



ANNOTATIONS IN E-LEARNING

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Abstract: Web-based learning has become an important way to enhance learning and teaching, offering many learning opportunities. A limitation of current Web-based learning is the restricted ability of students to personalize and annotate the learning materials. Providing personalized tools and analyzing some types of learning behavior, such as students' annotation, has attracted attention as a means to enhance Web-based learning. There has been a sharp increase in the volume and quality of electronic publishing on the web in the past few years. Many research journals are going on-line. The advantages of pelectronic publishing are obvious and enormous: instantaneous access to archives, paperless media and fast document search to name a few. However, annotation of documents in electronic form has been surprisingly underdeveloped. Existing word processing software offers some tools for electronic document annotation. But as of today, these annotation features are so modest and limited, that they lose out to the convenient common practice of working with paper versions of documents [1]. The results of a surveys conducted came as no surprise: the absolute majority of researchers and students prefer to print out an electronic paper before reading and annotating it. Our claim is that electronic annotations can not only be as convenient as their paper counterparts, but they are superior in terms of the additional advanced capabilities they can offer. This claim makes the basis of our Annotation Technology (AT). AT is a set of principles that form a foundation for development of advanced and successful electronic annotation systems.



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I. INTRODUCTION

Annotation refers to marks made by readers on reading matters. [2] proposed a division of annotation types into explicit and inexplicit. Explicit annotations e.g. text convey more meaning than inexplicit ones e.g. highlight, underline, asterisk, arrow, and graphics. Annotation can be a valuable exercise when trying to understand new information. The technique can be used to create a 'condensed' version of the original information for later review and to add additional information into the existing document. Annotations provide a way for learners to make a record of their thoughts or observations within the context of the original document and allow the informal sharing of knowledge related to an artifact or concept[3][4]. Sharing these annotations can provide the stimulus required to start discussions about a topic in a collaborative learning environment [5][6]. Reading texts from computer screens or other electronic devices plays an important role in browsing. In addition, many research projects and commercial products have been developed for electronic publishing on the Web. Thus, providing Web users with electronic annotation tools has received attention in both academia and industry. Without electronic annotation tools on the Web, users must use paper or word processing software if they want to take notes. Certain functionalities of annotation, such as editing or linking, are not fully supported by either of these two methods. Also, electronic documents are very popular and can easily be obtained on the Web. The need to make on-line annotations has increased for readers. However, how can a reader annotate online learning materials? There are two main alternatives to annotate the learning objects with metadata. They are manual annotation or automatic annotation. In the first alternative, the content developers or the experts manually tag the metadata values. In the second alternative, different machine processing information extraction algorithms tries to deduce the value of the metadata fields from the content of the learning object. Annotation is a useful practice for learners as it allows the 'in-context' addition of the learner's own knowledge with the information under review. This has made the technique popular where the reviewed information is of a specialist nature, such as technical specifications, religious texts and language translation, and is stored on paper. However, large amounts of material are now available as electronic documents hosted upon web servers where readers cannot generally make direct annotations. This increase in web-based learning materials means that there is a need for a mechanism to allow the insertion of annotations directly into web pages. The two key advantages of inserting annotations into the web page are:

- the ability to share these notes with other learners and
- being able to access the annotations from any web enabled computer.

These facilities allow learners to collaborate by sharing their ideas about the learning material with other learners who are accessing the same material. Annotations also provide third party, subjective metadata about the contents of a web page that can be analysed to provide additional information for use in web searching and dynamic link generation. This raises the possibility of using annotation contents, for example, as part of the ranking criteria in search engines and dynamically generated web tours. A study of annotations made by US college students to personal copies of academic textbooks highlighted the variety of forms of annotation made by the students to assist in their learning [2]. These annotations ranged from simple highlighting of key words and phrases to 'concept map'-type structures seeking to place core concepts within the greater context of the subject. A study of the annotations made to text by university students and academics revealed that the most common style and purpose of annotation was highlighting to identify key parts of the document for later review [7]. These highlights are a generic form of annotation with a commonly described meaning, whereas other types of annotation, such as notes and symbols, may only have explicit meaning for the original annotator [8]. The main advantage of annotating paper-based documents stems from attaching annotations to the context of the surrounding information and having them remain within the original context. This allows the annotations to contain the minimum amount of information required for understanding, which in turn allows the reader to interpret the information at a glance. However, the rise of electronic learning and the increasing use of the Internet means more educational materials are being published as web-based resources and the ability to make 'in-context' annotations to these new materials would allow the benefits of paper-based annotation to be transferred to the e-learning domain. Computer networks offer new alternatives for creating, storing, accessing, distributing, and sharing learning materials. Electronic annotations can be stored and accessed remotely for users; and they can be shared with other users. The Internet provides new channels for interactions between instructors and students, instructors and instructors, and students and students. With the broad popularity of the Internet, peer-to-peer (students and students, and instructors and instructors) and instructor-to-student interactions could be easy and effective. Electronic annotation allows users to take and share notes without face-to-face interaction. Students would benefit due to the support of electronic annotation by the mobility of notes and contents, and the flexibility of time and place for reading and learning. However, without face-to-face interaction, online discussion and instruction should be considered for providing immediate help and interactions. Electronic annotation could be enhanced by providing discussions to facilitate the exchange of views, pacing the dialogue and provoking post-task reflection. An online instructor should be able to help students of varied abilities by providing immediate feedback, preventing misconceptions and mistakes, and guiding correct behavior. Reading and annotating could be enhanced by appropriately structuring the discussion when users communicate across a network.

II. ATTRIBUTES OF ANNOTATION

Annotations can be described by three attributes:

- Content: The annotation content can be either very

understandable to an occasional reader, or very personal in meaning. The degree of semantic distance between the annotation and the original text varies from totally unrelated to the context to a selection in the original content or an add-on content [9].



- Form : Annotation forms include styles such as underlining

and coloring, and different positions such as within the document and stand-alone. [2][8] Identified annotation forms as various kinds of underlining, highlighting-within-text, on the margin or

in blank space, such as circles, stars, drawings, short notes and extended notes.

- Functionality: Annotation functionalities include reading,

editing, linking, and sharing. [1][10][11] examined general annotation types and functions from the perspective of usage. Marking for later reference is to remind the reader certain key points. Brief notes written separately for later reference serve as a pool of text and ideas. [2] suggested that annotations serve as procedural signaling to attract attention in future readings, as to place marks to aid memory, to work on problems, to record interpretations, to trace progress through narrative, and for incidental reflection on the material at hand. New technologies can enhance annotation practices through multimedia features unique to online environments.

III. ANNOTATION STRUCTURE

The structural components of any annotation can be roughly divided into three primary elements:

- Body : The body of an annotation includes reader-generated symbols and text, such as handwritten commentary or stars in the margin.
- Anchor : The anchor indicates the extent of the original text to which the body of the annotation refers; it may include circles around sections, brackets, highlights, underlines etc. Annotations may be anchored to very broad stretches of text (such as an entire document) or very narrow sections (such as a specific letter, word, or phrase).
- Marker. The marker is the visual appearance of the anchor, such as whether it is a grey underline or a yellow highlight. An annotation that has a body (such as a comment in the margin) but no specific anchor has no marker.

IV. ANNOTATION DISPLAY TYPES

IT-based annotation systems (which include standalone and client-server systems) and Web-based annotation systems (which permit users to upload texts and are collaborative software that allow text editing and versioning functionality, in addition to annotation and commenting interfaces) utilize a variety of display options for annotations, including:

- Footnote interfaces that display annotations below the corresponding text.
- Aligned annotations that display comments and notes horizontally in the text margins, sometimes in multiple columns
- Interlinear annotations that attach annotations directly into a text
- Sticky note interfaces
- Voice annotations, in which reviewers record annotations and embed them within a document
- Pen or digital-ink based interfaces that allow writing directly on a document or screen.

Annotations can be

- formal (comments by scholars) or informal (handwritten notes),
- published or unpublished (annotations by a copy editor).
- Written only for self or with other readers in mind.

Typical contexts for annotations include the following:

- Annotations a reader makes to herself, such as students make when studying texts or researchers create when noting references they plan to pursue.
- Annotations a reader intends to share with the text's author, such as editors or teachers make when commenting on a work in process.
- Annotations a reader intends to share with other readers, such as library patrons sometimes make when illicitly commenting in a library text or editors make in annotated editions.
- Annotations an author intends to share with readers.

V. EXISTING ANNOTATION TOOLS

An annotation is both an object added to a document and the activity that produces this object. From two sets of objects, documents and formal representations, two functions can be created: a function from document to formal representations, called *annotation* and a function from formal representations to documents called *index*. The corresponding activities are annotation and indexing. So, we can also formalize non-semantic annotation as a function from documents to non-formal representation, and the activity to create this function. To extract properties characterizing annotation tools, we studied the annotation activity and what characterizes it. We established that the annotation activity on a computer depends on three main factors:



- The author of the annotation (the annotator).
- The addressee of the annotation (the user of the annotation).
- The fact that the annotation is semantic or not.

These three factors provide following four properties of annotation tools:

- *Automatic versus manual annotation:* Annotating is the process that creates a function from a document to a representation, formal or not formal. Creating such a function involves three sub-processes.
 - To choose a document or a part of document to be annotated (source);
 - To choose the element of representation that is the result of the function (target)
 - And finally to define the properties of the function itself.

Consequently, automatic annotation means that the three annotation sub-processes are performed automatically by a software agent; manual annotation means that they are

performed by a human agent, even if he/she uses software tools for that and semiautomatic annotation means that the human agent is helped by the software tools to perform at least one of the three annotation sub-processes.

- *Cognitive versus non cognitive annotation:* Two properties describe the annotation addressee. The first is the cognitive aspect of the annotation i.e. whether annotation can be handled by human and in this case, annotation has a visible shape and we call it "cognitive annotation" [12].

- *Computational versus non computational:* The second aspect describing the annotation addressee is whether the annotation is computational i.e. aimed to be used by a software agent or not i.e. non computational

- *Semantic versus non semantic annotation:* The third factor characterizing annotation activity on a computer is the fact that whether it has an explicit semantics for the computer, and not only for the human that created it or handle it (semantic).

Based on the above mentioned annotation activity factors and properties of annotation tool, we can classify some of the existing tools as under:

Table1: Existing Annotation Tools according to categories

Semantics →	Semantic Annotation			Non Semantic Annotation		
	Author	Addresssee	Manual	Semi-Automatic	Automatic	
	Cognitive and Non-Computational	Non Cognitive and Computational	Cognitive and Computational	Cognitive and Non-Computational	Non Cognitive and Computational	Cognitive and Computational
	Annotea, Yawas, ThirdVoice, Markup-Up	Edutella, OntOmat, SHOE, WebKB, Karina	Mangrove, SMORE	Imarkup, Acrobat, Web-Notes, CoNote, WebAnn, Epost	Manual index in libraries	Knowledge Pump, Xlibris
			MnM, Melita, Teknowledge, IMAT		MyAlbum Annotate	
		AeroDA ML	KIM, MnM, Magpie, COHSE	Google's Toolbar	Google Search Engine	Cached Google Links



The existing tools can also be studied on the basis of the following factors which describe the ways in which the currently available annotation programs/tools differ:

- *Input*: Annotation technologies can accept input from any combination of the following: keyboard (typed annotations), microphone (voice annotations), mouse or drawing tablet (freehand drawing), or stylus combined with a digital display device.
- *Interface*: Annotations can be displayed as hyperlinks that open in a separate window, as highlighting, as freehand marks directly on a text, as interlinear text and markings inserted directly into the body of the primary text, as columns aligned with the primary document such as CommonSpace or as animated callouts activated by the reader such as Fluid Documents. In conversational environments, where a reader wants to share her annotations, technologies might also support a threaded-reply interface (see MRAS) so that responses to one another's comments can be tracked easily.
- *Base text*: The type of text that the software can annotate can be a stand-alone text document, a web page, a sound file, a video, an email, or another annotation (that is, annotations made on annotations).
- *Anchor*: Annotation technologies can allow readers to associate, or anchor, an annotation with a particular string or passage of text, a particular paragraph, an entire document, or an absolute pixel position (such as 300 pixels from the top of the document and 50 pixels from the left margin). Additionally, some technologies allow readers to associate a single annotation with multiple text passages such as Annotator and XLibris while others only allow annotations to be anchored at points defined by the primary text's owner such as PageSeeder.
- *Storage*: Annotations can be stored in the same file as the primary text or they can be stored independently of the primary text, usually in a shared database. Independent storage in a database allows maximum flexibility in searching, filtering, and sharing the annotations among multiple users.
- *Searching and filtering*: Readers can search for and filter out annotations based on information that is catalogued when the annotations are stored. Common criteria for cataloging annotations include annotation creator, creation date/time, permissions (who has permission to view the annotation), type, and purpose.
- *Specialized behaviors*: Many programs associate specialized features or behaviors with annotations. These behaviors include email notification when an annotation or the document is updated.

VI. REQUIREMENTS FOR E-LEARNING ANNOTATION TOOLS

General annotation tools usually provide domain-independent annotation supports. They are designed to fulfill the general requirements such as ease of use, efficiency, etc. [13]. However, these tools do not take into considerations of special requirements for special domains. For example, in the context of e-learning, the annotation of learning material has different requirements. The requirements for e-learning annotations tools are listed below:

Usefulness: It takes into account teaching/learning context

- Teaching/learning domain (topics to be taught).
- Teaching/learning objectives and the addressee of the annotation.
- Teaching/learning activities (exercise, lab work, lesson, field studies, etc.).

Shareability: It enables teaching/learning actors to communicate through annotation.

- With an explicit semantic related to the teaching/learning context.
- By complying with e-learning standards (LOM, IMS-LD, etc.).
- By the means of the visual form of the annotation are used to.
- By enabling to share annotation with others in the same e-learning context

Usability:

- Annotation made manually does not disturb teaching/ learning activities
- Annotators are put in their usual teaching/learning context while annotating.

1. ANNOTATIONS IN LEARNING

Based on an extensive field research on textbooks, categorized the different kinds of annotations by forms and its functions:

- *underlining or highlighting titles and section headings*: this kind of annotation serves as signaling for future attention. Drawing an asterisk near a heading or highlighting it will remind the reader that there is something special about that topic, something to be considered or explored in more detail.
- *highlighting and marking words or phrases and within-text markings*: the main goal is signaling for future attention – from themselves or from collaborators. The annotated pieces of text typically carry important and valuable observations. The act of highlighting text also helps in memorizing it.



- *notation in margins or near figures*: any kind of diagrams, formulas and calculations that structure and elaborate the document contents e.g. a calculation near an equation or theorem presented in a text, to quickly check its meaning and correctness.
- *notes in the margins or between lines of text*: these descriptive annotations are usually interpretations of the document's contents. These can be phrases in the margin that summarize or comment upon a section or a page. Single words are typically general terms, keywords and classification of a section. Such annotations help the interpretation of the whole text where the reader better establish the topic of the content of each part of the text creating his own mental structure and decreasing the overall cognitive load.

In all of these cases the value of annotations are for both annotators and future readers. Memory adding, signaling attention, problem working and interpretation annotations definitely benefit the annotator but may also benefit other readers – provided that the annotations are explicit, readable and understandable. The basic idea of a Web annotation system is that the user has the ability to change, add or attach any type of content to any online resource, similar as she would do it with a paper document. An application (usually a browser plug-in) enables the user to modify the Web pages, highlight parts of it and add tags or comments, while the back-end of the system just need to check these annotations and associate them with the specific user and the specific URL. Annotating on a computer-screen is an activity that competes with the reading itself, due to the lack of direct manipulation. However, users will do so when the benefits are higher than the costs in terms of effort. These benefits may include the saving of time needed for re-finding, summarizing, organizing, sharing and contributing online annotations. A rather economical view on the balance between the drawbacks and benefits has been given by information foraging theory, in which he described the above activities as *information enrichment*.

Today, both companies and academia institutions train learners to complete tasks and solve problems through project-centered learning. Since it may not be feasible for all participants involved in the projects to meet on a regular basis, they must be assisted by information and communication technology. To support this collaboration there are specific methods for Computer Supported Collaborative Learning (CSCL) provided by learning environments and other platforms can be adapted to fit this need. For the best results of the learning process, the methods should help each learner to *act individually* to reach her own goals and to *cooperate* by sharing and discussing ideas to accomplish an assignment. As discussed in the previous section, in the same way annotations contribute for memory aiding, text interpretation and information re-finding, web annotations provide the same functionality in the online environment. Web annotations are accessible anytime and anywhere, with diverse sharing possibilities, clearly enhancing workgroup collaboration for cooperative tasks and learning processes. However it is important to remark that the full richness of paper annotations will only be achieved if the digital annotations hold the same beneficial feature of being '*incontext*'. 'In-context' annotations are visible within the original resource, enhancing it with the observations and remarks of the annotator, which are likely to help in individual tasks in similar ways as is the case with paper documents [10].

The following are common electronic annotation functions:

- Linking annotations. Links can be categorized as coarse-grained or fine-grained [14]. Alternatively, links can be distinguished as uni- or bi-directional, regular or multiway, and manual or automatic. By linking annotations, the user can navigate and search notes from different documents. Annotations such as conversations and e-mails are frequently presented as post-reply threads.
- Naming and addressing. The names of notes and links are required for navigation and searching. For on-line public sharing, addresses can be URLs on the web. The system should provide automatic addressing and naming for users.
- Indexing. An annotation Index represents a list of all annotations on a page [7]. This function provides an overview of the page, and is a convenient mechanism for editing, sorting and managing the annotation.

General requirements for educational web annotation systems

As a result of investigations into the literature surrounding web annotation and assessment of publicly available systems it is possible to draw together a number of requirements and desirable factors for such systems, both as educational and general research tools. The factors can be further broken down into conceptual and technical, with conceptual factors being those that are intrinsic to annotation and the technical factors

being those related to the implementation of the conceptual factors. The essential factors are:

Conceptual:

- (a) Text annotations. The ability to add textual annotations to the webpage is fundamental in order to benefit learning by the integration of further context with the original content.
- (b) Private annotations. Learners must feel assured that there can be no adverse reaction from the comments that they choose to make otherwise they may choose not to make any annotations.

Technical:

- (c) No additional software necessary. In order to limit potential barriers to usage it should not be necessary for the student to install additional software in order to use the tool.
- (d) Accessible. The system should be compatible with assistive technologies, such as screen readers and be usable with only a keyboard.



(e) Browser independent. The core functionality should be usable in all of the major browsers in order to be available to the largest number of learners.

(f) Maintains page integrity. The underlying page must remain essentially the same when viewing with the annotation system as it would otherwise. This is to ensure that the learners are not being adversely affected by the use of the system.

The desirable factors are:

Conceptual:

(a) Graphical annotations. The ability to add graphical annotations provides greater flexibility to the students and allows the use of resources that may present interesting concepts in novel forms.

(b) Linking annotations. A significant benefit of annotations is the ability to reference materials that are not provided in the main text. By creating hyperlinks learners can develop new

information webs and revitalize older content by providing links to more recent arguments and ideas.

(c) Shared annotations. In order to obtain the benefits of Collaborative Learning it is necessary to provide the ability to share annotations amongst students. This can increase the likelihood of peer-learning occurring.

(d) Annotation reports. The ability to collate annotations into structured reports would allow the students to create their own learning materials for future reference and for use when studying for examinations.

Technical:

(e) Open architecture. An architecture that allows other developers to create systems that utilize the core functionality and add new features and process is desirable in order to focus upon the different need of learners in different subjects and locations.

(f) Non-commercial. Although the available commercial systems are highly competent, the advantage of non-commercial systems is apparent in both the initial cost but also they are more likely to be based upon an Open architecture.

The requirements in the 'essential' category are deemed to be fundamental when online annotations are to be used to support an educational process. These requirements address the minimum level of functionality needed to provide a beneficial experience to the students. The 'desirable' category contains a higher proportion of conceptual, rather than technical, requirements and provides for features that will make an annotation system more flexible and interesting to use. By allowing different annotation types to be made the student is free to select those most appropriate to the material, the learning process or their learning style. These factors are neither exhaustive nor absolute as slight differences in the problem domain would most likely alter the requirements significantly; however, the listed requirements are intended to provide a generic overview of the considerations likely to be encountered when developing or selecting a system for implementation.

VII. CONCLUSION

In this paper we discussed the role of annotation in learning in general and in e-learning in particular. From the background research it has become clear that the act of annotating supports the learning process in paper-based situation. However, when it comes to online learning, annotation becomes an additional cognitive burden, due to the lack of suitable tools and intrinsic problems related to reading from a screen and interacting via keyboard and mouse. From the comparison of online annotation with paper-based annotation it becomes clear that there is a difference between both types. Online annotations were typically short and had a certain purpose in terms of re-finding, sharing or commenting. The high amount of highlighting in paper-based annotations has an intrinsic value. Based on the results we conclude that emphasis in the development of annotation tools should be put on added value by better exploiting the annotations (for example for enhanced re-finding tools, visual overviews, grouping, sharing, collaborating) rather than to try and mimic the 'old-fashioned' paper-based annotation. At the same time, writing an annotation should cost as little effort as possible, as otherwise people will inevitably resort to other ways of getting their things done [2]. This poses a design challenge for the development of annotation systems and provides an explanation why these kinds of systems have not found an audience yet. Furthermore, we think that the development of added value for annotations will provide many more opportunities for personalizing the learning environment and for facilitating communication and collaboration between learners. Annotation is a valuable learning practice that can support reinforcement of existing knowledge and the contextual integration of new knowledge. The growth in online learning increases the desirability for a mechanism for web annotation and the provision of collaborative features has the potential to increase the benefits obtained from such a web annotation system by allowing users to learn from their peers. Empirical study of both the use and benefits of such annotation systems needs to be performed in order to identify the validity of the technology when applied to different types of learners, particularly different levels of understanding, such as schoolchildren, university students and lifelong learners. However, those studies that have been undertaken, generally based upon adult learners, suggest that there is a correlation between the availability of annotations and an increase in learner understanding.

Wider adoption of web annotation technology could eventually benefit all users of the web, not just those directly using web based learning resources. The resulting annotations could be utilised by search engines as additional data to rank and filter pages according to relevance, both by explicit key words and by implicit means though existing links, created either by the original page author or by other readers.



VIII. FUTURE DEVELOPMENTS IN ANNOTATION

As the volume of information and specific learning resources accessible through the World Wide Web increases, so does the desirability of online annotation tools; however, as the format for learning resources becomes more standardised, there is currently no emerging standard or specification for the format of annotations. Without a formalised structure it is unlikely that organisations will commit to the implementation of an annotation system as they would be unable to migrate the annotations they have already captured to a new system. Therefore, it is essential that a standard ontology be devised that provides the basis for annotations and gives a level of interoperability between the different systems. With a standardised ontology for annotations it would be possible to utilise annotations in new ways, such as 'overlays' for content in reusable learning objects (RLOs). For example, an RLO could be supplied with a set of annotations by the author or a third party that would allow additional information and links to be displayed at the learner's request adding a new layer of contextualisation to the original resources dependent upon the needs of the learner. Annotation sets could also be produced by an organisation to address the problems encountered by their own students without the need to update the underlying RLO. This may assist students in developing new insights into the materials with which they are working and help reinforce existing knowledge by allowing access to different contexts. Developing an adaptation mechanism that utilises freeform, yet structured, annotation data to influence the display of content would present a significant challenge, and yet may produce rewarding results. For example, one learner may state a preference for annotations being listed in a tabular format, whereas another user may desire to see those same annotations in a 'concept map' format, both of which could be generated automatically by the system. However, this would require either the creation of explicit links between annotations or the use of an algorithm to identify the relevance of an annotation to the desired context according to its content.

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