Kritikos: creating an engineering student community search engine for learning resources

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INTRODUCTION

Engineering students and their teachers in further and higher education use a variety of strategies to find useful learning resources on the internet, to a varying level of success. The most popular search engines can often fail to place the most useful resources of direct relevance to education and the students' discipline on the first page or two of results. Many important engineering subject-specific terms (e.g. stress, fatigue, fracture, circuit, current, etc) produce results more relevant to other disciplines. The resources that are found are also often of variable or unknown quality, and students complain of having to spend large amounts of their time searching and evaluating websites. Also, some useful resource formats may not be immediately visible. For many learners, visual content including interactive animations and moving images are increasingly useful as they can help make concepts clearer and more interesting.

This paper reports on the findings and outcomes of the JISC-funded ENGrich project (engrich.liv.ac.uk) and how working with a team of engineering students led to the development the visual media search engine, *Kritikos* (kritikos.liv.ac.uk). Based on Google, Kritikos allows users to quickly find visual and text-based learning resources such as videos, animations, presentations, documents and images which are specific to the engineering discipline they are studying. The results are displayed visually for

each resource type as live thumbnail galleries, allowing faster judgment as to the potential relevance of resources than is possible by text-only results.

The really novel and world-leading aspect of the search interface is that it also incorporates features common to social media sites, allowing students to share information about the usefulness and relevance of resources to their modules, courses and degree programmes, subsequently displaying this information alongside search results for all users, effectively developing a community of student learners. Students can also "favourite" resources to allow them to create their own collections, and they are also able to rate the activities of their fellow students. This helps democratise results and also acts as an incentive for individual students to build up a reputation for discovering and sharing useful educational resources. All the student activity is stored in the Learning Registry (www.learningregistry.org), and the rich intelligence produced is accessible to teachers to inform them of exactly what resources their students find the most useful for their learning for each aspect of the engineering curriculum.

We report on the results of surveys of engineering students designed to understand the role of internet searching and web-resources in engineering students' learning, and how we worked collaboratively with a team of engineering students to develop the Kritikos search engine interface. Some initial usage data is reported, and its potential considered for other disciplines.

1 STUDENTS' DIGITAL LITERACY SKILLS

1.1 Use of social media and internet searching to find learning resources

Over ten years ago, students' preference for use of the internet rather than library-book research was identified. [1] Students had become very much social learners. However, there were already concerns as to the quality of resources found on the web, especially with it becoming the primary source of reference information for many students. More recently Kyung-Sun et al have surveyed over 800 students in the US and Singapore to find out about their use of social media platforms as information sources. [2] They found over 95% of students used Wikipedia and Social Networking Sites such as Facebook for information sources. User reviews (such as those in Amazon.com) and video sharing sites (such as YouTube) were also widely used, by about 70% of students.

Whilst the internet allows access to information on a scale unimagined even ten years ago, 'For many of today's undergraduates, the idea of being able to conduct an exhaustive search is inconceivable. Information seems to be as limitless as the universe. And research is one of the most difficult challenges facing students in the digital age'. [3] However, teachers are never surprised to hear their students say "I just type it into Google and see what comes up." The acknowledged difficulty for students is to identify what is useful, reliable and relevant.

In Engineering, internet searching can provide huge numbers of "hits" – 145 million results returned (in June 2013) when searching for "stress" in Google.co.uk. However, the first non-medical result is only found on page 16 (related to stress in the marine environment), and the first engineering-related result on page 18 (related to stress corrosion cracking). Whilst any digitally literate student should be able to add "engineering" to the search term, usefully bringing Wikipedia engineering-related results to the top, this is followed by many industry and professional websites which are time-consuming to read through in order to identify reliable learning resources which are relevant to the curriculum. Some guidance as to preferred websites may be provided in reading lists by their teachers, but like textbooks, the presentation

style and academic level preferred by the teacher may not always be the same as their students. Also unless they are regularly reviewed, it is easy for sites to go off-line or become obsolete.

1.2 Previous engineering resource-discovery projects

The 2006 Community-Led Image Collections (CLiC) Project [4] identified a 'discovery gap' in the educational sector – the gap between how users search for information (typically through Google), and the provision of high-quality teaching and learning resources. The CLiC report also identified a distinct lack of image collections in the engineering discipline relevant to teaching and learning, and one reviewer of the Image Case Study in CLIC observed: "Much of engineering is not static but dynamic, so dynamic images are not just flashy but actually useful."

In 2007 the Pilot Engineering Repository Xsearch (PerX) project produced a subject-based pilot service (http://www.engineering.ac.uk/) which cross-searched metadata within the engineering learning and research communities. The project concluded that searches should not be limited to repositories aimed only at the engineering community. In 2008 the same group developed the TechXtra project website (http://www.techxtra.ac.uk/) which cross-searches 31 different text-based collections relevant to engineering, maths and computing. Neither PerX nor TechXtra were specific to teaching and learning materials, nor did they attempt to access, utilise or create usage metadata, or paradata, as has been achieved in Kritikos.

In summary, previous projects showed that the engineering community of both students and their teachers would benefit from creating an enhanced, peer-maintained, educational resource search service; one which delivers dynamic, visually-appealing, and interactive visual content, that could be tailored to users' interests.

2 ENGINEERING STUDENTS' USE OF HANDOUTS, WEBSITES AND TEXTBOOKS FOR LEARNING

There appears to be no published research investigating how engineering students find and use resources to support their learning. Therefore 138 undergraduate Aerospace, Mechanical and Civil Engineering students studying at the University of Liverpool were surveyed at the half-way point in the 2013/14 academic year (January 2013). They were asked to rate the extent to which they used their teachers' lecture notes and other handouts, websites found by internet searching or recommended by their teachers', and published textbooks, to support their learning in the context of coursework and self-study, and the results are shown in Figure 1. The overwhelming reliance on their teachers lecture notes and other handouts is perhaps unsurprising. It is also clear that the students use internet searching more than they use recommended textbooks, with more than half the students using recommended text books only a little or not at all.

There were approximately equal numbers of students from each of the 4 years of undergraduate study aggregated in Figure 1. The differences between year of study is small, although there is a greater use of websites found by internet searching towards the end of the degree course (30% of students use internet searching "all the time" in their final year, compared to less than 10% in year 1). There is also slightly more use of lecturers' handouts in the first two years (over 50% use them "all the time", compared with only about 40% in years 3 and 4).

The students were also asked the same questions specifically in relation to revision for their end of semester examinations. The results showed broadly the same trends,

however, students made less use of internet searching (only 35% used websites found by internet searching 'all the time' or 'quite a lot' for exam revision, compared to the 61% in this category in Figure 1 for coursework). Engineering students also make slightly less use of textbooks during exam revision (about 10% fewer students used them 'all the time' or 'quite a lot' compared to for coursework). These differences presumably reflect that much coursework requires access to a wider source of reference materials than just those provided by the teacher. Many comments collected with the survey clearly indicated of the engineering students' exam preparations focus on reviewing lecture-delivered material taught largely from lecture-handouts including copies of lecture slides and especially model solutions to assessments, especially past exam questions.

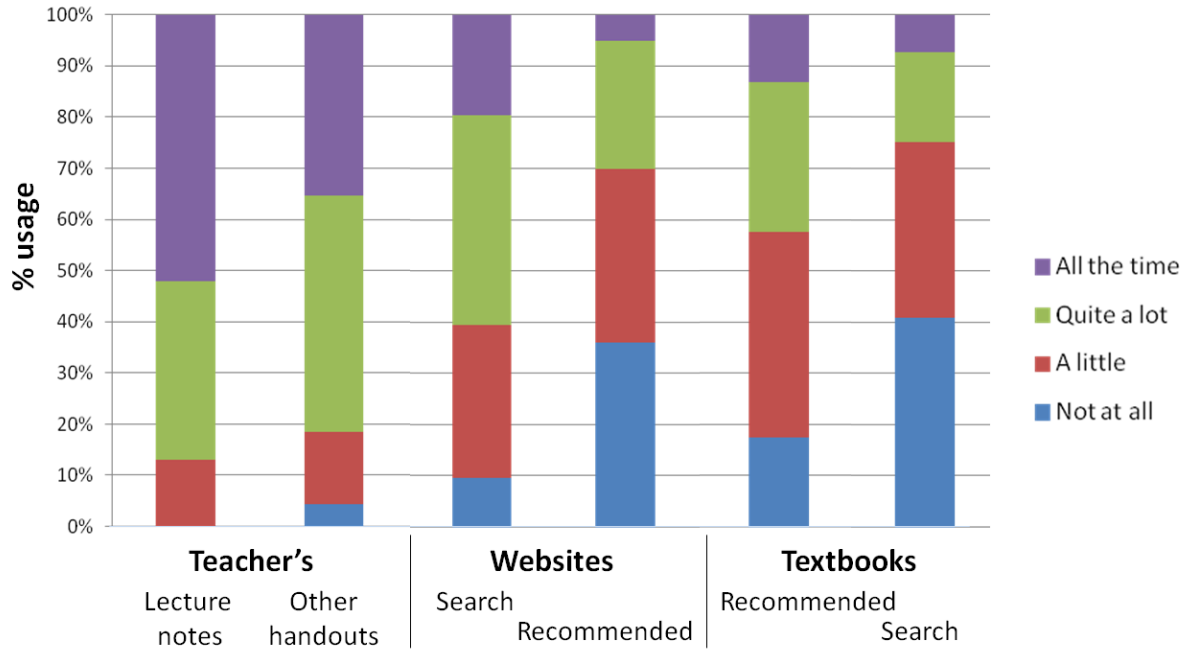

Fig. 1. Engineering undergraduate students' usage of their teachers' lecture notes and other handouts (e.g. worked solutions to problem papers), websites found by internet search engines (e.g. Google) and those recommended by their teachers, and textbooks either recommended by their teachers or those found by library searching, to support their learning in the context of coursework and self-study. Students were asked to identify whether they used them 'all the time', 'quite a lot', 'a little', or 'not at all'. (N=138)

Students were also asked to rate the extent to which they used discussions with their fellow students (either face-to-face or on social networking sites), direct contact with their teacher (face-to-face or by email), and internet discussion forums, during revision for their exams, as summarised in Figure 2. More than half interacted with fellow students (either face-to-face or in social networking sites) 'all the time' or 'quite a lot', whilst only 23% interacted with their teacher to the same extent. Very few students used internet discussion forums to any significant extent.

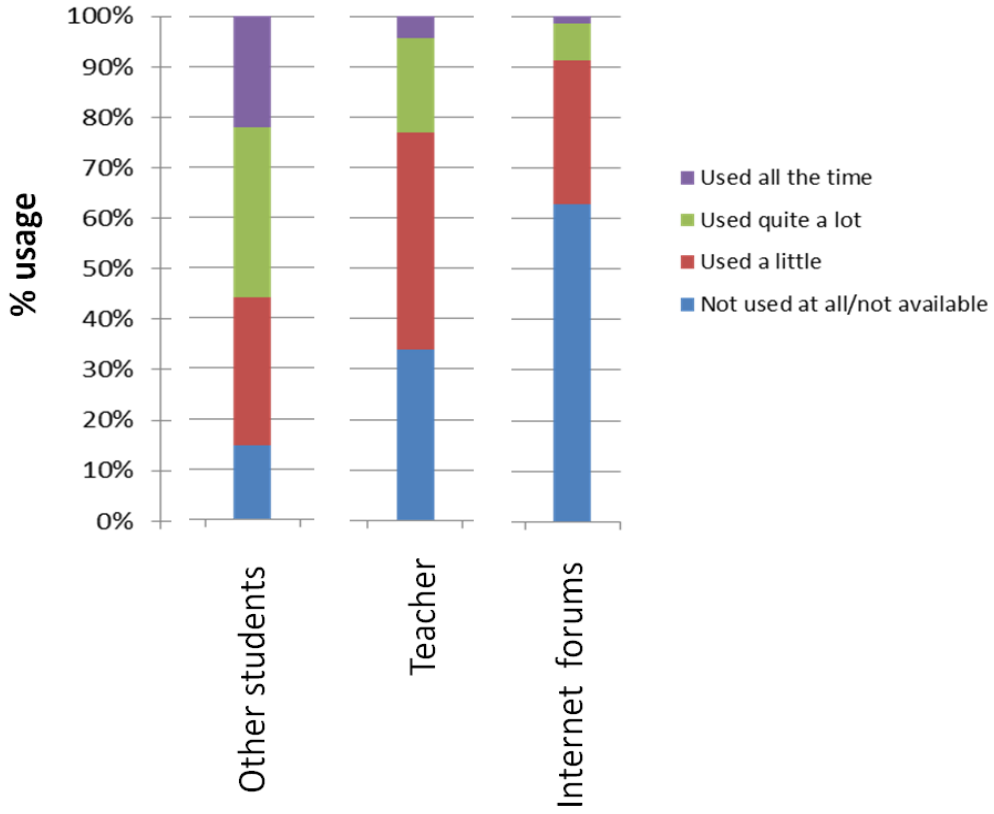

Fig. 2. Engineering undergraduate students' usage of face-to-face and social networking sites (e.g. Facebook) for discussions with fellow students, direct contact with their teacher (face-to-face or by email), and internet discussion forums, during revision for their exams. Students were asked to identify whether they used them 'all the time', 'quite a lot', 'a little', or 'not at all'. (N=138)

In the context of the development of the Kritikos community search engine, it is clear that many engineering students prefer web-searching to the use of textbooks, with 40% of engineering student never using a textbook they have found themselves, and almost 20% not using any textbooks that are recommended by their teachers. Web-searching to help learning is used by more than 60% of students 'all the time' or quite a lot', and is more common when working on coursework rather than preparing for exams. Finally more than 50% of students network 'all the time' or 'quite often' within their student community to help support their learning when preparing for examinations, almost twice the number than who contact their teacher, and many more than those who use external internet discussion forums.

3 THE *KRITIKOS* CUSTOM SEARCH AND COMMUNITY RESOURCE SITE

3.1 Engaging engineering students

Student community engagement was an important aspect of every stage of the development of Kritikos, as an early decision was made to focus Kritikos at the student community as the primary user audience. The rationale was that students could be used as the mechanism to change teaching practice, and encourage the adoption of the project principles within the academic community. We therefore made use of Engineering students through regular focus group meetings: a mix of 2nd, 3rd and 4th year students (Engineering, Mechanical Engineering, Aerospace Engineering and Civil) formed our 'student reference group'. They helped in the design and

development of the Kritikos user interface, and in populating the Learning Registry (see below) with approximately 25000 records relevant to the engineering modules they had studied. The students were also instrumental in confirming our 'TripAdvisor' approach, with emphasis being placed on producing resource paradata usage information over metadata for resource discovery, as the former was felt more important in helping to form judgements about the potential usefulness of a resource.

3.2 The Kritikos user interface

Kritikos has a simple structure with a main search page which also returns results, as shown in Figure 3, using the Google custom search API against a user's query allowing us to filter our searches by many parameters, including file format and site or domains. To display thumbnails, we used APIs from file-sharing sites, such as YouTube, Vimeo, Flickr and Slideshare, as well as Google Docs Viewer functionality. Student or teacher authentication is clearly an issue, to ensure usage metadata returned to the Learning Registry is from genuine students or academics. The problem was solved at an institutional level, as a proof-of-concept, by authenticating by generic sign-in to the University portal or on the Kritikos site.

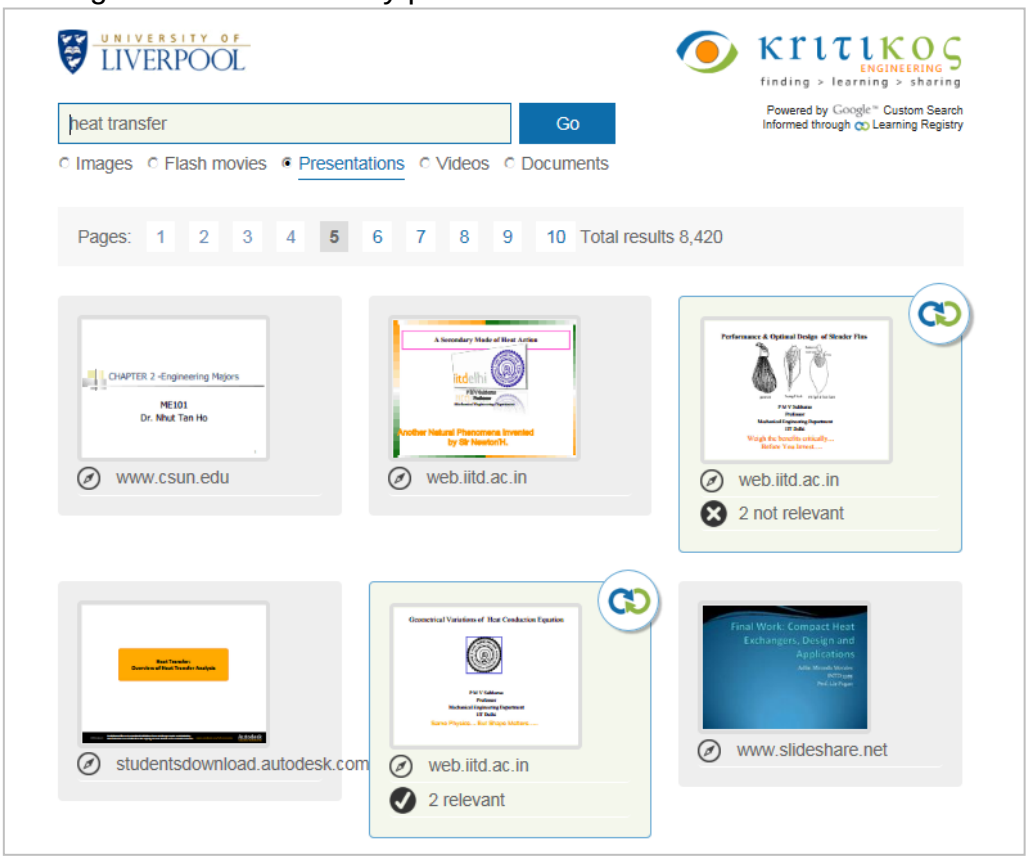

Fig. 3. Kritikos main search page with search results for 'heat transfer' presentations. The blue and green icons indicate that there is some activity relating to the resource stored in the Learning Registry.

All the student activity is stored in the Learning Registry (www.learningregistry.org), an open-source system designed to facilitate the exchange of data on learning resources. To give us full control, a Learning Registry "node" was installed and configured at Liverpool, allowing us to extract specific data more efficiently. Apart from the personal information, which is encrypted, the rest of the data is also open for re-use by other parties under a Creative Commons [Attribution Share-Alike] license.

Each Resource Details page (Figure 4) provides a larger live view of the resource, plus contextualised data from Learning Registry for that resource, and an interface to allow users to interact with the resource and their add comments.

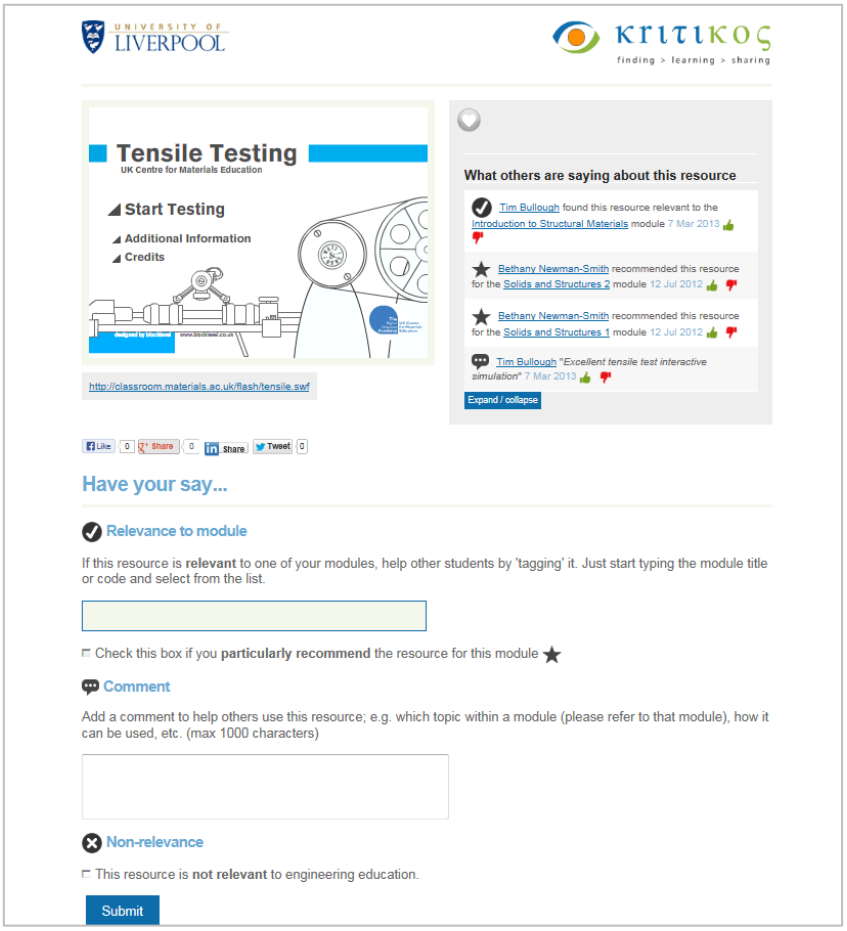

Fig. 4. The resource details screen allows signed-in users to preview the resource, to see what others are saying about it, to share their own opinions including associating it with a module, and to 'favourite' the resource.

Kritikos can also go directly to the Learning Registry and retrieve, order and display all resources which have previously been associated with any module, plus all 'favourited' resources for an individual signed-in user. This effectively produces a student-community set of resources for each module, and allows individual students to bookmark and retrieve the resources they have personally found most useful.

3.3 Student usage of Kritikos

The full functionality of Kritikos has been initially limited to Engineering students at the University of Liverpool to prove that the concept works, and to develop case studies of implementation before wider dissemination. Prior to release of Kritikos to the Engineering student community at the University, 25000 resource records were published directly into the Learning Registry (approximately 600 resources for each module), including identifying modules that the resources related to, and comments about individual resources. This pre-launch publishing was to ensure the functionality of Kritikos would be apparent to student users from its launch. Kritikos was finally made available to Year 3 undergraduate and masters engineering students for four weeks before the end of the 2012/13 session, primarily with the aim of them being

able to use Kritikos for aspects of their project reports (mainly to find contextual background information and technical references required in their reports). This allowed us to fully trial the system, prior to wider implementation planned at the start of the 2013/14 session.

In the 4-week period in which Kritikos was used primarily by Year 3 undergraduate students, we had over 1000 discrete users of Kritikos (95% from the University of Liverpool, which we know for certain were our engineering students), undertaking just under 900 searches, with each user viewing an average of 10 pages (mainly resource detail pages) with an average user visit duration of over 10 minutes. This was an encouraging indicator of student engagement with Kritikos. It was interesting that almost half the searches were to find documents. Students told us that Kritikos allowed them to find very useful and relevant published documents not limited just to Journal publications, but also including published industry and professional/academic documents of relevance to their engineering project work which had been difficult to find by normal searching. Images, presentations and videos were also popular resource formats. An interesting facet of the analytics is that it records the search terms entered by all Kritikos users, plus the user journey through the Kritikos site, both of which will allow interesting analyses of student behaviour in the future.

Only a small number of students linked resources to modules being studied, or added comments about resources, for sending to the Learning Registry. However this was not unexpected as the focus of the students' searching was primarily related to their individual project-work, hence a multitude of different topics and not specifically relevant to their fellow students or associated with their modules.

We plan to progress development of Kritikos with development of custom searching for other academic disciplines, plus the development of 'stand-alone' versions of Kritikos which can be implemented at module level or single activity/course level, and which would not require an institutional interface. The latter would then allow individual academics from any University or discipline to utilise Kritikos without requiring significant institutional involvement and development.

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