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'mat': A New Media Annotation Tool with an Interactive Learning Cycle for Application in Tertiary Education

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Abstract: This paper provides an overview of the design process of a new online media annotation tool. This work-in-progress report will step through some design decisions as aided by reviewing learning theory and related experiences outlined in the literature; design principles from a user interface perspective; and user testing of the first design iteration. The first of a three stage development of the media annotation tool, 'mat' (MAT), is designed for learning from video, with later stages enabling other media (audio, image, other) plus assignment building with media inserts. User testing reinforced several design decisions plus initiated some change.

Introduction

A new online media system was designed to aid collaborative artefact-centred learning at RMIT University, comprising two tools: a media annotation tool ('mat') and a shared media project lab ('smpl'). The first tool—and the focus of this paper—'mat' (MAT) is an online 'media annotation tool' that provides a learning environment for annotating various media, e.g. audio, video, image, text. It allows for analysis of specific aspects of the media with a linked structured discussion area, for purposes of personal study through to a complete activity or learning cycle, incorporating peer collaboration and teacher feedback.

A small network of staff at RMIT University designed MAT to meet identified needs, energised by viewing a 2005 Massachusetts Institute of Technology (MIT) demonstration of their tool 'XMAS', or Cross Media Annotation System (see MIT, 2005), and from a search of available annotation tools in an attempt to find a media-centred tool that might already have the functionality required. The scope of desired functionality included: works for all operating systems; smart login; group management; annotate text, audio, video, webpages, images; create essays that display text, audio, images and video in context; and media management. The tool design was refined over time, aided by a review of literature and the input of early adopters in contrasting disciplines, which allowed user testing and consideration of application of MAT into specific contexts. Three developmental stages were planned. For Stage I, MAT enables video upload and annotation (and has since been tested in a vocational medical laboratory course and is currently in pilot application in higher education). Stage II development will enable annotation of other media (audio, image, text, web files, and Echo/lecture recordings), and Stage III will enable assignment building with media inserts.

The design process for MAT was initially influenced by theoretical concepts and related experiences in the literature, and reflection on user interface design principles. The next design iteration was influenced by feedback during design user testing by key stakeholders i.e. early adopters and, in particular, their student cohorts. The user testing of the Stage I interface was conducted over two sittings, with learner groups from two differing undergraduate cohorts, physical education and applied communication. This paper highlights some of the reflective practices behind the iterative design process.

Design Responsiveness to Review of Literature and Usability Issues

For many years traditional annotation has been used by learners to engage with learning materials, especially to signal, place-mark, work examples, interpret, and trace a path of attention (Marshall, 1997). Over the last 10-15 years there has been interest in electronic annotation (Hwang, et al., 2007; Nokelainen, et al., 2005), however, a number of tools developed tend to focus on annotating web pages only, with few especially designed for learning purposes (Glover, et al., 2007; Hwang, et al., 2007). Those that have been designed for education enable annotation of one or a variety of artefacts, from web pages e.g. 'Annotizer' Jung et al (2006); digital text e.g. 'MarkUP!' (McMahon & Dunbar, 2003); images, audio, video plus QuickTime movies e.g. 'ProjectPad[2]' (Northwestern University, n.d.). Not all available annotation tools are generic enough for immediate use within a given university's software and hardware systems. This includes compatibility across operating systems, compared to e.g. Mac only 'MarkUP!' (McMahon & Dunbar, 2003), or Windows only 'Vannotea' (Schroeter, et al., 2003), and specific server/media storage arrangements.

In the first design iteration of MAT, consideration was given to how the interface would accommodate annotation of video, audio, image, text, web files and Echo (lecture recordings), the management of groups and their media and markers, and a complimentary menu system supporting all functions, plus, to eventually support a media-rich assignment component. The tool had to be web-based so as not to be reliant on any particular operating system, software download or any other factor inconsistent with RMIT's standard operating system. The interface design also needed to be as intuitive as possible for ease of learner use. A three column grid system for the interface was developed (see Figure 1). The main central column comprised (in order top to bottom) the video, timeline and annotations/ commenting area. The left hand menu provides administrative and activity commencement functionality. The wider right-hand menu is the main navigator providing group information, marker definition and a list of markers created by/for the member who is logged in. Both the right and left hand menus went through significant design iterations to be as simple and intuitive as possible. Overall, the colour scheme and the menu system needed to direct the main focus to the central column rather than the supporting menus.
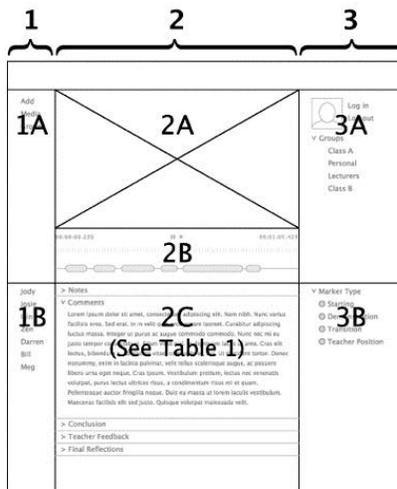
1 Left Hand Navigation
  1A Admin – adding media, creating new group (individual or many)
  1B Group member list to move between media in your group

2 Main Central Screen
  2A Video (media area)
  2B Timeline and markers
  2C Annotation and commenting area (see Table 1)

3 Right Hand Navigation
  3A Log in/out and group information
  3B Marker definitions and marker list

Figure 1: Media annotation tool interface

Several studies highlight concepts relevant to annotation in an electronic environment. Petkovic et al (2005), Jung et al (2006) and Krottmaier and Helic (2002) each claim that in comparison to paper-based annotations, electronic and/or web-based contexts offer more powerful annotation environments, extending to features allowing collaboration. Glover et al (2007) discuss the need to maintain the advantage of immediacy/closeness of annotations to the artefact to keep discussions in context. Dwyer and Suthers (2006) note that both text and non-text representations (e.g. visuals) can change in meaning depending on a given context, and draw collaboration and context together in that "collaborative practices produce powerful, context-specific mechanisms and we should create software environments that cultivate them" (p.509). Van der Pol, Admiraal & Simons (e.g. Van der Pol, et al., 2006) tested and found that 'anchoring' discussion to specific components of an artefact of academic text lead to increased focus and efficiency of discussions.

To allow context-specific collaboration in MAT, any selected and marked aspect of media is directly linked to its own annotation area, with peer comment and teacher feedback areas available (enabled depending on the type of activity and whether a full learning cycle is required). In MAT Stage I, learners can watch a video—with regular functions of play, pause, stop—identifying and selecting segments of video relevant for their current learning. They can mark chosen segments with a coloured 'marker' on the timeline of the video (also with the option of selecting a 'shape' identifier e.g. an embedded triangle in the marker). For each marker used, an annotation area is automatically generated that remains directly linked to that segment of video, providing asynchronous text entry areas for writing notes, and collaboration as required. MAT aims to keep annotations anchored to the aspect of artefact under learning focus; by linking each segment of learner-selected media with its own asynchronous annotation area, it provides potential to keep each discussion 'on task'.

Kozma (2000) notes the advantage the electronic environment of a computer has in "integrat(ing)… resources and the structuring of activities that support learning" (p.8). However, how to structure a learning cycle within a technological tool such as MAT is a significant issue. Kienle (2006) prescribes four steps to computer-supported collaborative learning including 1) preparation by the facilitator; 2) work with own material; 3) work with other's material(s); and 4) discuss and negotiate. "These steps rely on the participants' collaboration but should also be supported by the system's functionality" (Kienle, 2006). Krottmaier and Helic (2002) also note the need for system support, noting that "some technical problems have to be solved and tools must be created to support users in writing and managing annotations" (p.2). They also suggest that a structure utilising categorisations could render annotations more useful, with categories "like 'Question', 'Answer', 'Problem', 'Solution', 'Rating' etc. … (as helpful for a subsequent reader) in selecting whether to read or not to read the annotation or even the content" (p.2). This contrasts with a caution from Dwyer and Suthers (2006), who say users may resist categorisations, seeking more flexible or unanticipated ways of collaborating. Lin et al (1999) examined several technological tools that facilitate reflection in particular, and advocate 1) in-built support, where it is clear to see advancement against learning goals; 2) reflection used in a cycle of learning where learning steps scaffold on to previous steps; 3) explicit representation of learner understanding, e.g. "reflective social discourses" (p.57); and 4) explicit representation of growth of learner understanding over the span of the learning. In teacher education literature, significant factors to enable a reflective learning cycle tend to include: linking theory to practice; peer discussion; and teacher guidance and feedback. Hatton and Smith (1994) provide a good (and much quoted) paper covering this detail, and note that learning activities can help provide a learner with the opportunity "for giving voice to one's own thinking while at the same time being heard sympathetically, but in a constructive and critical manner" (p10).

ANNOTATION AREA	INTENDED ANNOTATOR	INTENDED USE
Notes	Learner*	Once a segment of media is selected, initial notes can be written in this area, with potential for analysis/reflection; linking theory to practice; testing own 'voice' or opinion
Comments	Peers**	In this area, other learners (in a designated group) can provide multiple perspectives on the learner's notes and the chosen segment of artefact
Conclusion	Learner*	This area can provide a space to conclude theory/knowledge/opinion (iterative or final) on the segment of artefact, utilising own notes, others comments, and any other learning activities used to analyse the segment, such as topic readings
Teacher Feedback	Academic/ tutor/supervisor	Here the teacher can provide feedback from reading the conclusion and viewing the segment of linked artefact, and possibly digging further into notes/comments/further evidence in artefact where required
Final Reflections	Learner*	This area can provide a final step to close each of the learning cycles, particularly where the above steps are all enabled; an opportunity for the learner to bring the teacher feedback into their learning and decide on their final positioning

* Usually one learner who is the principal 'media' student e.g.: designed or collected the media under focus, but could be more than one learner
** Usually fellow students (but could include guest expert, workplace supervisor, other) who have been granted access to the group

Table 1: Annotation areas in MAT, as components of a learning cycle

MAT is designed to automatically generate an annotative learning cycle (or part there-of) linked to each marked segment of media. The full learning cycle has labelled areas (see 'annotation areas' in Table 1), which can

be progressively 'closed' at pre-determined times or circumstances (e.g. due dates). The 'Conclusion', 'Teacher Feedback' and 'Final Reflections' areas can be set to become visible once the preceding sections (e.g. 'Notes', 'Comments') are completed, depending on the nature of the learning activity. MAT is structured for learning, but considered by the authors/designers as not being over-structured. The titles given to the annotation areas (Table 1) are quite generic, and thereby anticipated as broadly useful. However, teachers or learners can determine 'meaning' for the titles other than typical (e.g. 'Teacher Feedback' could be redefined as 'student moderator comment' or 'invited guest expert', or other; 'Conclusion' could become the 'team solution for problem' area, or other), or certain annotation areas can be turned off to meet particular activity needs. MAT has the flexibility to be used for a range of learning scenarios. One learner may use it for personal study, e.g. selecting sections of a recorded lecture for pre-examination revision, and writing personal meaning-making notes against marked sections. Another may use it as part of a group, e.g. sharing a video recording of a chemical procedure or phenomenon and using the full learning cycle available for note making against each marked segment of media, harnessing peer perspectives, drawing conclusions, feedback from teacher, and final reflections.

The markers that learners use to identify segments of media are unnamed and undescribed until the teacher and/or learners do so in setting up the activity. The markers could—for a simple example—be named and described to help draw out contrasts presented in the artefact under focus such as 'Good safety example', 'Poor safety example', with descriptors entered to make their meaning further explicit for effective engagement with the activity. (Further to this, each time a learner marks a section with a 'Good safety example' marker, they can sub-label each marker with a 'tag' name to further define it for themself and to aid later location for readers, e.g.: 'Bunsen burner'; a capability added by the web developer during development.)

Design Responses to User Testing

In general, the user testing was valuable in affirming much of the intuitive nature of the interface design and in providing ideas for further investigation. User testing of MAT Stage I (video) was conducted over two sittings. This involved small groups of learners from two differing undergraduate cohorts, the first involving physical education (PE) students (n=9), then applied communication (AC) students (n=6). The aim was to receive key stakeholder feedback on the interface design before production of MAT commenced. A questionnaire was administered after the students had interacted independently with the interface, to harness their first impressions of the tool before a whole-group discussion and a presentation of MAT. Table 2 illustrates that after the students had interacted with the MAT interface all had at least some idea of what the tool did and at least some understanding of how they would use MAT.

QUESTIONNAIRE 2 ∨	COHORT ∨	1 yes	2	3 a little	4	5 not at all	
Question 1 Did you understand what this tool does?	Physical Education	3	5	0	1	0	n = 9
	Applied Communication	2	2	1	1	0	n = 6
	Total	5	7	1	2	0	n = 15
		80%		20%			
Question 2 Did you get an understanding of how you would use it?	Physical Education	4	4	0	1	0	n = 9
	Applied Communication	1	4	1	0	0	n = 6
	Total	5	8	1	1	0	n = 15
		86%		13%			

Table 2: Interface user testing data (quantitative)

A further questionnaire was administered at the end of each user testing session—after whole-group discussion and presentation—and yielded valuable qualitative feedback from both groups. The overriding theme expressed by the PE group was the perceived value in MAT's ability to harness multiple perspectives of peers and feedback from their teacher. One divisive item in the PE group was the colour scheme, with a relatively positive comment of "colours work well in drawing you to the most important parts. Shading out other areas that are not as important would help", compared to "it was dark and brooding, perhaps making the writing bigger would help to (sic). It's very official". Presentation was also picked up in the AC group, where one response nominated the

"Colour scheme, aesthetics" as the item needing most improvement in MAT. The mixed responses to the colour scheme/aesthetics initiated personalisation options for the tool, including the option for learners to choose a light or dark interface, and wider colour selection for markers.

The markers—originally referred to as "tags" in the user testing stage—received a significant amount of comment from both cohorts, including a mix of positive and negative commentary. In the early questionnaire, the markers/tags were nominated overwhelmingly as the item most needing improvement, with several responses expressing either confusion about or improvements required to the markers. Suggestions included clearer names and descriptors; "tallies of frequency of a tag [used]"; and the possibility of overlapping tags (markers) to allow different discussions to occur in overlapping areas of the artefact under learning focus. After the whole-group presentation and explanation, opinion shifted somewhat with students referring to the markers in the final questionnaire in an almost even mix of 'best feature' and 'needs improvement' categories. While this reduced the criticism, it identified the need for improvement to the markers if students are to manage the tool easily in isolation. Further suggestions for improvements included making the markers bigger for improved visualisation, and the ability to "click on the tag underneath the video, [and] have the key tag on the side light up".

While tallies of markers are not explicitly featured in MAT, letter and number options have been added to the marker identifiers (also further aiding accessibility). The option of choosing numbers instead of shapes in the markers there-by allows a ready count for learners who select and mark a large number of media segments. Markers have had other significant design modifications, including larger size and extensive consideration to enhancing overlapping markers, such as signposting the marker with flags to allow users to identify overlapping tags easily. Additionally, while adding notes students can see which segment of media they are annotating by unrelated markers fading, and the selected marker remaining in full colour. This is to make it explicit which marked annotation area and related segment of media the student is working within. Another student response suggested "Names under the video so you know what video you are looking at". The left hand menu now accomplishes the need for media identification; as learners switch between various group members' videos, the name of the media 'owner' is highlighted so they are reminded at a glance whose/which video they are providing comment against.

The understanding of private use versus community/interaction with others was the most contrasting theme in the AC group, illustrating that initially some only saw potential of single person use of MAT while others saw it principally for group purposes. This is an example of one idea affirmed (i.e. planned for but not necessarily explicit in the interface design), regarding the ability of MAT to be used for shared or personal use as 'groups' in MAT can be of 'one' or multiple. Other examples included descriptors to further define markers, and the need for a support or help tool to explain how to use MAT, both planned for development.

The prototype of MAT Stage I (video) was developed based on the final design iteration. It was trialled mid-development in a vocational medical laboratory course using an authentic learning activity*, with the MAT developer and designers present to support the learners and teacher. The students viewed videos of laboratory procedures over two classes, each time to "prepare for a particular electrophoresis prac in an online environment". The markers prepared for two activities were: (1) 'Recognised equipment/solutions' and 'New equipment/solutions'; (2) 'Identify the steps (of the procedure)' and 'Identify hazards'. The students worked in pairs for this trial, and chose one person to make initial 'Notes' against segments of video they marked, while the other responded in the 'Comments' section for each marked area, swapping roles for activity 2. While this trial provided an opportunity for the developer to test the working features of MAT, it also provided the learners with a blended learning experience that combined "online learning with experiential, offline, hands-on learning" (Godwin & Kaplan, 2008).

* Balding, K., & Colasante, M., (2009) 'Interacting with video; Video: electrophoresis procedure', RMIT University

Conclusion

MAT is a media annotation tool for students and their lecturers to have in-context discussions centred on an uploaded media artefact. The interface design supports personal study of media through to offering a structured learning cycle, anchoring comments with selected aspects of the media and allowing multiple perspectives from peers and teachers. MAT, in its final stage, will provide a media-rich system where students, lecturers and guests can annotate, comment and finally create a media-rich report. This paper provides a work-in-progress report, illustrating how design iterations of MAT Stage I (video annotation) were influenced by theoretical concepts and user testing. Undergraduate student feedback in design user testing reinforced several design decisions while also initiating some needed change.

The next steps involve implementation and examination of MAT, plus further development of the tool. Learning effectiveness of MAT (Stage I) is currently being formally evaluated in RMIT University as part of the

first author's master of education research (Deakin University). This involves a single case study examination of the pilot application of MAT. The learner cohort is studying a practical placement subject (Semester 1, 2009), uploading video footage that demonstrates their individual practice on professional placement, and selecting key segments of the video to form the basis of critically reflective learning cycles.

Further development of MAT will include completion of the next stages of production to provide for media other than video, including audio, image, text, web-page, Echo (lecture recordings), plus an essay building tool to harness selected media excerpts and their related annotations into a media-rich report. Additionally, the related tool 'smpl' (pronounced 'simple'), designed as a 'shared media project lab' peripheral to MAT, is now developed and provides a simpler version of MAT without an imbedded learning cycle, where learners share and comment on each others projects in general and is currently in undergraduate use.

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