IETC 2014

A technological approach to creating and maintaining media-specific educational materials for multiple teaching contexts

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Abstract

Depending on the teaching context different types of educational materials are used. To best support the various forms of communication, the educational content should be provided in a suitable media form. For example: visual PowerPoint slides for face-to-face teaching; detailed lecture notes for follow up at home and self-study; online content for e-learning. Each media type has particular characteristics, which lead to a range of individual ways of creating content using media-specific authoring tools. The effort required to offer concurrent educational materials for different teaching contexts increases with every additional medium. The author has to create and maintain every single document, although there is an overlap in content and structure between all the materials.

This paper discusses the requirements for authoring and maintaining those documents and how they are received and analyzes the lack of current authoring technology. Based on this pre-study, a technological approach is demonstrated, which combines media-specific formats and authoring tools with a connected single-source content system.

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Peer-review under responsibility of the Sakarya University.

Keywords: Media Specific Writing; Multiple Teaching Contexts; Authoring Technology

1. Introduction

In history, the most common form of education was the traditional lecture at medieval universities. Commonly, an instructor would read from a hand written source to the audience. Due to the lack of expensive hand written books, the only way to receive the content was by listening to the readings and explanations while taking note

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Since this time, the teaching process has evolved rapidly. To this day, a number of different ways to access educational sources exist. Teaching and learning take place in a lot of different forms and situations. For the best outcome and learning success, it is important that every teaching context is supported by the best fitting learning strategies and educational materials. Every teaching context is specified by some individual characteristics, and teachers have to care about these to be able to create and provide the best possible education environment. Nowadays there is hardly a teaching situation imaginable where only a single communication channel is used like the oral speech of the lecturer. To take into account of other receiving ways, new teaching forms and communication channels are used to deliver the learning content to the audience. Nearly all kinds of teaching environments use additional educational materials to support or replace the teacher in the learning process. If you look at today's students daily learning routine, it can be seen that the learning “environment is filled with visual, electronic and digital texts, those texts that are referred to as ‘multimodal’” (Walsh M. 2006). It's for that reason that more and more modern educational documents in different media forms are produced with the help of computer technology.

### 1.1. Planning and creation of educational materials

When an author wants to provide adequate education materials for a teaching context, one has to pass a complex creation process. Kerres (1999) suggested an approach based on multiple steps. In the first step, an author has to determine the topic, identify the target audience, and set adequate learning objectives. Based on this screening, the appropriate contents are chosen to fulfill these objectives. In the next step, the decision has to be made in which didactic manner the author wants to guide through these contents. The selected contents get organized into a learning path which defines in what order these contents get presented to the audience. The result of this phase is a structured topic which contains all contents in a learning friendly order. Not until then is it time to think about the educational materials which should be used to deliver these contents. The author has to decide which media form can support the chosen teaching context in the best way possible. On the base of this media selection and the elaborated contents in form of the structured topic, the author can start to create the actual education materials. Kerres (1999) refers to the fact that the didactical preparation of a learning topic should be detached from the media-specific depiction of the associated contents. This creation process ensures that an author can concentrate completely on the line of argumentation, without thinking how it is visualized on the educational materials. Several authors have stressed the importance that the content development should be done independent from the material production. Using the example of presentation slides, Tufte (2003) states that the borders of the medium restrict the writer in his possibilities to express the content. Keller (2003) takes this idea little further: “But PowerPoint has a dark side. It squeezes ideas into a preconceived format, organizing and condensing not only your material but - inevitably, it seems - your way of thinking about and looking at that material.” This basic idea can be applied for all other media forms too, because every medium has some particular limits for the expression of content.

### 1.2. Providing educational materials for multiple teaching contexts

It gets even more difficult when an author wants to provide a course with its elaborated contents in some additional concurrent teaching contexts. Walsh, M. (2009) analyzed several studies, where multiple educational materials were used in some multimodal learning environments. She came to the conclusion that learners can profit by the mixture of different media forms. It is certainly possible to use only one single document for all teaching situations. However, the desired learning success can then fail because the learners cannot follow the content of the course in an appropriate manner. In a previous publication, Walsh, M. (2006) states that various factors have influence on the interaction between the reader and the material. Beside some other factors, she points to the “the immediate situation in which the text is being read at any particular moment.” (Walsh, M. 2006) Because of the uniqueness, every teaching situation uses some specific forms of education materials. For example: visual PowerPoint slides for face-to-face teaching, detailed lecture notes for following up at home, and self-study online content for e-learning. Not all educational material suits to every teaching context. This has the effect that several unique documents are required to support each teaching context adequately. The author has to create and maintain every single document, although there is an overlap in content and structure between all the materials. The problem is, these materials differ in style and extent. This paper describes the impact of media-specific styles of educational
materials, and discusses the requirements for authoring and maintaining those documents. After analyzing the lack of current authoring technology, a new approach is demonstrated on how authors can create and maintain those educational materials more efficiently.

2. Media style characteristics

The style of educational materials differs in context of the perceptive situation. An author has to care about the following style characteristics of media forms to be able to create materials which fit the target teaching environment.

2.1. Access type

How do participants get access to the materials? In general, this can be divided in two ways: private and public. Students have private access to material when they get their own copy of a document and can use it on their own. The other way is by public access, when only the instructor has a single example of the material. The most important difference is that the instructor has complete control over the use of the document. For example, this can be seen on a PowerPoint presentation. The audience gets public access when the instructor presents the slides with a projector. The instructor controls the presentation time and duration of each slide. It's not possible for a student to go back or stay any longer at a specific slide in the material.

2.2. Materialization

There is the distinction if the materials are delivered in a digital or analogue way. Digital documents require an electronic device to use them, while a usual sheet of paper can be used without any technologic prerequisites.

2.3. Semiotic style

There are different semiotic systems (text, image, video, audio etc.) which are used in media types in a variety of ways. Depending on the teaching context, all of these semiotic systems have different advantages and disadvantages. This means that some semiotic systems are more adequate for some media forms than others. Images, for instance, can be perceived and conceived in a fast and intuitive way while texts can describe details more precisely. The author does not only have to choose from different semiotic systems. There are also a variety of possibilities to depict the identical message with divergent use of signs and symbols from the same system. For example, some media types prefer text as short bullet items (like presentation slides), while others use well written full sentences.

2.4. Degree of specificity

Content can be expressed in different degrees of specificity. Depending on the teaching context, authors have different preferences in which level of detail they want to present on the topic. For example, when presentation slides are used to visualize the oral speech of a lecturer, the content on the slides is usually compressed to some short abstract phrases while extensive lecture notes can contain explanations in a more detailed fashion.

2.5. Content fragmentation

Every media form has a specific way to group and order the depiction of the content on the low level of the document structure. On the one hand, there are some media types which don’t need much effort to achieve this media-specific fragmentation layout. For example, fluent continuous text produced with a word processor gets fragmented into several sheets of paper automatically by the software. On the other hand, there are media types with a more strict fragmentation layout like PowerPoint slides. The author has to care about the content fragmentation and spread the whole topic into several uniform slide fragments.
2.6. Expression variety

To depict a message, it is not always possible to use the same expression in all types of media forms. Every media type supports a set of structural elements to express messages and organize the content. The quantity and behavior of these elements are not the same for all types of documents. For example, it is impossible to use a video or audio clip on a simple sheet of paper.

3. Authoring technology

After exploring some important style characteristics of media types, it is apparent that several independent educational materials are required to support multiple concurrent teaching contexts adequately. This section will provide an overview about current authoring technology approaches which can be used to create those educational materials. It is necessary to distinguish between two basic strategies: firstly, creating individual separated files by using media-specific editors, and secondly, generating materials from single-source contents automatically.

3.1. Media specific authoring tools

The most common way to create educational materials is certainly the usage of some media-specific editors. There is a wide range of authoring software solutions which are designed to create and edit only one particular media type. For instance, there are the well-known software packages like Microsoft Office, Apple iWork as well as some open source alternatives such as Apache OpenOffice. All of these packages contain editors which support some specific media forms like presentation slides (e.g. Microsoft PowerPoint) or continuous text documents (e.g. Microsoft Word). Using these tools lends a big advantage to the creation process. Usually these editors are able to take care of all media specific characteristics of the particular target media. For instance, almost all word processors offer an empty sheet of paper after starting a new document. From the beginning, it is clear which media type is the most desirable. Additionally, an editor like this mostly offers designing tools which are specialized to create content for the current media form. Endowed with a media-specific editor, it is easy to produce educational materials which fulfill the most common design requirements.

Returning to the fundamental issue of multiple concurrent teaching contexts, it has to be clarified how such tools support the creation and maintaining of different educational materials. Depending on the target media types of the educational materials, a number of media specific authoring tools are deployed simultaneously. Usually an author has to create an independent document file for each teaching context to take into account all relevant media characteristics. Therefore the number of files increase with every new teaching situation. For example, when an author offers presentation slides, lecture notes, and e-learning resources for the same learning content, there are already three separate files and three different authoring tools involved. The most significant down side is that the files are not connected to each other, hence the only way to share redundant content between the files is to use the well-known copy and paste function (Rockley et al. 2012 p.50). This leads to problems when parts of the content or structure are to be changed. This can happen, for instance, when an old course may be updated and reused in a new semester. New content should be added, and existing content should be moved to another position or deleted. The author has to apply all changes to every independent file redundantly and manually.

3.2. Single source publishing

Figure 1 shows the basic components of a traditional single source workflow. The main idea of this approach is that there is only one single source storage which contains the whole content base, without any layout or formatting information. Furthermore, various transformation rules exist which direct how this single source content gets transformed into some media-specific output materials. (Stigler 2003 p.203)
The single source publishing approach was developed originally for technical documentations in the early 1990s. The goal was to reuse existing content for different document versions to support various communication channels (Rockley et al. 2012 p.50). Because of similar requirements, authors of more recent studies have proposed that this authoring technology can also be used to produce educational materials (Walsh, L. 2007 p.914, Closs 2011 p 26).

Mackenzie (2011 p.92) states, that this “method particularly suits projects where the content of the different versions overlaps significantly and the information is likely to be revised or updated frequently”. This way has a huge advantage over the first approach which was dealing with several separate files. With a single source strategy, it is possible to make content modifications (like inserting, moving, or deleting) at a central point. “A document is updated one time and then ‘transformed’ rapidly and dynamically into multiple formats as needed” (Sapienza 2002, p. 157).

When publishing from single source content, it does not mean that all output materials are using the exact same content and structure with only another media style. A fundamental idea is that the whole learning subject is split into smaller content fragments (individual texts, pictures, videos etc.) and stored at a central point. From this basic set of information, pieces of content for the output material can be chosen arbitrarily. Rockley et al. (2012 p.51) explains this development as follows: “At the beginning, single sourcing meant identical content and multiple channels, but as authors became concerned about the effectiveness of identical content used in multiple channels, they moved to customized content. This type of content is customized to meet the needs of the customer, the type of content to be developed, and the channel. Content is deliberately built for customized output from the single source to meet specific audience needs or output requirements.”

Despite all the advantages, there are also downsides of this approach. In Figure 1, it is visible that the single source content gets created and changed by a generic editor. Like any other authoring software, this editor supports a limited set of expressions to depict the content. The consequence is that the output materials can only contain content expressions which are supported by the editor. For instance, when the editor is not able to handle video material, it is impossible to get a movie clip into the output material. Another problem becomes visible by looking closer at the transformation rules and the automatic output creation process. The problem is, an author can influence the appearance of output material only in an indirect way. The author has to revise the transformation rules for the target media type to change the output appearance. These rules contain strict instructions for a computer on how to transform the single source content into a media-specific file. On the one hand, this works fine for media-types with strictly defined layouts, like fluent continuous texts with predefined style templates. On the other hand, there are media types which allow a bit more creative designing, like free positioning and orientation of pictures and texts in presentation slides. For example, Pötzsch (2007, p.95) was able to show that a lot of PowerPoint users create free designed text-image-collages without use of the default layouts. For a computer algorithm, it is impossible to do something like this on the base of a transformation rule. Finally, it can be summarized that on the one side, the single source publishing approach is able to manage overlapping content at a central point, but on the other side, it can be seen that this technology is unable to take care of all media specific characteristics of the output materials.

4. The best of both worlds

Based on these previous findings, a technological approach is demonstrated which combines both authoring strategies into a single approach. The objective is to get the best of both worlds: using media specific editors with some kind of single source content management. Figure 2 demonstrates this functionality.
The base for this approach is the idea that the characteristics of materials and their media types can be divided into two groups: shared characteristics which are the same for all concurrent materials, and media-specific characteristics which are unique for every single material. The concurrent educational materials were created on the base of a planned and structured course topic, therefore they share the same structure and content. In contrast, the depiction of the content, layout, and formatting are media-specific characteristics.

To confer about the shared media characteristics, each concurrent material is connected to the same external single source base. This central data store contains all information which is shared between the concurrent materials such as the overall structure and redundant content. As all materials are connected to the central data store, it is possible to apply changes to all other connected materials. For instance, when an author deletes some content in a material, this content change gets committed to the single source base. From here, this change gets applied to all other connected materials.

Furthermore, all these materials are saved in traditional media-specific file types. Therefore these files can be edited with usual authoring tools. This means the author can use all options which are offered by the media-specific authoring software to create materials in an optimal way. Since the material files are connected to the central data store, all the concurrent materials belong to the same structure; a set of ordered and encapsulated structure items. Nevertheless, it is the task of the specific media file to depict the content of these structure items. There are 3 ways to handle a structure item in a specific medium:

- Each connected material can use particular expressions to explain the same content. So it's possible that the same message is depicted in one media file with text, and in another media file with a picture.
- It's possible to use shared content which is synchronized between all connected materials by the central data store. This means when an author changes a shared content text in one material, these changes get committed to the single source base and thereby are applied to all other connected materials.
- Apart from the ability to use shared content or media specific alternatives, it is also possible to leave out structure items. It's not required that every structure element from the single source base must be present in every material. It therefore means that each connected material has only a subset of the central super structure.

The connection between the single source base and the material files can be realized with software plugins inside the media specific authoring tools. These plugins have to synchronize the shared structure and content with the single source base.
5. Conclusion

The findings of the study show that in current teaching environments, it is not easy to provide the best suiting educational materials, particularly when similar content should be taught in multiple teaching contexts. The currently available authoring approaches have great difficulties in various areas. Some strategies are not able to create all media types in adequate ways, while others are not able to manage the overlapping learning content in an effective manner.

For all the media specific characteristics of the educational materials, this study suggests a new authoring approach that combines media-specific formats and authoring tools with a connected single-source content system.

At the moment, two Microsoft Office plugins are being developed to connect the content between Word and PowerPoint files as a first implementation of this concept.

References