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Choosing an Online Learning Platform focusing on Reusability of Learning Objects and its Implications for Comparison Schemata Design

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Abstract: *Project decisions about suitability of existing online learning platforms are often discussed by using project specific proprietary comparison schemata or via a comparison service offered in the world wide web. As educational material in form of learning objects becomes more available focusing on content reusability aspects is becoming more important for online learning platforms due to cost minimization in content production and preparation for content reusal. Exactly these reusability aspects can hardly be found in these comparison schemata. In learning platforms learning objects are stored in database management systems by using document management systems. Modularization of courses and course building elements as objects are essential for reusability. For effective administration, storage, search, and retrieval of these elements as a part of a reusability process metadata descriptions of the processed learning objects are neccessary and fundamental. Our approach to enrich comparison schemata by adding reusability specific elements fills the existing gap between metadata and reusability features implemented in available online learning platforms and popular used comparative analysis tools for online learning platforms, respectively.*

Keywords: *Reuse, Learning Object, LOM, Metadata, Online Learning, Comparative Analysis*

1 Introduction

This paper investigates which criterions for comparative analysis of online learning platforms are considered to be relevant for decisions focusing on content reusability aspects of these platforms when using currently available and often reviewed information systems like [Lan01], [Edu01]. The term online learning platform in this scope is defined by webbased applications to deliver or present educational multimedia course materials on a learner's side and to offer administration features on a tutor side through management of course relevant metadata while authoring support is offered by content management and content creation. Due to the lack of reusability specific categories in these information systems a set of already existing criterions is collected. Referring to this investigation this paper describes an approach for handling a criterion enrichment by adding reusability specific categories to comparative analysis tools.
Therefore the term reusability is described as it is understood in the context of the content of a learning platform as an object in section 2. As a result of this description a metadata schemata for learning objects named *Learning Object Metadata (LOM)* which is proposed by the *Learning Technology Standards Committee (LTSC)* of the *IEEE [LWG01]* is introduced which is especially useful for the attribution of learning resources [HFM+01]. After mentioning use cases working on *LOM* and currently not solved granularity problems in *LOM*, section 3 handles the reusability aspects of learning objects implemented in currently available learning platforms. Afterwards this paper is going on discussing included reusability specific criterions in the comparison schemata of [Bat99], [Edu01] and [Lan01]. The following section 4 states a proposal of a hierarchically structured set of criterions with specific categories and elements to allow comparative analysis among online learning platforms. Finally this paper ends with a conclusion and an outlook of its discussed subject in section 5.

2. Reusability

Reusability in general is a possible method for saving monetary and non monetary costs. In the context of learning platforms reuse of learning system components - the implementation itself in modularized form as it is used in

different online courses - or its content can be established. While modularized configurable implementation is a well solved problem in recent online learning platforms like *Lotus Learning Space* by *Mindspan Solutions*[1], *Netcoach* by *Orbis Communications*[2] or *Hyperwave eLearning Suite* by *Hyperwave*[3] - e.g. by configuration of hiding or including a chat or a discussion forum to specific courses for online learning platform users - reusing content as learning objects in form of documents, images, other multimedia components or a collection of such components is recently a matter of research [LWG01]. In the scope of this paper reusability has to be understood as reusability of content representing documents or objects as a part of a document in form of educational multimedia material used for testing of knowledge or transfering knowledge to a learner.
Content oriented reuse of course material can be done by copying a selectable collection of course documents in whole or building templates from formerly used courses - e.g. like it is done in *Lotus Learning Space*, *WebTycho*[4] or *Hyperwave eLearning Suite* which are based on document management systems (DMS) on top of *Lotus Notes / Lotus Domino*, or *Hyperwave*, respectively. At least if content oriented reuse on a more detailed layer is focused, the typical automatically generated metadata of such DMS have to be replaced by more abstract and learning specific metadata schemata.

2.1 Knowledge Representation through LOM

To describe a coherent context of a complete reusable unit in [LWG01] the term learning object is used. The metadata of a learning object *LOM* is the information about this object. When storing learning objects in local or distributed repository systems, this metadata can be used to provide effective retrieval, management, transfer, and use of learning objects, e.g. from a repository system into a course context, by working on the corresponding *LOM* entries instead analysing the content of a learning object. Beside that additional metadata information which is not part of the learning object itself can be stored in *LOM*. Consequently, the result of the use of metadata is a reduction of costs through reusability of the described learning objects while facilitating the maintainance of learning objects. *LOM* offers data elements and a structure for these data elements to describe metadata of a learning object. It contains nine main categories of metadata elements representing information about the related learning object as described in [LWG01].
Since other metadata schemata like those from *ARIADNE*[5] - a consortium of 20 European universities and 5 international corporations - provide mappings to *LTSC*[6]'s *LOM* and the *IMS*[7] *(Instructional Management System)* metadata specification model which is compliant with *LOM* [MBG+01], the relevance of *LOM* is becoming increasingly fundamental for online learning platforms.

2.2 Retrieval and Repository Administration

In online learning platforms working on top of a DMS the automatically generated metadata can be used and often is used on its own to establish the administration of learning documents. A more detailed access to learning resources on a sub-document layer results in the need of adding an additional metadata schemata, if comfortable retrieval mechanisms for learning objects should be realized.
So the learning platform repositories should consist of a content repository separated from the metadata repository. Retrieval is done through explicit usage and search on metadata which references other metadata or its represented learning object.

2.3 Granularity

As mentioned before it is of enormous importance, if either reuse should be done on a document oriented layer or on a sub-document layer inside the DMS environment of a learning platform, too, because in a DMS accessibility of documents is fundamental, but accessibility of element parts of a document is usually not supported by the DMS without programmatical effort. Furthermore it can easily be seen that metadata descriptions of more detailed reusable content compared to a document level can also be used on higher non detailed abstraction levels.

1. URL: http://www.lotus.com/home.nsf/welcome/learnspace
2. URL: http://www.orbis-communications.de/index_nc.htm
3. URL: http://www.hyperwave.de/e/products/els.html
4. URL: http://tychousa.umuc.edu
5. URL: http://www.ariadne-eu.org
6. URL: http://ltsc.ieee.org
7. URL: http://www.imsproject.org

For an increased support of this functionality a granularity element is included in the *LOM* schemata describing the type and abstraction layer of a learning object. One not yet solved problem in *LOM* is that this granularity describes a two dimensional area while [LWG01] describes the granularity as a single one dimensional field with no further specification or description about the vocabulary which build the entries for this *LOM* element. The horizontal direction of the granularity represents the type - not format - of the learning object (e.g. explanatory text section of a learning unit or in contrast questionary text of an exam), while the vertical direction of the granularity represents the abstraction layer (e.g. icon, chart, image, explanatory text section, chapter, document, lesson, course; see [HFM+01]).

3. Current Situation

At the moment commercial and non-commercial well-known online learning platforms only attempt to support *IMS* or *IEEE/LOM* or rather announce development of this features in near future [Edu01]. So on the producer and researcher side developers of online learning platforms see the need to support detailed metadata specifications and those features are partly implemented.
The currently available versions of comparison schemata in general do not contain any category named reuse or reusability and only one well referenced comparison schemata [Edu01] contains information regarding metadata in its *general* section.

3.1 Learning Platforms

The following learning platforms were investigated for this paper to see whether they already support any type of metadata for learning objects or whether support is planned or if it is possible to add an own support via a framework or an application programmers interface if existent.

WebTycho

At the *UMUC* home campus in Adelphi, Maryland, a web-based education delivery system named *WebTycho* has been developed. It is based on *Lotus Notes / Lotus Domino* and due to the replication features of this platform *WebTycho* is offered via several servers located in Germany, Japan, and the United States. *WebTycho* itself is neither freely available nor commercially offered but often counts as a reference system when comparing online learning platforms.
Its current authoring support for reusability of course content offers storing of template objects ranging from whole courses to single documents. Subdocument layer elements reuse has to be done manually. Metadata support beside that of *Lotus Notes / Lotus Domino* is not implemented so far.

Lotus Learning Space

For practical investigation purposes version 3.5 of the *Lotus Learning Space* was used in this scope. In general the same reusability options like those from *WebTycho* are supported.
Corresponding to [Edu01] *Lotus Learning Space* version 4.0 allows import of *AICC* courses while *IMS* support is announced. Import and export of course content and course state in XML format is already supported.
Since *Lotus Learning Space* is a database template for *Lotus Notes / Lotus Domino* with partly open course design (partly changeable sources), actors with designer or manager rights in their *Notes* access control list can apply implementation specific changes to the learning platform via *C/C++-API*, *Java-API*, *Lotus Script* and *Lotus Formula Language*.

Netcoach

The *Netcoach* system is implemented in *Lisp* and uses the server's local filesystem as the storage system and repository for all user and course specific data. Courses, exams and user data are stored in different but task immanent files in single *Lisp* structures.
Although this results in a well modularized form, reusability of data is only supported per exporting of courses. Exported data is proprietary so that it can only be imported in *Netcoach* servers again.
Netcoach uses its own metadata structure of course content. The current implementation does not offer mappings or imports and exports to other metadata formats.

Hyperwave eLearning Suite

The online learning platform *Hyperwave eLearning Suite* is running on top of the *Hyperwave Information Server* which is a document management system which stores its documents in an object relational DBMS (*Hyperwave* recommends *Oracle*). The *Hyperwave Information Server* and its related additional components are developed at the *Technical University Graz, Austria.*

The underlying document management system offers superficial support of metadata while the *Hyperwave eLearning Suite* itself does not support metadata description of learning resources. System immanent development of metadata support or access to course content via an application programmer's interface is supported but results in high efforts.

Direct reuse of courses or course documents above subdocument layer is possible through system functions.

Ilias[1]

The open source *Ilias* online learning platform is developed at the *University of Cologne, Germany.* It uses a modularized architecture based on *LAMP (Linux, Apache, MySQL, PHP). Ilias* uses a proprietary format named *VRI (Virtual Resource Index)* to refer to the modularized learning objects dynamically. It directly uses this addressing type of learning objects to support reusability.

The *Ilias* metadata system *VRI* is based on the concepts of *IMS, ARIADNE* and *Dublin Core.* This allows direct mappings from *VRI* to these target formats. It is used on the course layer, the learning unit layer, the documents layer, and subdocument layers like pages or page elements of the learning platform contents.

Since *Ilias* version 2.0 XML templates can be used for increased reusability of course content and course properties.

3.2 Comparison Schemata

In [Bat99] Bates suggests an online learning platform comparison schemata named *ACTIONS.* This name is derived from its main comparison categories: Access, Costs, Teaching, Interactivity, Organisational issues, Novelty and Speed. Without classifying a specific online learning platform it can be implied that the reusability criteria costs and speed are influenced in form of *pre-programmed multimedia* and the amount of needed *re-programming* of course materials when stored in repositories or not. The terms reuse or reusability of learning materials itself are not mentioned. Further aspects that can be treated as content reusage oriented aspects are not discussed.

The *LandOnline* service offered in the world wide web [Lan01] compares different commercial and non-commercial online learning platforms. It is updated and reviewed frequently and its comparison schemata consists of 3 main categories with a total of 15 subcategories containing a total of 62 criterions. At the moment 55 different platforms are reviewed. Regarding the classification of mentioned platforms in reusability contexts the criterion *IMS_compliance* is the only criterion giving information about learning object reuse.

While *Edutech* is offering a detailed comparison analysis service in general it is superficial regarding reusability. It is updated frequently and compares 108 criterions on 9 learning platforms. Only its *general* section handles all available authoring support with reusability oriented criterions.

The obtained list of the considered criterions with reusability aspects over all mentioned comparison schemata therefore consists of the following elements: *IMS* compliance, standards / metadata support (*IMS, IEEE, AICC*), XML support, programming interfaces, web technology compatibility (compatibility of presented learning objects with common web media types), import / convert existing material, flexible resource pool (for the course developer).

4. Adding Reusability Features in Comparison Schemata

Summarized it can easily be seen and implied that currently offered popular comparative analysis tools do not comply with online learning projects needs when decisions have to be made regarding which online learning platform should be used.

In this section of this paper a proposal is introduced to add reusability features in comparison schemata. The introduced main category of the comparison schemata enrichment is named *reusability* and consists of subsections named *basic*, *learningObject*, and *additional.*

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1. URL: http://www.ilias.uni-koeln.de/ios/index-e.html

The notation follows the rule that a higher section identifier is separated from the included subsection identifier by the separation character '.' (e.g. *reusability.learningObject* means that *learningObject* is a subsection of the category *reusability*).

4.1 Fundamental Reusability Specific Criteria

- **reusability.basic**: Category grouping general information for reusability support.
- **reusability.basic.architecture**: Category describing the general architecture of the online learning platform.
- **reusability.basic.architecture.type**: Data element describing the fundamental type of the online learning platform (e.g. monolithic or modular architecture).
  reusability.basic.architecture.DMS: Data element describing the document management system of the online learning platform (e.g. no clean separation in architecture, *Lotus Notes / Lotus Domino*, *Hyperwave Information Server*, *Zope*).
- **reusability.basic.architecture.ServerServerReplication**: Data element decribing if the system provides server-server replication to reuse the same course content at a different location through distribution.
- **reusability.basic.development**: Category grouping developmental aspects of the online learning platform code.
- **reusability.basic.development.systemTemplate**: Data element describing if the online learning platform is a template system as an included application for a DMS (*Lotus Learning Space*, *Webtycho*, *Hyperwave eLearning Suite*) or if it is an encapsulated code (*Netcoach*).
- **reusability.basic.development.sourceCodeAccess**: Data element describing if platform source code is accessible (*Ilias*, *Hyperwave eLearning Suite*, partly available in *Lotus Learning Space*).
- **reusability.basic.development.APIs**: Data element describing which programming languages are supported through APIs.

4.2 Learning Object Specific Criteria

- **reusability.learningObject**: Category grouping learning object specific information.
- **reusability.learningObject.access**: Category grouping information about accessibility of learning objects.
- **reusability.learningObject.access.type**: Data element describing the type of access to a learning object (programmatic through API functions, manually by author through platform function).
- **reusability.learningObject.access.granularity**: Data element describing on which content layer the access of learning objects is supported (course layer, document layer, subdocument layer, element collections, single elements).
- **reusability.learningObject.metadata**: Category describing metadata support.
- **reusability.learningObject.metadata.type**: Data element describing the type of metadata representation in the platform (proprietary, *LTSC LOM*, *ARIADNE*, *IMS Global Learning Consortium*, *Dublin Core*).
- **reusability.learningObject.metadata.version**: Data element describing the version of supported metadata.
- **reusability.learningObject.metadata.mappings**: Data element describing which mappings exist to other metadata formats.
- **reusability.learningObject.metadata.supportLevel**: Data element describing the level of metadata support in the used metadata format (fully, partly, percentage value).
- **reusability.learningObject.metadata.cardinalityType**: Data element describing the number of metadata sets associated to the number of learning objects (1:1, 1:n, m:1, m:n associations).
- **reusability.learningObject.metadata.usage**: Data element describing how metadata is used by the platform (used in retrieval process; import-/export functions).

4.3 Additional Criteria

- **reusability.additional**: Category describing additional criteria with content reusability support.
- **reusability.additional.interoperability**: Data element describing the ability to integrate the platform in an existing computer infrastructure (e.g. to use common webservers, protocols, data standards and programming languages).
- **reusability.additional.contentStorage**: Category describing the platform content storage system.
- **reusability.additional.contentStorage.type**: Data element describing the type of database used (filesystem; proprietary platform build-in; external RDBMS, ORDBMS, XML DB, object-oriented DB).
- **reusability.additional.contentStorage.dataFormat**: Data element describing the format of the stored content (XML, relational tables, proprietary, BLOB, CLOB).

reusability.additional.contentStorage.accessType: Data element describing the content access type (programmatically through API, macro definition/manually by platform function).
reusability.additional.metadataStorage: Similar to reusability.additional.contentStorage but for metadata.
reusability.additional.metadataStorage.type: Similar to reusability.additional.contentStorage.type but for metadata.
reusability.additional.metadataStorage.dataFormat: Similar to reusability.additional.contentStorage.dataFormat but for metadata.
reusability.additional.metadataStorage.accessType: Similar to reusability.additional.contentStorage.accessType but for metadata.
reusability.additional.export: Category grouping data export specific information about the platform.
reusability.additional.export.datatype: Data element describing which type of data can be exported (courses, documents, images, text sections, audio, video, applications, exams, &c.)
reusability.additional.export.format: Data element describing the format used to export the corresponding data type (XML, object specific format)
reusability.additional.import: Similar to reusability.additional.export but for import.
reusability.additional.import.datatype: Similar to reusability.additional.export.datatype but for import.
reusability.additional.import.format: Similar to reusability.additional.export.format but for import.
reusability.additional.transcoding: Data element describing to which formats learning objects or metadata can be automatically/manually transcoded (format conversion) by the platform.

5. Conclusion and Outlook

This work proposes a criterion enrichment by adding content reuse specific categories to comparative analysis tools to support architecure decision making in an online learning environment. After analysis of existing learning platforms and their reusability features implemented in currently available versions an abstract description of decision making on learning platforms was investigated and afterwards concrete existing often refered comparative analysis tools were analysed. Referring to this analysis a proposal has been stated following a logical structure and associates online learning platform properties and features, stored learning object and their metadata properties to significant and meaningful identifiers in comparison schemata design for online learning platforms.
Investigated online learning platforms fit in the proposed schemata enrichment very well. Future work might result in implementing the proposal into existing comparative analysis tools. Furthermore an introduction of project characteristic coefficients describing a typical specific property rating spectrum of a project will be investigated. This might allow a more specific choice of an available set of target platforms due to the large scale and variety of different types of reusability demands in online learning projects.

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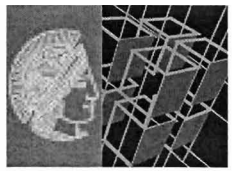

Choosing an Online Learning Plattform focusing on Reuseability of Learning Objects and its Implications for Comparison Schemata Design

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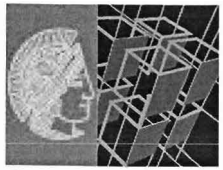
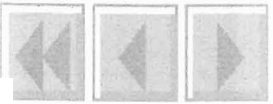
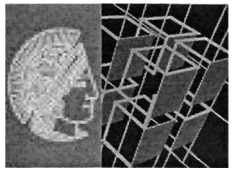


Outline

1. **Research Project k-Med**
2. **Reusability of Content**
3. **IEEE LTSC LOM**
4. **Learning Platforms**
5. **Comparison Schemata**
6. **Adding Reusability Category**





1. Research Project k-Med

- **K-MED: knowledge-based multimedia medical education**

  www.k-med.org

  project is jointly funded by

  the BMBF (Federal Ministry for Education and Research) and

  the STATE OF HESSE, GERMANY in the framework of NEW MEDIA FOR EDUCATION

  started April 2001 and will proceed until the end of 2003

  15 academic institutes from several German universities

  11 medical institutes in 6 medical domains

  1 psychological institute (instructional design and evaluation of K-MED)

  1 institute of graphics and design

  2 institutes of computer science

- **Goal:**

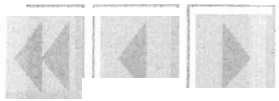
  enhance education in the medical basic study period

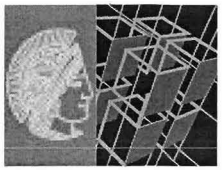
  high reusability of educational resources

  content usage by a common repository in a different context

  content modularization, metadata, and ontology

  support of self-study independent of place and time schedule





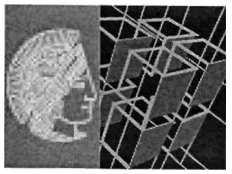
2. Reusability of Content

Main approaches of content specific reusability:

1. **Whole documents or courses are stored**
   - lower probability of direct reuse without modification
   - results in excessive versioning with just small differences
2. **Modularization of content**
   - higher effort to access modules
   - direct reuse without modification
3. **Hybrid approach**
   - granularity level of modules
   - different types and formats of modules

Content modules are called LEARNING OBJECTS.

- **Production of multimedia LEARNING OBJECTS is expensive and requires special production knowledge.**



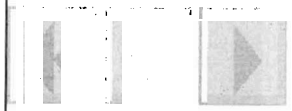
3 IEEE LTSC LOM

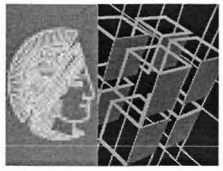
Modularization means
- **higher effort to access the learning object**
- **high convenience of retrieval tools wanted**
  - by using meta data (data about data)

Learning Objects Metadata (LOM):
- **from IEEE P1484.12 Learning Objects Metadata Working Group**
- **currently available as IEEE P1484.12/Draft Version 6.4**
- **widely spreaded interest though LOM is no standard yet**
  - will be standardized in the near future

Advantages:
- **tailored solution to get metadata of learning resources**
- **hierarchical and well-defined datastructure**
- **supports the ability to import and export learning objects**

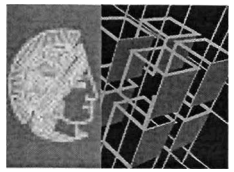
Major disadvantage:
- **one dataset consists of a lot of single fields**
  - acceptance of the authors





4. Learning Platforms

- **K-MED will be based on a platform offering**
  - a presentation system,
  - user profiles,
  - access control,
  - community building,
  - user tracking,
  - authoring support,
  - intelligent ontology-based retrieval tools, and
  - storage for learning objects and learning objects metadata support
- **Which existing platform is appropriate with a minimal amount of customization?**



5. Comparison Schemata

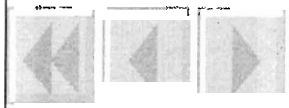
Comparative analysis tools for learning platforms:

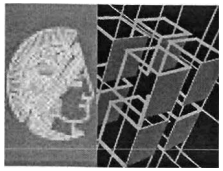
- **Edutech, http://www.edutech.ch/edutech/tools/comparison_e.asp ,**
- **Bruce Landon's web tool for comparative analysis, http://www.c2t2.ca/landonline/ ,**
- **Thot / 205 plates-formes de e-formation, http://thot.cursus.edu/rubrique.asp?no=12074 ,**

  Virtual Learning, bm:bwk Österreich, http://iol3.uibk.ac.at/virtuallearning/member/login

Underlying comparison schemata have no common categories describing reusability

- **intersection of categories is small**
- **nearly no content reusability specific criteria mentioned**





Comparison Schemata (2)

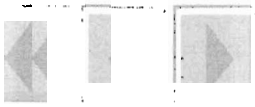
Applying an existing comparison scheme on commercial and non-commercial learning platforms

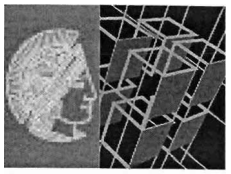
- **We could not decide, if a platform for K-MED offers acceptable**
  - authoring support,
  - intelligent ontology-based retrieval tools, and
  - storage for learning objects and learning objects metadata support

Existing schemata criteria are not significant for reusability focused decisions when choosing a learning platform!

Reusability specific criteria do not reflect

- **the structure and architecture of learning standards (or drafts like LOM),**
- **the basic ideas of content modularization (with different granularity levels), and**
- **object oriented (learning object) modelling approaches**





6. Adding Reusability Category

Approriate Plattform?

Comparative Learning Platform Analysis

Scheme

Categories ...

Administration

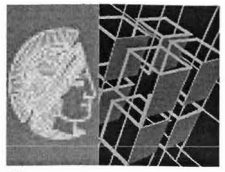
Pedagogical Tools

Reusability NEW!!

basic	learningObject	additional
- architecture - development	- access - metadata	- interoperability - contentStorage - metadataStorage - export - import - transcoding

Quizzing Features

...



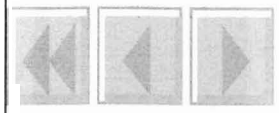
7. Conclusion and Outlook

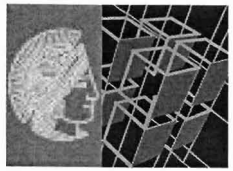
In this work we

- **evaluated existing comparative learning platform analysis tools and their underlying schemata and**
- **proposed a criteria enrichment for (existing) comparative learning platform analysis tools.**

Outlook

- **find an appropriate learning platform for the K-MED,**
- **offer an open criteria scheme to enrich comparative analysis tools,**
- **extend the proposed reusability specific criteria scheme.**





Thank you for listening!

Do not hesitate to ask me any questions.

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Outline