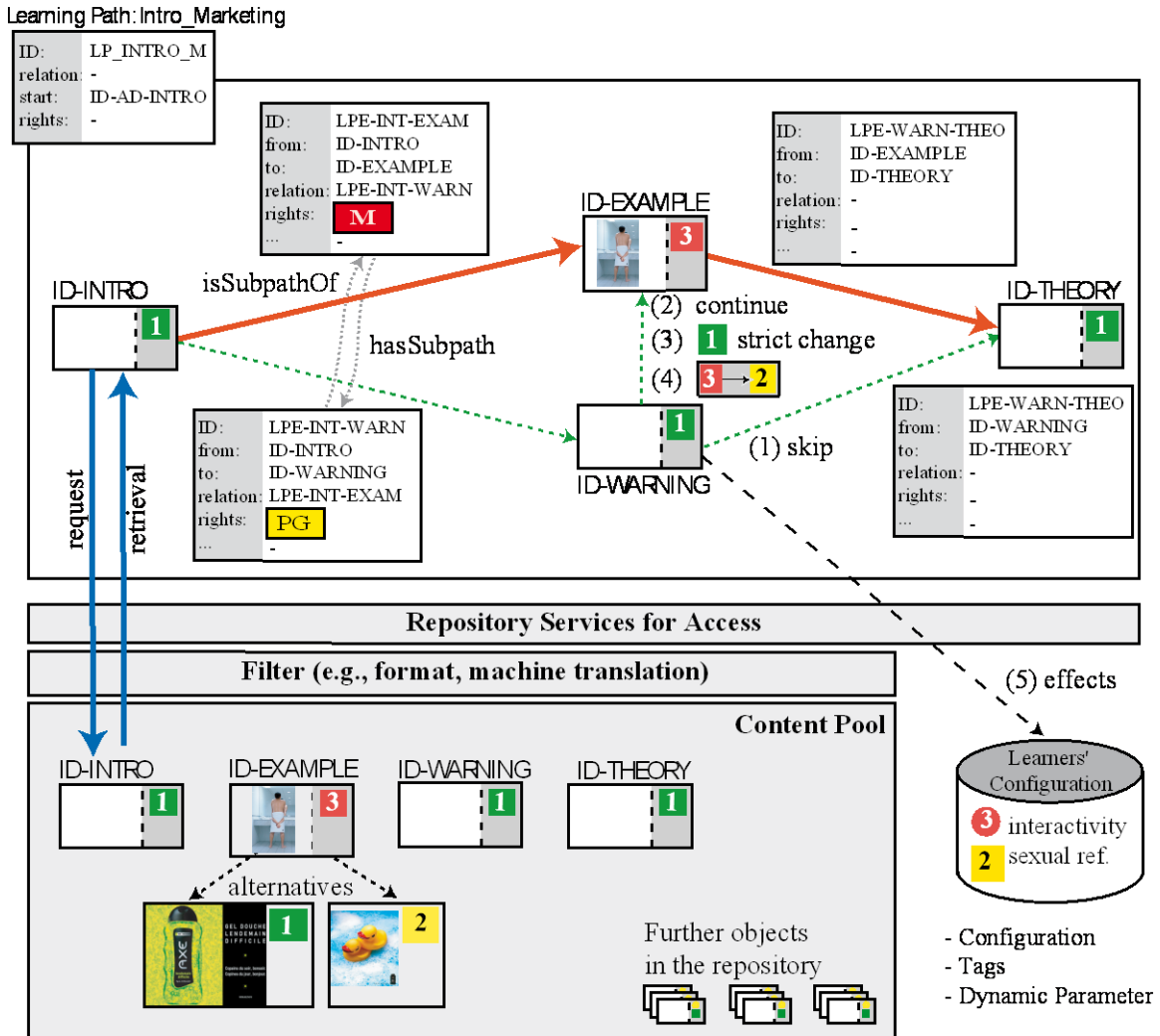
Figure 3: Example of an adaptive learning path; based on [Reiners et al., 2007]

Note, that concept analysis or machine translation can also be used to improve the quality of object retrieval as keywords can either be translated to find further content objects in other languages or be expanded using dynamically generated synonyms; see [Reiners et al., 2007] and [Dreher et al., 2006] for further details.

Adaptive Learning Paths

The assumption that the one-size-fits-all method for delivering the learning material in a static manner without any further content and pedagogical revision would only be valid if all individuals learn in the same way [Alavi et al., 2002]. Even though the concept of adaptation is discussed in literature, e.g., by [Conlan et al., 2002][Dreher et al., 2004][Berlanga, 2005][McAndrew, 2005][Sassen et al., 2005][Towle et a., 2005][Van Rosmalen et al., 2005], described with concepts [Reiners et al., 2007] [Reiners et al., 2003] and demonstrated in first prototypes [Nussbaumer et al., 2007], the methodology to overcome the static and linear learning paths is not yet found in mainstream courseware and virtual learning environments.

Fig. 3 describes an example for an adaptive learning path; see especially [Reiners et al., 2007] for a detailed description including further extension of the concept. Here, the first part of an e-learning course "Introduction to Marketing", consisting of four learning objects, is given. Starting

with a general object (with the identification term ID-INTRO) for introduction, the learning path continues with a first possible example for marketing campaigns (ID-EXAMPLE) and a basic theoretical description (ID-THEORY). Note that the concept allows several abstraction levels and therefore, each object might consist of further objects rather representing full learning units than small text blocks or images. The course as well as each object is annotated with meta-data describing the content and its properties with respect to educational purposes. Since the focus is set on the learning path and therefore on the relations (edges) between the objects, the only visualized meta-data element is the degree of sexual reference shown by a small colored square on the right side: 1 for non and 3 for strong sexual reference. For the edges the meta-data is reduced to the elements required to describe the scenario of two learners, one being offended by unexpected appearance of nudity or sexual references (G, general audience), while the other is not (M, mature). The meta-data element *rights* represents the minimum level that is required by the user in its configuration setting; G for none, PG for mild and M for strong sexual references. The learning path and edges are annotated with the following elements: unique identification (ID), first object on the learning path (start), rights, the relation to other paths or edges, respectively (relation) and in case of edges the source (from) and target (to) node.

Within the content pool, the objects are interconnected to represent existing relations. That is, the object ID-EXAMPLE with a sexual reference level of 3 is connected to objects representing the same content but using other examples with other levels. Whenever an object is selected for visualization – and adaptivity is allowed – the best match from the set of related objects is chosen. Note that the selection is based only one attribute in this example. In case of several attributes, the best match has to be chosen based on the combination of all differences.

The learning path shown in red – with the objects ID-INTRO, ID-EXAMPLE, ID-THEORY – is the main path defined by the author or lecturer, respectively. Due to the content of the object ID-EXAMPLE showing sexual references with a half naked person, the relation between ID-INTRO and ID-EXAMPLE requires a minimum right level M. Other users are not able to follow the intended learning path but are guided to a related path with a lower level of required rights, here edge LPE-INT-WARN from ID-INTRO to ID-WARNING containing a warning message as well as a question how to continue (allowing sexual references, presenting an alternative, or skipping to the next possible object on the learning path). Based on the answer and the configuration of the learner's profile, the following outcomes are possible; see Fig. 3 where the item numbers are also given:

1. The user prefers to skip the learning unit ID-EXAMPLE. This (explicit) decision by the learner would result in using edge LPE-WARN-THEO to the learning unit ID-THEORY.

2. Due to the warning, the user knows what to expect and continues with learning object ID-EXAMPLE without any substitution.

3. The user wants to see the example but only with content having no sexual references (here marked with a green rectangle with the number 1). For the next step, the system selects an alternative object for ID-EXAMPLE (which has to be written in advance and stored in the content pool) Note that this strict decision would not allow objects with a fixed or best matching distance like an object having only mild sexual references.

4. The user can set a transformation rule for meta-data elements such that a value "3 – strong sexual references" is only seen as "2 – mild sexual references" and therefore allowed to be shown. The transformation rule is also applied to other values affecting them in a proportional manner. The learning process continues with element ID-EXAMPLE.

5. The previous cases described temporary changes on the selection process. If the learner allows adaptation to its behavior, the answer – including the effects on his configuration –

would be stored in the user profile for later usage. Furthermore, the user can explicitly set the element sexual reference in the configuration too strong, and continue with the learning path seeing the examples.

In the example in Fig.3, the users' current configuration – shown in the lower right corner – would prevent the usage of the main learning path but follow the alternative path. In learning object ID-WARNING, the user might – depending on its rights to change the configuration values – choose one of the five possible options described above. Depending on the current mood, the user might decide to allow object with a higher level than usually and therefore would set a temporary transformation rule that would lower all meta-data elements for sexual reference by one level. The user would continue with ID-EXAMPLE on level 3 (strong sexual reference) matching the users' setting of 2 as a result of the transformation by one level.

We should point out, that the concept for the adaptive learning paths encompasses far more options than shown in the example above, where we had to limit ourselves by simplifying the number of meta-data elements and modeling techniques to focus on how cultural recognition can be realized in different ways. Especially the substitution of objects – based on the previous behavior of the learner – and modification of the content pool like new objects, new relations or changed meta-data elements are not demonstrated in this contribution and can be read in [Reiners et al., 2007].

Important in this scenario is that the modification of meta-data and configuration elements can be limited for some learners on a specific learning path. Otherwise a young learner could override mechanisms to prevent him from seeing material not being appropriate. Furthermore, we distinguish between an adaptation based on the learners' decision (direct or explicit) and behavior without explicitly involving the user (indirect or implicit).

Improving Adaptivity Using Concepts

The previous section described how the adaptation of the content can be realized using static meta-data elements. This approach has two major drawbacks: (1) the high quantity of required predefined alternatives for each object on the learning path to allow individualization as well as consideration of culture within the selected learning material and (2) the necessity of adequate meta-data, tags, and relations to other objects. In addition, it is impossible for the course designer or lecturer to cover all possible scenarios in advance, especially if the system allows reusability of all objects and dynamic composition based on the learning behaviour and configuration of the learner profile. Even though the author is able to define static meta-data for the general or intended usage of the learning object, we need to specify the dynamic view within other contexts or by individuals with different backgrounds. One possible approach is the annotation of objects with tags by users in addition to the meta-data elements, whereas the quality, accuracy, and correctness for matching requests might be decreased or blurred. Especially without control mechanisms, authors can add or leave out certain keywords or meta-data elements to pass given barriers and bring objects of inappropriate content into the learning material.

We suggest a dynamic conceptual analysis to define alternatives for objects and, in particular, preventing the presentation to the wrong audience. Fig. 4 shows the object ID-EXAMPLE on the main learning path, which is about displaying an advertisement containing sexual references tagged with the concepts attractive, advertisement and nudity, whereas the first two are also marked as mandatory. For the course designer and the lecturer, the mandatory concepts are important to guarantee that the relevant subjects are contained in the learning material. The meta-data of the learner specify the level 2 regarding the allowed sexual references. Furthermore, the concept set *culture1* – not allowing nudity – as well as the concepts *attractive* and *sexuality* are assigned to the learner. The concept sets are stored in a database and represent cultures or other
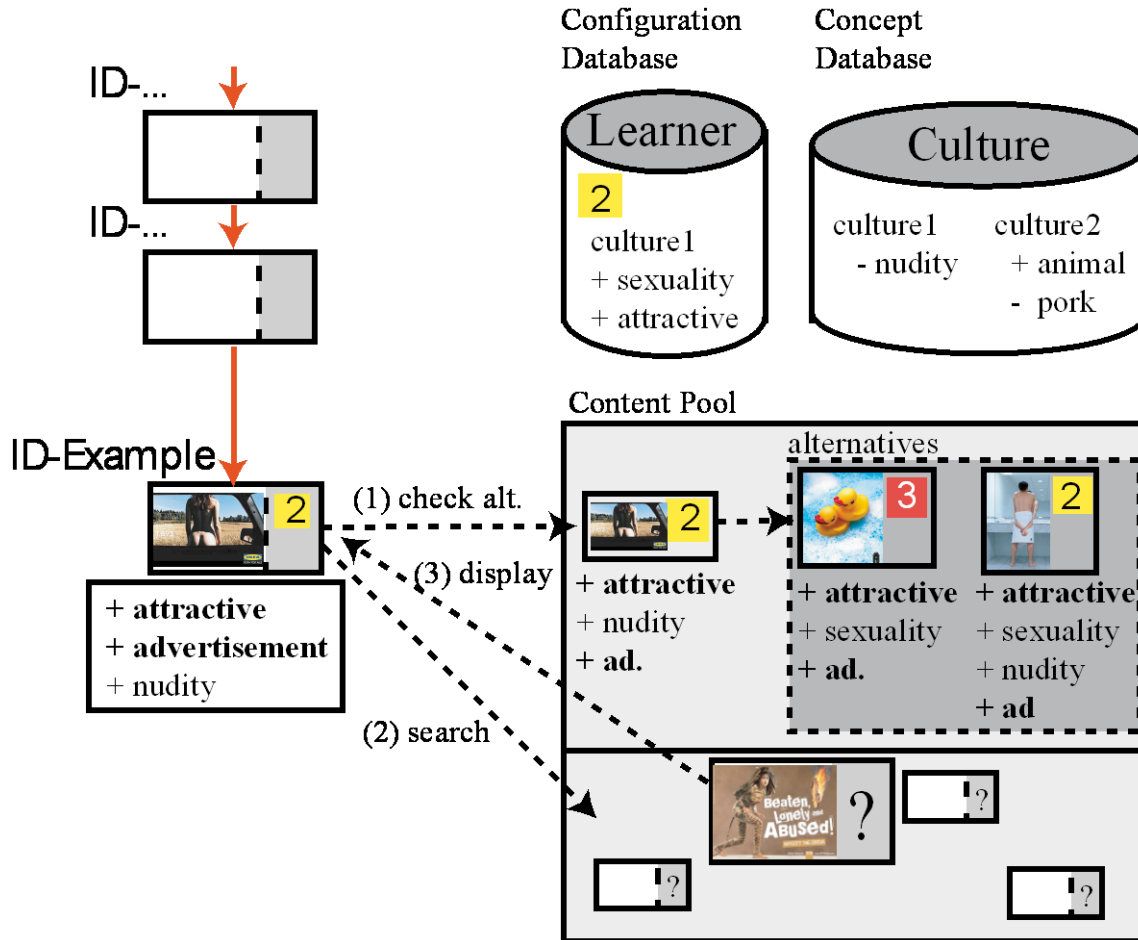
Figure 4: Example for using concepts within the object selection; based on [Reiners et al., 2007]

groups. The learner can associate himself with these sets, so that certain concepts would be used for him in the further selection of learning material. Note that learner can add or remove concepts with respect to match their individual characteristics.

Even though the meta-data element *sexual reference* would match the current object on the learning path, the concept *nudity* is set for ID-EXAMPLE but not allowed by the user. From the two alternatives (Step (1) in Fig. 4) for ID-EXAMPLE, the first one would be allowed from the concepts but not the meta-data and the second one would not match due to the concepts. If the user does not allow any variation in the meta-data or concepts, no object from the predefined alternatives can be displayed.

Next, the repository is searched (Step (2)) for an object that matches the concepts *attractive* and *advertisement* but not *nudity* as this is not allowed by the learners' configuration. The objects are either annotated with concepts (tags) during import or on-the-fly during the search process. The best match – an advertisement for PETA having an attractive female dressed like a tiger and, therewith, not showing nudity – is returned in Step (3). The usage of concepts allows a distinct selection of objects. Assume a learner associated with *culture2*. Objects about animals like pigs are allowed, but if the concept changes, for example, to a supermarket having pork on display, the

object would not be suitable. The system would prevent the inclusion of the object in the learning path including the originally planned object as well its alternatives.

Conclusion

We have presented the schema for sophisticated, fine-grained, dynamic, learning path adaptivity set in an e-Learning environment. In the future, these systems will permit cross- and multi-cultural learning scenarios to be confidently and competently matched with individual user learning needs taking into account, for the first time, cultural sensitivities, respecting the cultural norms and ethics of learners, without the need for special segregation of learners or learning content. Future learners may make university and course selection decisions based on the ability of the educational provider to demonstrably respect and accommodate the diverse cultural norms and ethics found among the peoples of the world. A now well established, but far simpler example, can be found in the air travel industry for example, where multilingual flight attendants and culturally-specific meal options are already commonplace.

There are still several questions that are not answered in this contribution. How can it be implemented? Is it working in a real course? Is it accepted by learners and lecturers? Is it used? Even though the research project is not yet finished and many questions cannot be completely answered yet. But first indication from a preliminary prototype that realized most of the adaptive concept was successfully tested within a virtual classroom setting. We performed several evaluations about acceptance and requirement for the virtual education, indicating to continue the work in progress [Sassen, 2007]. Nevertheless, the drawback of SmartFrame – out first prototype – was the small number of learning objects, i.e. redundant objects which represent the same content in a different way. This is also the main argument for every adaptive approach that relies on the quality of the repository. Inclusion of Internet objects or unknown learning objects was not possible as the quality could not be verified. And bear in mind the automatic analysis of the content and verification that the content is correct regarding the current demand. Including the conceptual analysis in our approach, we are able to overcome this problem as we can determine the concepts of an unknown object, on which we can base our selecting process during the search of an alternative.

We are currently implementing several components: (1) an improved repository with dynamic layers representing the various networks of relations between objects, (2) components to edit and visualize objects and relations, (3) improved methods to detect the concepts in an unknown text and (4) an extended component for the adaptivity and dynamic learning paths. The experiments from SmartFrame and other projects is used to build required components and set up an innovative learning environment, either standalone or being integrated in systems like Moodle [Moodle, 2008] or Blackboard [Blackboard, 2008]. Note that our overall goal is to improve e-Learning and classroom teaching so that we always keep in mind the people that will later use the system. Therefore, interface development for various user groups is an important topic, next to the necessity of requiring a large content pool and continuous evaluations to verify the progress. Our results will be posted at http://www.eaglesemantics.com and http://www.smartframe.de.

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Biography

Torsten Reiners is currently postdoctoral researcher at the University of Hamburg, Germany. His research and teaching experiences are in the areas of clustering and mining large data sets, online-algorithms and the incorporation of bio-analogous meta-heuristics in simulations models (applied to container terminals), fleet logistics, information systems as well as several topics in e-learning and software development. Within his PhD-thesis "Simulation and OR with SMARTFRAME" he demonstrated concepts for didactical models. Besides scientific publications, he participated in national and international research projects and is currently doing research in semantic networks to improve cross-border communication and (e)learning as well as machine translation. Another interest is about (virtual) worlds and their interconnectivity and exchange without barriers. This research includes the development of highly adaptive systems, automatic processing of documents and their analysis as well as evaluation, the usage for educational purposes in a multicultural setting, and the usage of innovative platforms like virtual worlds. Torsten Reiners is co-founder of Campus Hamburg and Students@work, an initiative to promote education as well as Hamburgs' universities in Web 3D. The co-operation with Heinz Dreher is in the field of conceptual analysis and its application with respect to an automatic assessment lab and adaptive content repository.

Heinz Dreher is Associate Professor in Information Systems at the Curtin Business School, Curtin University, Perth, Western Australia. He has published in the educational technology and information systems domain through conferences, journals, invited talks and seminars; is currently the holder of Australian National Competitive Grant funding for a 4-year E-Learning project and a 4-year project on Automated Essay Grading technology development, trial usage and evalua-

tion; has received numerous industry grants for investigating hypertext based systems in training and business scenarios; and is an experienced and accomplished teacher, receiving awards for his work in cross-cultural awareness and course design. In 2004 he was appointed Adjunct Professor for Computer Science at TU Graz, and continues to collaborate in teaching & learning and research projects with European partners.

Dr Dreher's research and development in the hypertext domain has centred on the empowering aspects of text & document technology since 1988. The systems he has developed provide support for educators and teachers, and document creators and users from business and government. 'DriveSafe', 'Active Writing', 'The Effectiveness of Hypertext to Support Quality Improvement', 'Water Bill 1990 Hypertext Project', 'A Prototype Hypertext Operating Manual for LNG Plant Dehydration Unit', 'Hypertextual Tender Submission - Telecom Training Programme', were all hypertext construction and evaluation projects in industry or education. The Hypertext Research Laboratory, whose aim was to facilitate the application of hypertext-based technology in academe, business and in the wider community, was founded by him in December 1989

Acknowledgements