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Development of a Standard for Representation of Cases – Generalization of Case-based Learning in Learning Technology Systems

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Abstract

The goal of learning technology standardisation is to create systematic ways of describing learning material and scenarios. This paper deals with the issue of development of a standard for representation of cases, which are used in case-based learning. The standard is designed for learning technology systems and viewed from the user's perspective. First, IMS QTI was described as an example of standards. Four sample cases were then analysed: one from the PharmaPaC project, two from the SwedKid project, and one from two courses taught at the Department of Interactive Media and Learning. We have proposed a case structure description comprised of parts of a case item, types of case items, different patterns of a case section, and relationship between a case, case section and case item. The developed structure can be used as a basis for elaboration of an informational model of the case standard that may increase the level of case reusability and cooperation between case creators and users. The cases and implications of standards for the users were discussed at an ELHE workshop. The discussion suggested that standards can be a good starting point for creation of learning objects, and the standard for cases can facilitate their use in instruction. Despite there was an opinion that standards could limit creativity of learning objects creators, we believe that the use of standards is not an option but compulsory when learning objects are used. In future work we will develop XML-based notation for description of cases and consider Resource Description Framework to add semantic capabilities. We will also take into consideration standards like IMS Content Packaging and EML (Educational Modelling Language).

Abstract in Swedish

Sammanfattning på svenska
En målsättning med lärteknologistandardisering är att utveckla en systematik för att beskriva lärresurser och scenarior. Detta paper behandlar utvecklingen av ett förslag på standard för representation av case för s.k. case-baserat lärande. Standarden har designats för användning tillsammans med IT-stöd och har utformats ur ett användningsperspektiv. Först beskrivs IMS QTI som ett exempel på en lärteknologistandard. Fyra exempel har sedan analyserats: ett från projektet PharmaPaC, två från projektet SwedKid oc ett från två kurser vid Institutionen för interaktiva medier och lärande. Vi har föreslagit en struktur som beskriver ett case olika beståndsdelar, typ av beståndsdelar, olika mönster i ett case olika delar, samt relationer mellan dess olika beståndsdelar. Den föreslagna strukturen kan användas som en bas för utveckling av en informell standardmodell för att beskriva case, med syfte att öka återanvändbarhet och samverkan mellan ett case skapare och dess användare. Standarders inverkan på användandet av casemetodik diskuterades på en ELHE workshop. Workshopen menade att standarder är en bra utgångspunkt för att skapa lärobjekt och att en standard för att beskriva case kan förbättra den pedagogiska användbarheten. Det fanns dock en uppfattning om att användningen av standarder riskerar att hämma kreativiteten hos dem som skapar lärobjekt. Vi tror dock inte att

användningen av standarder är en valfri möjlighet vid konstruktion och användning av lärobjekt- det är en nödvändighet. I framtida arbete kommer vi att utveckla en XML-baserad notation för beskrivning av case, samt utforska möjligheterna att använda RDF (Resourse Description Framework) för att hantera semantiska egenskaper. I detta arbete kommer vi även att ta hänsyn till redan existerande standarder så som IMS Content Packaging och EML (Educational Modelling Language).

Keywords: Learning technology standardisation; Interoperability; Content management; IMS; RDF; Semantic Web; Case-based learning.

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1 Introduction

The goal of learning technology standardisation is to create systematic ways of describing learning material and scenarios. Standards make learning management systems able to cooperate and exchange learning objects and their metadata. Naeve, Nilsson, and Palmér (2001) propose a learning framework including a semantic layer and supporting standards. The framework utilises a combination of semantic Web techniques to search, locate, and exchange metadata. Anido (2002) provides another example of activity in development of educational metadata for learning resources. Many specifications and guidelines are created by several bodies engaged in standardisation, one of which is IMS – IMS Global Learning Consortium, Inc. (IMS, 2003). It works on several specifications for on-line distributed learning, e.g. IMS Question & Test Interoperability Specification (IMS, 2002). Designers of educational systems such as the ContentNet framework use such specifications for interoperability of educational content (Torres da Silva, Pereira de Lucena, & Fuks, 2001).

To implement a standard, a way is necessary for describing specifications independently from any output facilities. XML (eXtensible Markup Language) is a possible solution, which involves marking up a document with text-based tags. In a number of projects, XML is used for the exchange of information between different systems, e.g. geographical information systems (Badard & Richard, 2001) or systems for archiving and preservation of electronic thesis and dissertations (Dobratz, Schulz, Potter, & Strabala, 2001). However, XML syntax does not permit to express rich semantics. To overcome this obstacle, Semantic Web technologies, such as Resource Description Framework (RDF), can be employed (Nilsson, Palmér, & Naeve, 2002). RDF description is a set of connected statements, each one being a triple of the form ‘subject-predicate-object’.

Case-based learning is a learner-centred method that emphasises discussion and reflection on real-life situations and develop critical thinking and argumentation (Lynn, 1999). Cases are usually comprised of rich multimedia content and used in teaching different disciplines. There is a number of studies of using multimedia cases in teacher education (Cannings & Talley, 2002; Dolk, den Hertog, & Gravemeijer, 2002; Johansson & Tarassov, 2004). Availability of cases as learning objects can facilitate use of case-based learning but it will require utilisation of a specification for case description. This paper is concerned with analysing cases, used in teaching three different subjects areas, and developing a standard for representation of cases, which are used in case-based learning. The standard is designed for learning technology systems and then viewed from the user’s perspective.

2 An Example of a Standard – IMS Question and Test Interoperability specification

In this section, we will dwell upon the IMS Question and Test Interoperability specification (IMS QTI) as an example of a standard for learning technology systems. In our opinion, a standard is a systematic way of describing objects. A standard defines the structure of objects and provides guidelines for describing objects. IMS QTI is designed for the description of assessments at a structural level that is independent from the testing tools and computer platform (IMS, 2002). It describes basic structures for the representation of test and question data. IMS QTI defines different types of questions and XML tags for each element of the specification. According to this standard, questions are called *items* and they include questions themselves, presentation instruction, response processing, feedback, and metadata describing the items. Items form sections. Tests are called *assessments*, which are built of one or more sections. Figure 1 depicts the structure of an assessment and a section.

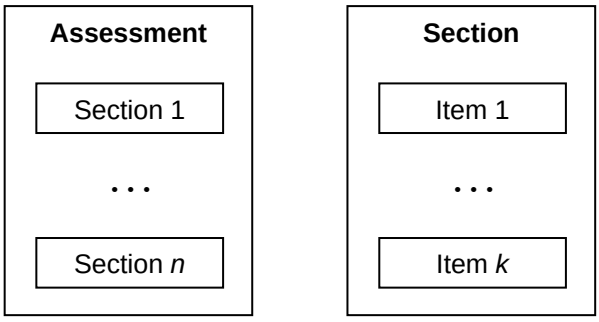

Figure 1. Structure of an assessment and section

The structure of an item includes three main parts. The *presentation* part gives the instructions on how to present the question and possible responses. The *response processing* part describes how to process the response and assign a score to it. The *feedback* part contains the feedback information to be shown to the test taker. Items can be of basic and composite types that are shown in Figure 2. The basic types are true/false, multiple choice, multiple response, order objects, connect-the-points, image hot spot, fill-in-blank, and short answer. A composite type usually combines different basic types.

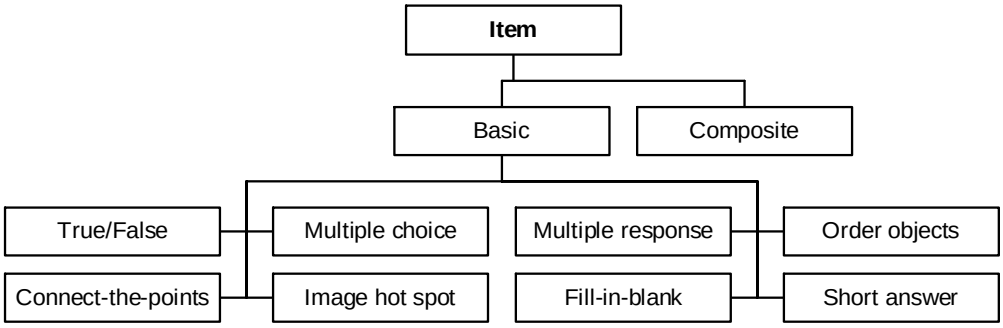

Figure 2. Types of assessment items

IMS QTI defines XML tags for marking up each structural element of an item, section, and assessment. A typical XML tag structure is: `<tag_name parameters> tag_content </tag_name>`. As an example, we will consider the description of the question "What rectangle has perpendicular diagonals?" (Tarassov, Tarassov, & Kyurshunov, 2003). The

whole item representing the question is surrounded by the *item* tag. This tag denotes the title and identifier of the item, and contains all the parts of the item:

```
<item title="rhombus" ident=" Question2">
  <presentation label="Question2"> ... </presentation>
  <respprocessing> ... </respprocessing>
  <itemfeedback ident=”Correct" view="Candidate"> ... </itemfeedback>
</item>
```

For our question we can choose a standard fill-in-blank question type, and then the student will be expected to enter a line of free text. The XML code for the presentation of the question looks like the following:

```
<presentation label="Question2">
  <flow>
    <material>
      <mattext texttype="text/plain">What rectangle has perpendicular
        diagonals?</mattext>
    </material>
    <response_str ident="Question2" rcardinality="Single" rtiming="No">
      <render_fib fibtype="String" prompt="Box" maxchars="40">
      </render_fib>
    </response_str>
  </flow>
</presentation>
```

3 Analysis of sample cases

The first phase in development of a learning technology standard is to examine several samples of learning material. For the purpose of analysis, three cases were selected from different courses and project. The first case was used in two courses in the teacher education at the Department of Interactive Media and Learning (IML) of Umeå University. The second case was used in the PharmaPaC project (Pharmacological Patient Cases) designed for medical students. The last two cases are from the SwedKid project designed for teenagers. The analysis included several steps intended to determine case parts, describe the structure of case parts and cases, find different types of case parts, and find repeating sequences of case parts.

3.1 Case for teachers – “Filter or not?”

The first case that was selected for the analysis is “Filter or not?”. The case authors are Roger Borgeryd, Elza Dunkels, and Örjan Johansson. It was used in two courses in the teacher education at the Department of Interactive Media and Learning (IML) of Umeå University (Johansson & Tarassov, 2004). This case is about installing a filter program on children school computers. Students are to make choices and examine consequences of their actions. The aim of the case is to let students learn more about advantages and disadvantages of filter programs. The flowchart of the case shown in Figure 3.

The analysis of the “Filter or not?” case has shown that the case is comprised of several case parts. Every case part contains text, a link(s) to next case part(s), and optional additional information. The additional information, included in the case parts, may consist of images, web links, video, and digital documents.

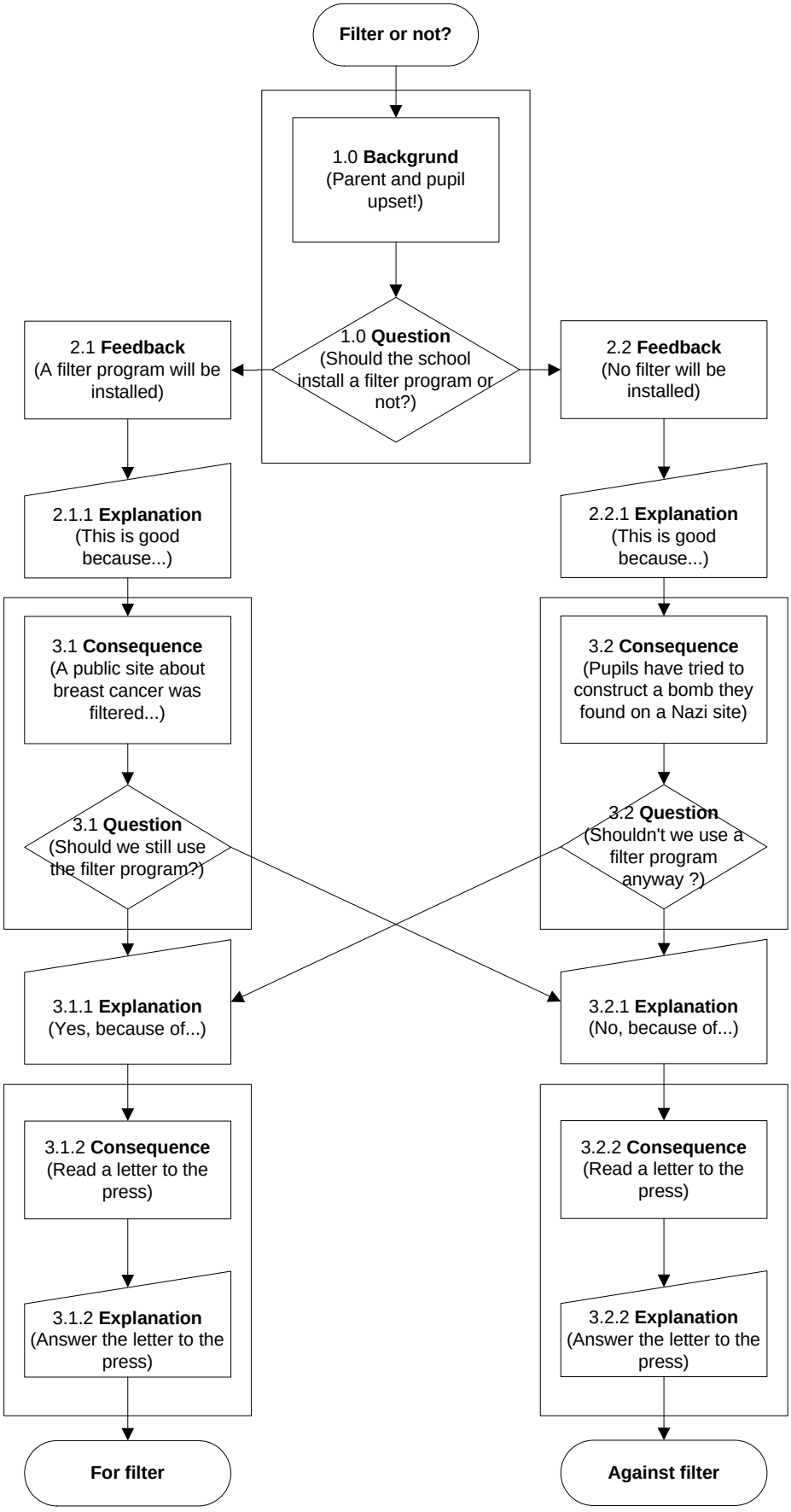

Figure 3. The structure of the "Filter or not?" case

During the analysis, we found that there are several types of case parts:

1. Information
    a. Situation description
        i. Background
        ii. Consequence
    b. Feedback
2. Question
    a. Multiple-choice
    b. Essay

The "Filter or not?" case has several branches but there is one main sequence of actions that is repeated several times:

1. Background – presenting initial information about the situation.
2. Question – presenting a problem and choosing an answer.
3. Feedback – response to the solution of the problem.
4. Explanation – necessity for students to argue for their solution.
5. Consequence – events after the student has taken the decision.
6. Question – presenting the next problem and choosing an answer.
7. Explanation – necessity for students to argue for their solution.
8. Consequence – events after the student has taken the decision.
9. Explanation – necessity for students to reflect on the problem.

The analysis of the aforementioned sequence of actions showed that typical patterns of actions within the case are:

- Situation description → Multiple-choice question → Feedback → Essay question
- Situation description → Multiple-choice question → Essay question
- Situation description → Essay question

3.2 Medical case – "First Aid"

The second case that was used for the analysis was developed as an introductory case to demonstrate the tools used in the PharmaPaC (Pharmacological Patient Cases) project (Osterberg et al., 2003). The case author is Örjan Johansson. The case was designed to help medical students learn how to work with the tools for case-based learning. Figure 4 depicts the flowchart of the case.

The analysis of the "First Aid" case has also shown that the case is comprised of several case parts. Every case part contains text, a link(s) to next case part(s), and additional information. The additional information may include images, audio, video, and laboratory data.

Types of case parts, which were found during the analysis, are:

1. Information
    a. Patient information
    b. Feedback
    c. Direction
2. Question
    a. Multiple-choice
    b. Essay

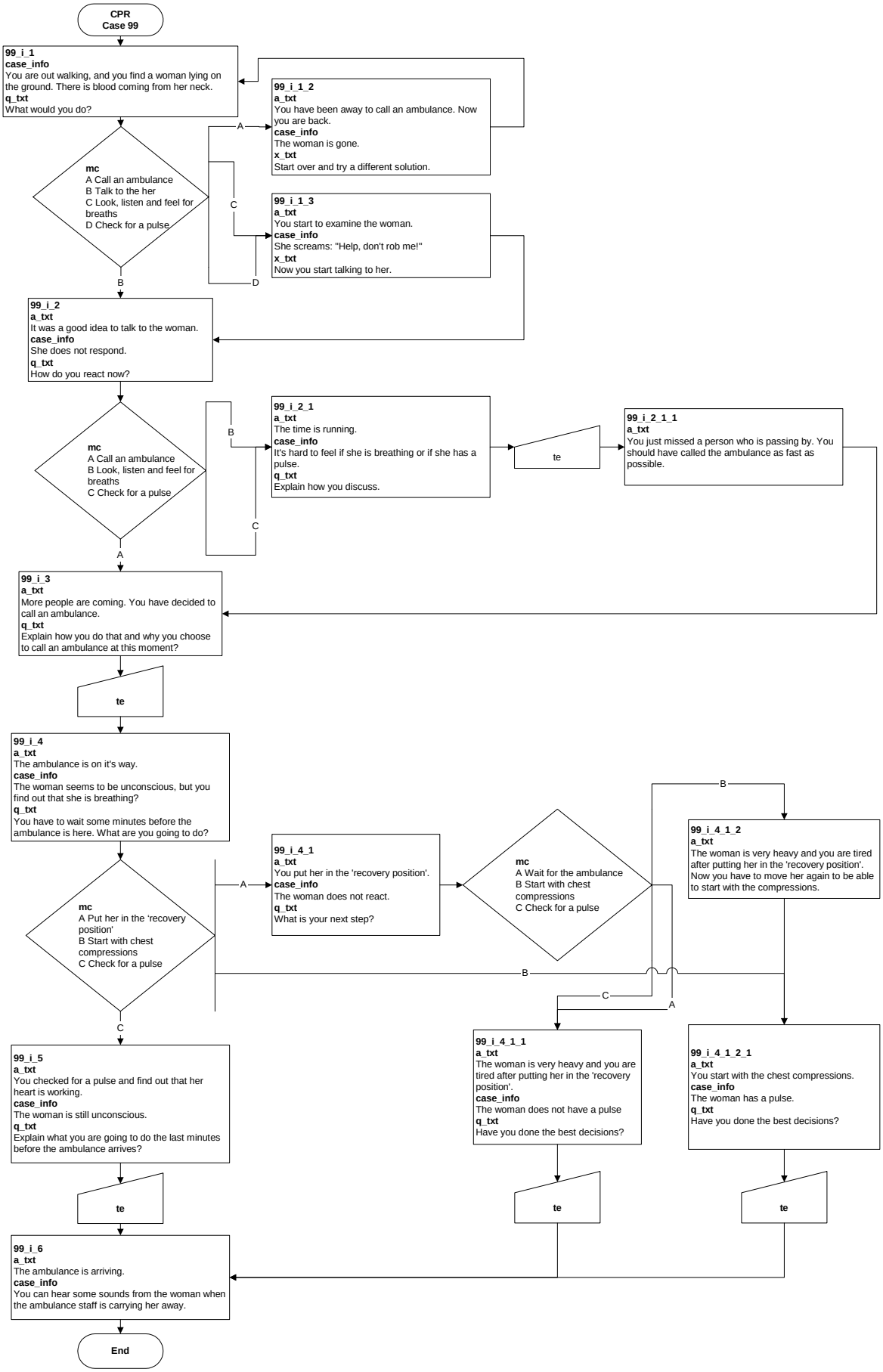

Figure 4. The structure of the "First Aid" case

The “First Aid” case includes many branches but we found three main sequences of actions.
Sequence I (the left “column” of the case diagram):

1. Patient information – presenting initial information about the patient.
2. Question – presenting a problem and choosing an answer.
3. Feedback – response to the solution of the problem.
4. Patient information – how the patient feels after the student has taken the decision.
5. Question – presenting the next problem and choosing an answer.
6. Patient information – how the patient feels after the student has taken the decision.
7. Explanation – necessity for students to argue for their solution.
8. Feedback – response to the solution of the problem.
9. Patient information – how the patient feels after the student has taken the decision.
10. Question – presenting the next problem and choosing an answer.
11. Feedback – response to the solution of the problem.
12. Patient information – how the patient feels after the student has taken the decision.
13. Explanation – necessity for students to argue for their solution.
14. Feedback – response to the solution of the problem.

Sequence II (the top of the case diagram):

1. Patient information – presenting initial information about the patient (99_i_1).
2. Question – presenting a problem and choosing an answer.
3. Feedback – response to the solution of the problem (99_i_1_2).
4. Patient information – how the patient feels after the student has taken the decision.
5. Direction – instructions on what the student should do next.
6. Patient information – presenting initial information about the patient (99_i_1).

Sequence III (the top of the case diagram):

1. Patient information – presenting initial information about the patient (99_i_1).
2. Question – presenting a problem and choosing an answer.
3. Feedback – response to the solution of the problem (99_i_1_3).
4. Patient information – how the patient feels after the student has taken the decision.
5. Direction – instructions on what the student should do next.
6. Feedback – response to the action of the student (99_i_2).
7. Patient information – how the patient feels after the student has taken the action.

Sequence IV (the right bottom corner of the case diagram):

1. Patient information – presenting information about the patient (99_i_4_1).
2. Question – presenting a problem and choosing an answer.
3. Feedback – response to the solution of the problem (99_i_4_1_2).
4. Direction – instructions on what the student should do next (99_i_4_1_2_1).
5. Patient information – how the patient feels after the student has taken the action.

The analysis of the sequences of actions described above showed that typical patterns of actions within the case are:

- Patient information → Multiple-choice question → Feedback → Direction
- Patient information → Multiple-choice question → Feedback
- Patient information → Multiple-choice question
- Patient information → Essay question → Feedback
- Patient information → Direction → Feedback
- Patient information → Direction

3.3 Teenager cases

The last two cases examined during the analysis are selected from the SwedKid project. The case authors are Camilla Hällgren and Professor Gaby Weiner. The cases are designed for teenagers and address issues of difference, conflict and diversity in modern society (SwedKid, 2003). The first case describes Maria's story and concerns the complexity of "We and them". It is shown in brief in Table 1. The second case is the dialogue focused on the question "Where do you come from?". Table 2 shortly describes that case.

Table 1. Maria's story concerning the complexity of "we and them"

Num	Content	Additional info
1.0	*Story:* Maria narrates about her family, religion, food habits, languages she speaks, her thoughts and friends.	Web links: http://susning.nu/Apartheid http://lankskafferiet.skolverket.se/ http://www.catholic.se
2.0	*Story:* Maria tells us about her life with the family in small Swedish community and connected difficulties because one of the parents came from South Africa. Consequently, the family finally decided to move to a new country.	
3.0	*Question:* Why do you think people in the village didn't think Maria's family belonged? 1) Because they were foreigners, and didn't adapt enough 2) The villagers didn't really mean it – Maria's family overreacted 3) Another point of view (opportunity to comment freely)	
3.1	*Feedback:* Maria's family did not need to adjust – it wasn't as if Maria and her family came from another planet.	
3.2	*Feedback:* It has to be something quite serious for anyone to move from the place where they were born and which they know as home	
4.0	*Story:* Maria really looked forward to beginning at a new school with new friends but the people around her continued to see her as 'different'. This was until the day Maria revealed that her mother was South African. Then everything changed.	
5.0	*Question:* What do you think Maria means when she says that the people around her didn't "see her". What did they see instead?	
6.0	*Question:* Have you had the experience of people not seeing you? 1) Yes 2) No 3) If yes, can you describe what happened?	

The analysis of the cases has shown that the cases are comprised of several case parts. Every case part contains text, a link(s) to next case part(s), and optional additional information. The additional information, included in the case parts, consists of web links.

During the analysis, we found that there are several types of case parts:

1. Information
    a. Introductory information
    b. Conversation
        i. Story
        ii. Dialogue
    c. Feedback
    d. Direction
2. Question

a. Composite (multiple-choice + essay)
b. Essay

The SwedKid cases have two main sequences of actions. Sequence I:

1. Introduction – presenting initial information about the character.
2. Story – the character's narration.
3. Composite question – presenting a problem and two choices of answers or open-ended question.
4. Feedback – response to the solution of the problem.
5. Story – the character's narration continues.
6. Question – necessity for students to reflect about the current situation.
7. Composite question – presenting a problem and two choices of answers or open-ended question.

Table 2. The dialogue focused on the question "where do you come from?"

Num	Content	Additional info
1.0	*Story:* Viekka narrates about his family, languages he speaks, food habits, religion, his thoughts and friends.	Web links: http://www.tornedalen.net http://lankskafferiet.skolverket.se/
2.0	*Dialogue:* The question may be asked in different ways but it may also be understood differently. Nasrin thinks that the question makes her feel as if she doesn't belong in Sweden.	
3.0	*Question:* Is there any difference between asking Emma and Nasrin where they come from? 1) No, there is no difference 2) Yes, there is a difference 3) Other comments	
3.1	*Feedback:* Is there anything suspicious about a person asking if you come from another country?	
3.2	*Feedback:* You are probably right.	
4.0	*Dialogue:* Viekka thinks it is odd that people are so curious. Rashid recognises the question too. He is often asked about where he comes from together with the comment that he "speaks Swedish so well."	
5.0	*Question:* what do you think it takes to be accepted as a Swede?	
6.0	*Dialogue:* In the dialogue, the question about what it takes to be regarded as a Swede is raised, and if it is desirable to be fully Swedish. Isn't it up to individuals, how Swedish they want to be?	
7.0	*Direction:* Look at how Viekka, Rashid, Jennifer, and Emma describe their roots. Think about what makes you feel most at home - where you have your roots.	
8.0	*Dialogue:* The dialogue finishes with some of the characters describing their roots. Rashid thinks for example that roots are more like a feeling, whereas Jennifer describes her roots in percentage terms.	

Sequence II:

1. Introduction – presenting initial information about the character.
2. Dialogue – conversation of the characters.
3. Composite question – presenting a problem and two choices of answers or open-ended question.
4. Feedback – response to the solution of the problem.
5. Dialogue – conversation of the characters continues.
6. Question – necessity for students to reflect about the current situation.

7. Dialogue – conversation of the characters continues.
8. Direction – instructions on what the student can think of.
9. Dialogue – conversation of the characters continues.

The analysis of the two described sequences of actions showed that typical patterns of actions within the cases are:

- Conversation → Composite question → Feedback
- Conversation → Essay question → Composite question
- Conversation → Essay question
- Conversation → Direction
- Introductory information
- Conversation

4 Structure of a typical case

Now that the cases are examined, we can define the structure of a typical case. The analysis has shown that a case usually consists of several case parts. We propose to call them 'case items' and Figure 5 depicts the structure of a case item. It includes item text, links to next case items, and optional additional information pertinent to the case item. A case item can be of different types, which are shown in Figure 6. All types are divided into two big groups: information and questions. Questions are intended to let students make decisions and explain their actions.

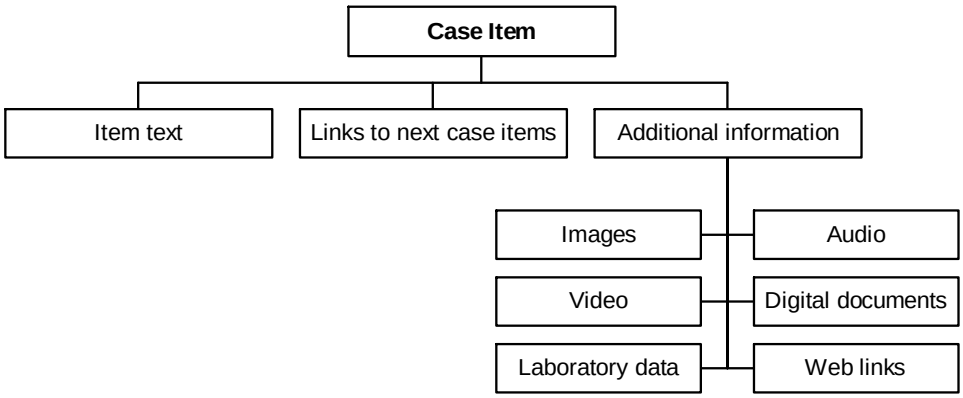

Figure 5. Structure of a case item

Our analysis showed that, as a rule, cases contain repeated sequences of actions. This entails that a whole case can be constructed with one or more case sections, which, in turn, are built with one or more case items. Figure 7 depicts how cases (a), case sections (b), and case items (c) are interrelated with each other. Case sections are to be organized according to the common patterns of actions that were extracted from the analysed cases. We found nine case section patterns and they are summarised in Table 3.

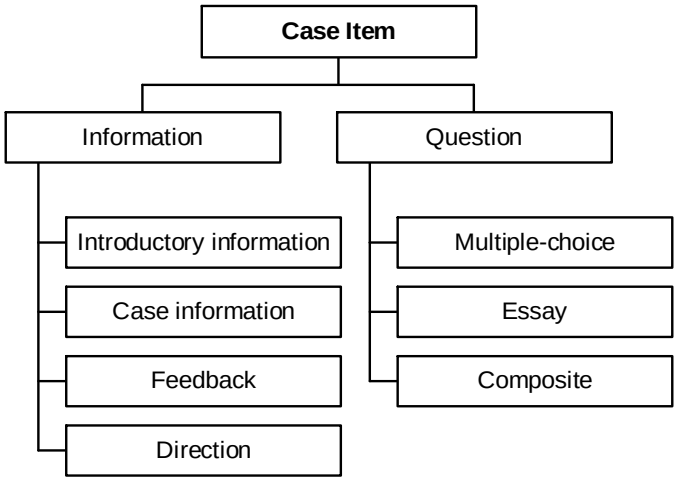

Figure 6. Types of case items

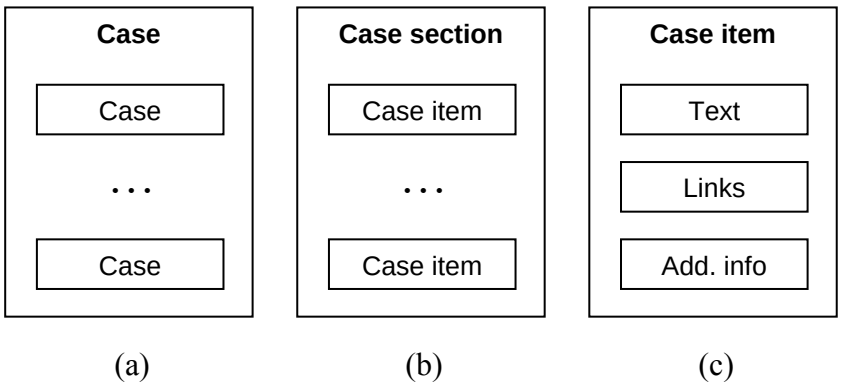

Figure 7. The relationship between a case, case section, and case item

5 Discussion

This study was concerned with developing a standard for generalisation of cases in learning technology systems. The proposed case structure describes parts of a case item, types of case items, different patterns of a case section, and relationship between a case, case section and case item. The developed structure can be used as a basis for elaboration of an informational model of the standard. We believe that use of the standard for description of cases may increase the level of case reusability and cooperation between case creators and users. It can also allow for creation of learning objects that will be interchangeable between diverse learning technology systems.

We think that the chosen cases are indicative and quite representative of how cases are used in learning nowadays. However, they all have a rather uncomplicated structure. We believe that cases will be simple in most circumstances but one could imagine cases that are more sophisticated and comprised of paths, which are more open and harder to foresee. A case path may even refer to external information and data that are out of the case authors control, depending on what actions the user/learner takes. This will certainly call for case tools that are more “intelligent”, and we are sure that such tools will be available in not too distant future. Such tools will need to do a much more sophisticated semantic interpretation and the bare

syntax of XML will not be satisfactory. It is especially problematic to try to express semantics merely using XML.

The cases chosen for analysis in the paper were also examined and discussed at the workshop within the ERASMUS Intensive Programme ELHE (@-learning in Higher Education) on 10 July 2003. The participants of the workshop were given an assignment to analyse one of three cases, describe the structure of the chosen case, and reflect on usefulness, advantages, and disadvantages of standards. The discussion outlined several advantages and disadvantages of standards. The participants thought that availability of cases with predefined structure (as learning objects) made their use in instruction easier, but it was noted that a standard might be limiting to a certain extent (not allowing to do everything needed) and boring. When the participants were asked if the standard facilitated and accelerated creation of online learning resources in the form of cases, the answer was 'Probably, yes', standards could be a good starting point for creation of learning objects, provided that the standard did not destroy creativity of learning objects creators. On the other hand, we believe that the use of standards is not an option but compulsory if learning objects are to be used. The reason for this is that standards are an important part of the definition of learning objects and essential to implement the vision of interoperability and reusability (Paulsson, 2003). One particular question raised during the discussion was about the implications of standards for the learner.

In future work we are going to develop XML-based notation for description of cases. As an alternative, we will consider Resource Description Framework (RDF) to add semantic capabilities (Nilsson, 2001). Cases that are more complex will be examined and implementation experiments with different types of cases are planned. More attention will be paid to considerations of the learner in the process of using standards. We will also put our work with cases into the perspective of standards like IMS Content Packaging and EML (Educational Modelling Language).

Table 3. Different patterns of a case section

Num	Case Section Pattern	Items
1	Case information → Question → Feedback → Question	4
2	Case information → Question → Feedback → Direction	4
3	Case information → Question → Feedback	3
4	Case information → Question → Question	3
5	Case information → Direction → Feedback	3
6	Case information → Question	2
7	Case information → Direction	2
8	Introductory information	1
9	Case information	1

6 References

Anido, L. E., Fernandez, M. J., Caeiro, M., Santos, J. M., Rodriguez, J. S., & Llamas, M. (2002). Educational metadata and brokerage for learning resources. *Computers & Education, 38*(4), 351-374.

Badard, T., & Richard, D. (2001). Using XML for the exchange of updating information between geographical information systems. *Computers, Environment and Urban Systems, 25*(1), 17-31.

Cannings, T. R., & Talley, S. (2002). Multimedia and online video case studies for preservice teacher preparation. *Education and Information Technologies, 7*(4), 359-367.

Dobratz, S., Schulz, M., Potter, P., & Strabala, P. (2001). SGML/XML-based electronic theses and dissertations: Existing projects and standards. *The Internet and Higher Education, 4*(2), 93-104.

Dolk, M., den Hertog, J., & Gravemeijer, K. (2002). Using multimedia cases for educating the primary school mathematics teacher educator: a design study. *International Journal of Educational Research, 37*(2), 161-178.

IMS. (2002). *IMS Question & Test Interoperability Specification V1.2*. Retrieved June 5, 2003, from http://www.imsproject.org/question/index.cfm

IMS. (2003). *IMS Global Learning Consortium, Inc.* Retrieved 30 September, 2003, from http://www.imsglobal.org/

Johansson, Ö., & Tarassov, V. (2004). CaseMaster - an interactive tool for case-based learning over the network. In F. Buchberger & K. Enser (Eds.), *@ - Learning in Higher Education II*. Linz: Universitätsverlag Trauner (this book).

Lynn, L. E. (1999). *Teaching and Learning with Cases: A Guidebook*. New York: Seven Bridges Press, LLC.

Naeve, A., Nilsson, M., & Palmér, M. (2001). *E-learning in the semantic age. In Proceedings of the 2nd European Web-based Learning Environments Conference (WBLE 2001)*. Retrieved 30 September 2003, from http://kmr.nada.kth.se/papers/SemanticWeb/e-Learning-in-The-SA.pdf

Nilsson, M. (2001). *The semantic web: How RDF will change learning technology standards*. Retrieved 29 September 2003, from http://www.cetis.ac.uk/content/20010927172953/viewArticle

Nilsson, M., Palmér, M., & Naeve, A. (2002). *Semantic Web meta-data for e-learning - some architectural guidelines. In Proceedings of the 11th World Wide Web Conference (WWW2002)*. Retrieved 29 September 2003, from http://www2002.org/CDROM/alternate/744/index.html

Osterberg, L., Stiller, C.-O., Törnqvist, E., Ayers, M., Youngblood, P., Bastholm, P., et al. (2003). A Web based course in clinical pharmacology. *Academic Exchange Quarterly, In Press*.

Paulsson, F. (2003). *Komponentbaserade lärmiljöer och lärteknologistandarder*. Unpublished manuscript.

SwedKid. (2003). *The SwedKid project*. Retrieved June 19, 2003, from http://www.swedkid.nu/

Tarassov, V. A., Tarassov, V. V., & Kyurshunov, A. S. (2003). Using XML and the IMS QTI standard for the development of assessment tools. In K. M. Sormunen, V. A. Tarassov & S. R. Bogdanov (Eds.), *Mathematics and Science Education in the North-East of Europe: History, Traditions & Contemporary Issues. Proceedings of the Sixth Inter-Karelian Conference* (pp. 312-317). Joensuu: University of Joensuu.

Torres da Silva, V., Pereira de Lucena, C. J., & Fuks, H. (2001). ContentNet: a framework for the interoperability of educational content using standard IMS. *Computers & Education, 37*(3-4), 273-295.

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