Learning, Media and Technology,
Vol. 30, No. 3, October 2005, pp. 281–297

JointZone: users' views of an adaptive online learning resource for rheumatology

Pat Maier[a]*, Ray Armstrong[b], Wendy Hall[a] and Muan Hong Ng[a]
[a]*University of Southampton, UK;* [b]*Southampton General Hospital, UK*

This paper describes an online learning resource for rheumatology that was designed for a wide constituency of users including primarily undergraduate medical students and health professionals. Although the online resources afford an informal learning environment, the site was pedagogically designed to comply with the general recommendations of the Standing Committee on Training and Education of EULAR (European League Against Rheumatism) for a rheumatology core curriculum. Any Internet user may freely browse the site content with optional registration providing access to adaptive features that personalize the user's view, for example, providing a reading history and targeted support based on scores from completed case studies. The site has now been available since early 2003, and an online survey of site registrants indicates that well structured pedagogical materials that reflect a learners' dominant 'community of practice' appear to be a successful aid to informal learning.

The context for JointZone: an undergraduate core curriculum for rheumatology

In 1999, the European League Against Rheumatism (EULAR) standing committee on training and education proposed a rheumatology core curriculum for undergraduate medical students, providing a set of minimal standards that could be applied throughout Europe (Doherty & Woolf, 1999). This proposal formed the basis of a project, funded by the Arthritis Research Campaign (ARC), to develop an interactive web site, JointZone, providing resources that addressed this curriculum. The curriculum aims to provide education that develops students' knowledge and clinical skills in relation to the musculoskeletal system. EULAR claims that those with a basic core

*Corresponding author. School of Civil Engineering and the Environment, Building 7, University of Southampton, Highfield, Southampton S017 1BJ, UK. Email: pjm@soton.ac.uk

ISSN 1743-9884 (print)/ISSN 11743-9892 (online)/05/030281–17

DOI: 10.1080/17439880500250485

knowledge in rheumatology should be able to assess, using appropriate history and examination techniques, an adult patient with locomotor symptoms. The learning objectives proposed by the core curriculum are:

- *Competencies in clinical assessment and diagnosis:* the student should be able to distinguish between normality and abnormality on examining the musculoskeletal system and should also be able to recognize the consequences of abnormality in terms of disability and handicap. They should also be able to recognize the commoner articular and extra-articular manifestations of locomotor disorders and in particular, they should be able to draw up an appropriate differential diagnosis and plan for investigation for the commoner presentations of musculoskeletal disease. These activities require the acquisition of skill in history-taking and also in examining the musculoskeletal system, for instance using the GALS (Gait, Arms, Legs, Spine) screen.
- *Knowledge of main characteristics and principles of management and rehabilitation of specific conditions:* **s**tudents should be able to specify symptoms, signs and predisposing factors and also be able to outline the investigation and management of the major rheumatic disorders, for instance sepsis, osteoarthritis and inflammatory joint disorders and bone disease among others.
- *Core knowledge, supporting diagnosis and management:* the acquisition of skill in assessing patients with musculoskeletal disorders should be underpinned by a sound basic knowledge of anatomy, physiology and pathology. Students should also have some knowledge of epidemiology and ability to interpret the results of pathology and imaging investigations. They should also be familiar with the more commonly used drugs as well as having a working knowledge of rehabilitation techniques and strategies to prevent musculoskeletal disease.

However, although JointZone has been guided by the EULAR curriculum and has an extensive 'library', it has drawn on the experience of an expert practitioner and been designed to meet the needs of practice. It is an informal learning resource and aims to provide a set of resources allowing the reader (student, health professional or patient) to browse and interact with it as he or she wishes.

The design of JointZone (www.jointzone.org.uk)

The pedagogical design

Case studies form the centrepiece of this resource. This pedagogical approach was selected as the EULAR curriculum emphasizes the application of skills and competencies in dealing with problems of the musculoskeletal system. Problem-based learning, and its implementation through case studies, reflects practice in real-life (Biggs, 2003, p. 232) and enables students to integrate knowledge within a professional context and develop diagnostic reasoning skills (Johnstone & Biggs, 1998). The case studies in JointZone reflect everyday clinical practice and follow 'the physician's normal activities and active reasoning process' (Washington *et al.*, 2003), 'structure

knowledge for use in functional contexts … [and] develop effective clinical reasoning processes' (Biggs, 1999). The materials are devised to follow a conventional patient journey. A referral is made from primary care (the general practitioner) to the specialist in secondary care (the rheumatologist). After taking a history and conducting a physical examination, a differential diagnosis is formulated. Investigations are then requested. Upon receipt of the results, the specialist may then settle upon a definite diagnosis and formulate a management plan. At each stage, users are given feedback on the choices they make, and the information they select is permanently made available to them during the case study.

A wide range of case studies was devised and the subject matter was chosen to reflect the commoner clinical problems presenting in everyday practice. These were constructed for beginner, intermediate and advanced levels to reflect both the complexity of the clinical problems and the knowledge and skills of the user (Table 1). The levels of the case studies were determined by degree of complexity and approach to clinical reasoning.

Hmelo *et al.* (1997, cited in Biggs, 2003, p. 238) distinguishes two strategies for clinical decision-making: *data driven* using data from investigations, which determine the diagnostic decision, and *hypothesis driven*, where the starting position is a possible condition which is supported or refuted by the data from investigations. Hmelo *et al.* claim that experienced doctors use a data driven strategy except for unfamiliar or complex cases. However, Round (2001) claims that experts tend to use three main methods: a hypothetico-deductive approach, as above, pattern recognition (combination of symptoms, recognized phrases from patients) and pathognomonic signs and symptoms where a particular finding can guarantee a diagnosis, e.g. ulnar deviation in the hands in rheumatoid arthritis.

In JointZone the beginner and advanced case studies were structured similarly. The main difference is that the beginner case studies offer a limited amount of information in order to diagnose the case and the advanced case studies are presented with a wider

Table 1. Interactive case studies

Case level	Complexity	Approach to reasoning
Beginner	Fairly simple clinical problems, limited information, limited choices	Diagnostic reasoning is bottom-up/data driven/pattern recognition—concerned with appreciating the particular significance of symptoms and physical signs
Intermediate	Typical clinical cases. Provisional diagnosis provided—student asked to consider whether correct	Diagnostic reasoning is top-down/ hypothesis driven
Advanced	Occasionally more difficult cases—wide range of information and data with a lot of extraneous 'noise' Student must make intelligent choices	Diagnostic reasoning is bottom-up/data driven/ hypothesis driven/pattern recognition

range of data. Both these case studies are data-driven, using history, examination and investigation results to enable diagnosis. The advanced case studies are a mimic of real life clinical situations where it is necessary to identify relevant data from a plethora of data. There is therefore a great deal of 'noise' in the system that has to be sorted by the reader. The intermediate case studies were designed for users to confirm or refute a diagnosis accompanied by data from investigations and patient response to treatment given by other health professionals. This reasoning method was hypothesis driven. It was felt that both bottom-up and top-down approaches to clinical reasoning exposed the user to a rich set of real cases, reflected the clinical reasoning processes in differential diagnosis and supported the spirit of the EULAR curriculum. We were interested to know, therefore, how well users felt their clinical reasoning skills would develop through the use of the case studies.

The procedural knowledge, as utilized in the case studies, is supported by a multimedia online library, which provides the necessary declarative knowledge for this domain. The library comprises: *basic science* (some very basic anatomy and immunology), *rheumatic disorders* (information about the various conditions encountered), *approach to patient* (history taking, musculoskeletal examination including the GALS locomotor screening system), *investigations* (blood tests and diagnostic imaging) and *disease management* for selected diseases. This material is presented in a searchable form as documents, images and streaming video. We were therefore interested to know whether JointZone users considered that their skills and knowledge had improved through the use of this application and how its various resources may have contributed to this.

JointZone and informal learning

Although the learning resources in JointZone are based on the proposed EULAR curriculum, it was never seen as being restricted to medical students. The authors designed the material so that it would be used by students, various medical professionals and interested lay people and it was hoped that mid-career professionals or those in training would welcome the opportunity to use these online resources as part of their continuing professional development (CPD). Since JointZone was not devised as a formal course, it was felt that it would sit well among other informal online learning environments. As an informal learning environment it was felt that the user would have arrived at the site with some intention of at least browsing the material. In terms of Eraut's levels of intentionality to learn, our users are likely to be 'deliberate' learners (planned to search the site to investigate/learn something) or 'reactive' learners (they discovered the site by chance, but explicit learning took place) (Eraut, 2000). Both these forms of intentionality to learn, with their accompanying 'explicitness' (i.e., users are aware of what learning did or did not take place), enable learners to document and record learning activity and become a source of evidence for CPD that recognizes informal learning. Informal learning is a recognized part of CPD within the National Health Service (NHS) where all staff are to 'seek opportunities to participate in personal learning' and 'agree a personal development plan with their line manager'

(Department of Health, 2001). The NHS in Scotland for example, has a postgraduate GP education framework that involves personal informal learning, organizational learning and personal planned learning. The personal informal learning includes: web sites, journals, bulletins, colleagues and patients, etc. GPs are expected to maintain 'educational receipts' in a suggested format of: (a) what was learned, when, so what?; (b) what next?; and (c) time spent (NHS Education for Scotland, 2003). We would expect therefore that JointZone could be used for such purposes.

The technical design

The JointZone team comprised an expert practitioner (a consultant rheumatologist), two technology consultants (a professor in electronics and computer science and a Ph.D. student) and an educational consultant. The Ph.D. student worked full time on the project for two years.

A corpus of information in a hypermedia environment is not always an ideal learning medium as it can overwhelm the user with information and offer little pedagogical support. It is essentially 'non-pedagogical' (Duchastel, 1992). However, this learning environment can be effective if the reader already has a fairly well-developed schema (a personal construct of related information) for the material being read. A schema acts as a filter for incoming information and provides a processing framework. For those with a well-developed schema, it may be that 'skimming' through material, as often happens when browsing, is sufficient to modify that schema, and hence learn. Those with significant existing knowledge may therefore use this technique to quickly update their knowledge. Those with the less well-developed schema of the novice have difficulty in a free browsing (hypermedia) context. They often cannot target the correct level of information, and flit from page to page in search of something they can understand and piece together. In the process they develop a cognitive overload and become frustrated. General browsing may therefore not necessarily lead to effective learning in either formal or informal contexts (Mayes *et al.*, 1990).

To take account of these potential difficulties, the JointZone team utilized web-based adaptive hypermedia as a means of providing learner support by personalizing the learning environment. Registered users to the site are offered personalized features such as:

- An initial 'test' to assess their level of knowledge (beginner, intermediate, and advanced).
- A tracking mechanism that enables the application to deliver suggestions for further reading relevant to the case under study and also tailored to that user's knowledge level.
- A record of the case studies they have completed, together with the scores achieved.
- A tracking tool that indicates to the user in graphical fashion the amount of time spent on viewing specific pages and by inference, the degree to which they have absorbed and digested that material. (Ng *et al.*, 2002a)

- A personalized site map serving as a personal navigation tool and providing a graphical view of what they had already read/viewed.
- A personalized topic map that encourages goal orientated reading by providing links to content relevant to a user's reading goal, browsing history and knowledge level.

The guiding principles in the design of JointZone were to:

1. Make the resources useful to a wide user group as an informal learning environment.
2. Address the learning outcomes of the EULAR curriculum particularly in relation to the development of clinical skills such as: history taking, examination, and differential diagnosis and provide information regarding basic science, rheumatic disorders, approach to the patient, investigations and disease management.
3. Present these multimedia resources such as: case studies, videos, glossary, site search engine, illustrations and documents in a richly linked hypermedia format to appeal to various learning preferences.
4. Design a site with adaptive features to cater for a wide range of users from novice to the proficient.

A questionnaire was designed to evaluate these features in order to determine the validity of our design.

Results: feedback from registered users of JointZone

The JointZone web site, developed and maintained in the School of Electronics and Computer Science at Southampton University, was launched in April 2003. It was publicized by the Arthritis Research Campaign at the annual British Society for Rheumatology meeting that month. It was also publicized on the web sites of the Arthritis Research Campaign (www.arc.org.uk), ILAR (International League of Associations for Rheumatology: www.ilar.org) and LTSN (Learning and Teaching Support Network: www.ltsn-01.ac.uk). The site was also reviewed in the *Lancet* (Larkin, 2003) and the *British Medical Journal* (Brown, 2003).

Visitors to the site were free to use the site anonymously or to register in order to benefit from the personalized features. We assume there have been rather more unregistered than registered users. The questionnaire was available to those who registered and by July 2004 there were 2143 such individuals. From this set of users we received completed questionnaires from 112 registrants; a response rate of 5.2%.

User groups

An important aim of JointZone is to provide resources that could be used by a wide range of individuals. Of respondents providing such information, health professionals (56%) were the largest group followed by students in health-related studies (34%), professionals in education and lay people (10%). The health professionals'

group comprised rheumatologists, GPs, nurses, podiatrists, physiotherapists and occupational therapists (Figure 1). Registered users came from a wide range of countries, including Argentina, India, Italy, Namibia, New Zealand and the US, although were UK dominated (89 of 133, 67%). When respondents were asked where they used the site we found that both health professionals and students predominantly accessed JointZone at their workplace or library (Table 2). Finally, when asked how they found out about the site respondents said: recommended/used in training course (23%, n=26), recommended by a friend (8%, n=9), from ARC publicity (37.5%, n=42), following an internet search (2.3%, n=25) and various references in journals.

The development of clinical knowledge and skills (addressing EULAR curriculum)

The degree of learning was assessed by analysing users' comments taken from Question 6A and 6B of the questionnaire. This allowed us to identify user perceived learning.

- *Question 6A.* Has using JointZone improved your *knowledge* in any particular area (e.g., clinical features, treatment)?
- *Question 6B.* Has using JointZone improved your *skills* in any particular area (e.g., history-taking, examination)?

All user comments were roughly mapped to the three main learning objectives of the EULAR curriculum with some comments being allocated to several learning objectives. The learning objectives used to categorized the data were:

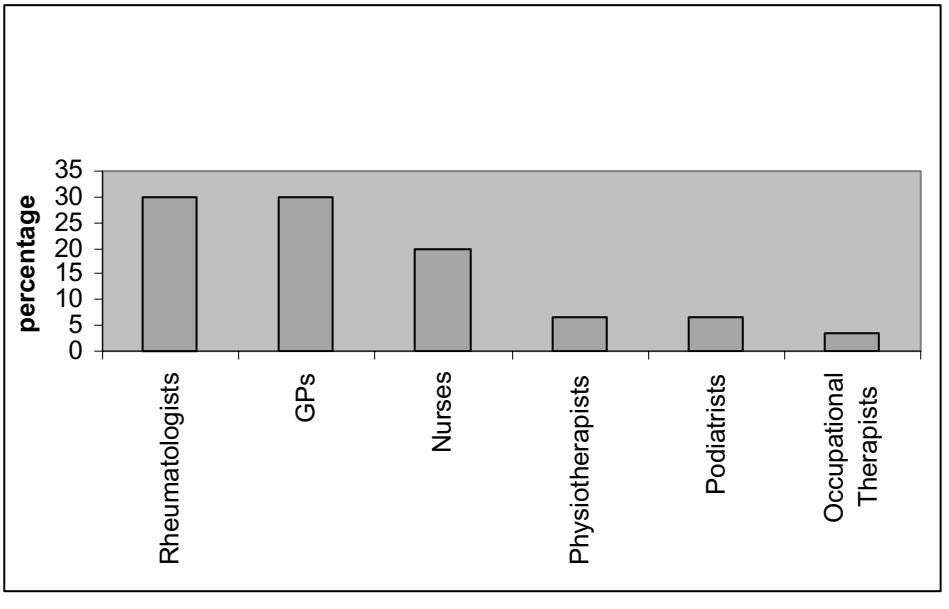

Figure 1. Cateogory of Health Professional as a Percentage of Health Professionals

Table 2. Point of access of users

	Work/library	Home	Both
Health professional	39%	19%	41%
Student	52%	27%	18%

- *Learning Objective A (LO A)*: Competencies in clinical assessment and diagnosis.
- *Learning Objective B (LO B)*: Knowledge of main characteristics and principles of management and rehabilitation of specific conditions.
- *Learning Objective C (LO C)*: Core knowledge, supporting diagnosis and management.

The comments from Question 6A (perceived knowledge gained) and Question 6B (perceived skills gained) were separated to determine users' view of the knowledge and skills they were gaining from the site (Figure 2). All user comments were further analysed for the most frequently occurring words. Those words with a frequency score of 10 or more across all users were: *clinical, examination, features, history, taking, diagnosis, treatment* and *knowledge* (see Figure 3).

An analysis of the perceived learning regarding the development of 'knowledge' and 'skills' can be seen in Figure 3. The question regarding the perceived gain in 'knowledge' contributed only three words (clinical, features, treatment) to the list of words used 10 or more times.

User view of the multimedia resources

When users were asked 'In what ways were the following features helpful in learning?' a rating of '1' indicated 'not much good' and a rating of '3' indicated 'very good'. The overall user view of the resources was: case studies (2.4), videos (2.4), glossary (2.3),

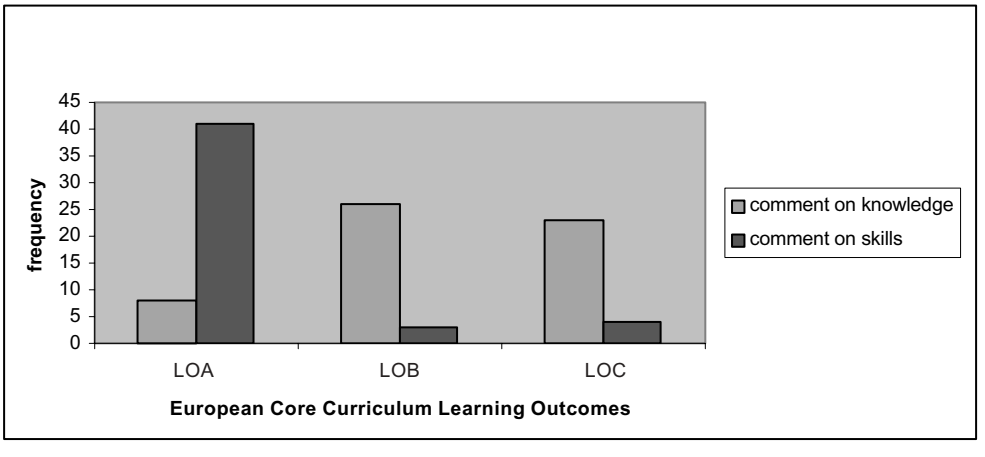

Figure 2. User Perceived Learning

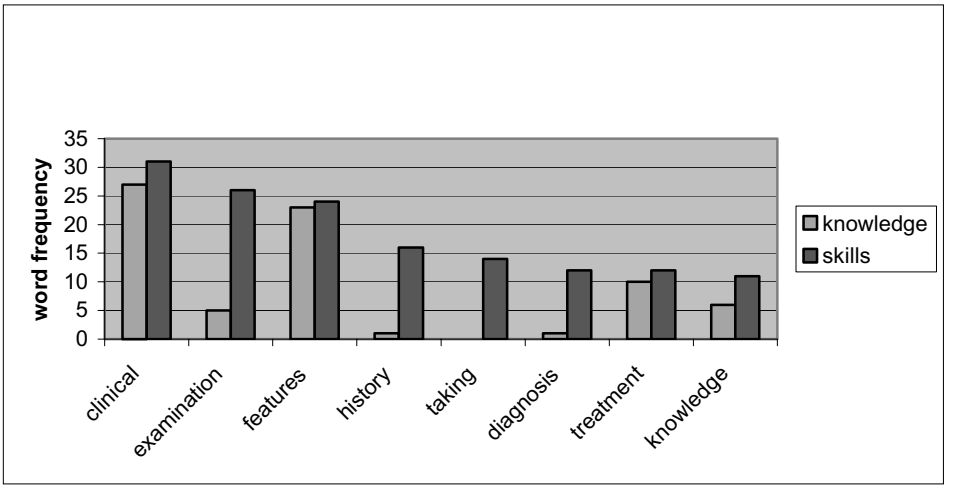

Figure 3. User Comments: Perceived Gain in Knowledge & Skills Identified by Frequently used Words

site search engine (2.2), illustrations (2.2), library content (2.4). For a breakdown of how the different user groups viewed the resources, see Figure 4.

User view of adaptivity features

When users were asked 'Do you think the additional features (activity tracking, adaptive features) available on registration are useful?' the majority of users felt that these

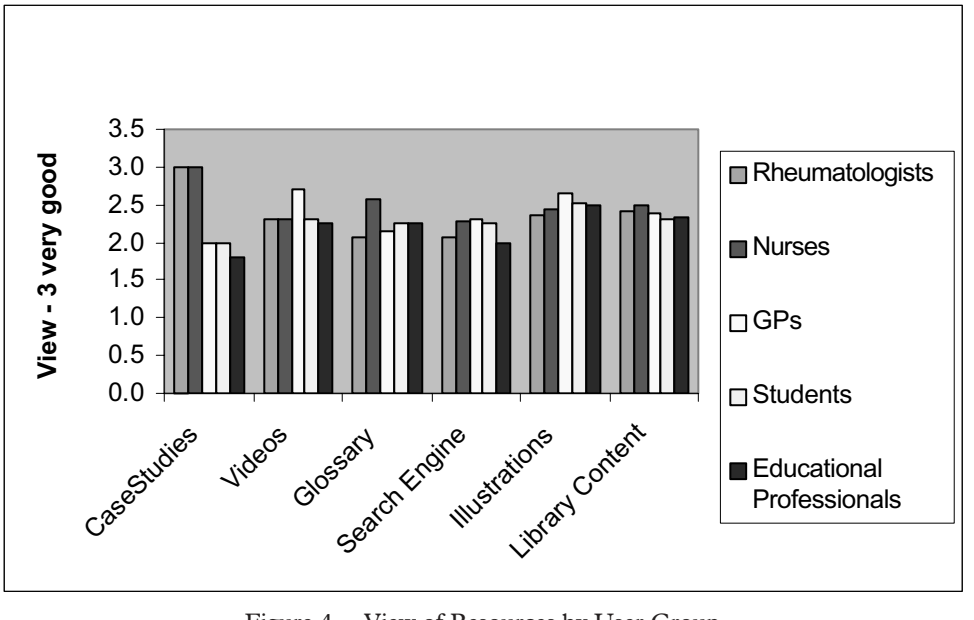

Figure 4. View of Resources by User Group

features were 'quite useful' (Figure 5). Occupational therapists, physiotherapists and podiatrists were grouped here as 'allied health professionals'.

When users were asked if they had any difficulty using the site 10 said 'yes' and 94 said 'no'. Some of the comments regarding difficulties related to: finding material on the site (n=1), downloading software to play videos (n=1), password issues (n=3), accessing resources (n=2), demotivated by score on case study (n=1), did not like being tracked (n=1) and slow Internet connection (n=1).

Some positive comments on the use of the system were: 'easy peasy', 'Tried recommending to colleagues—not enough publicity, very easy to use' and 'The ease of use has been one of the great features'.

Overall view

When users were asked 'Do you think the site is helpful in learning about rheumatology?', 64 felt it was very helpful, 38 quite helpful and two a little helpful, while no one reported that they felt it was not useful at all.

When asked how this learning resource compared with more traditional forms of learning such as books and tutorials, respondents said 'not as good as' (n=3), 'about the same' (n=37) and 'better' (n=60).

Additional comments from respondents were plenty and generally positive. A frequency word count on the comments revealed the top three mostly used words were: *useful*, *learning* and *excellent*. The concordance with these words showed 'useful' paired with: 'quite useful', 'most useful', 'very useful', 'useful source of materials', 'useful programme of upgrading skills'. 'Learning' paired with: 'good learning

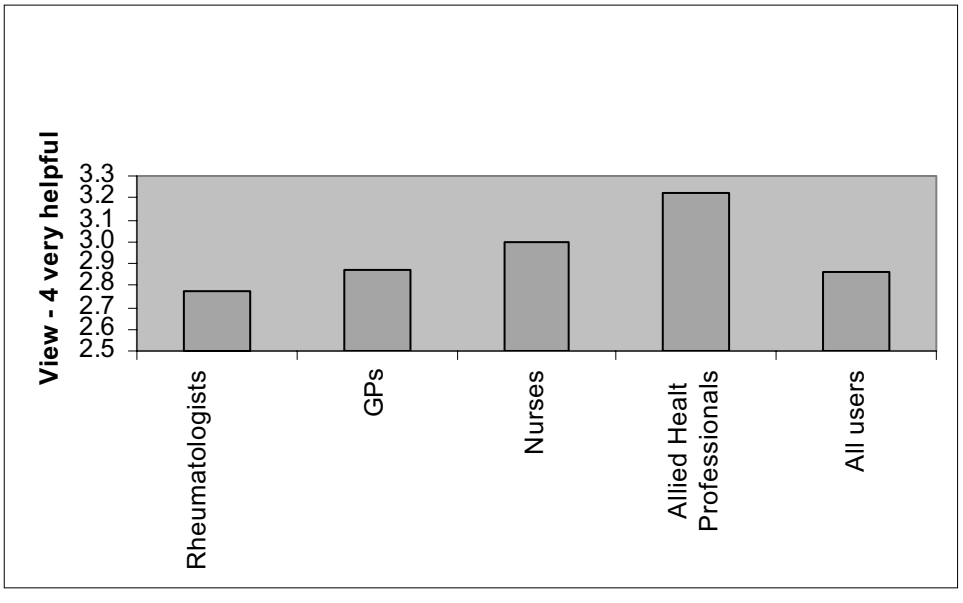

Figure 5. User View of the Helpfulness of Additional Features

experience', 'learning clinical examination', 'good learning tool advise all physios', 'no substitute for learning with peers', 'use in conjunction with other forms of learning and CPD', 'very good teaching/learning medium and works for successful learning'. 'Excellent' paired with: 'case studies are excellent', 'excellent and challenging site', 'excellent during my rheumatology placement', 'excellent resource', 'excellent site', 'excellent interactivity', 'excellent clinical teaching'.

When users were asked if they would recommend the site all but one of the 104 respondents said yes.

Discussion

The evaluation of the JointZone web site is considered under a number of subheadings as follows.

Access to a wide user group

It is gratifying to find that our aim of making this site attractive to a wide variety of health professionals has been successful as judged by the response to this survey. It is difficult to be absolutely certain that the responses that we have received are representative of users as a whole. The proportion of responses to the email survey is relatively small and this may only represent the 'tip of the iceberg', as many individuals visit the site without ever registering (all content is freely available without the need to register). Nevertheless, the responses that we have received have been almost universally positive. Although rheumatologists and GPs accounted for the majority of registered users in our sample, there was a significant range of health professionals: nurses, physiotherapists, podiatrists and occupational therapists, indicating a demand for learning materials on this subject amongst these groups. This may be a related to the NHS's approach to lifelong learning and the inclusion of personal informal learning as a form of lifelong learning and CPD.

It was also interesting to see how international our users were; they covered at least 18 countries, including, for example: Argentina, Germany, India, Iraq, Lebanon, Namibia, Thailand and others. Almost half of the rheumatologists responding were outside the UK. This illustrates the wide scope informal learning can provide.

A key attraction of online learning is that it may be pursued anywhere and at any time. The library content caters for the need for reference material while the case studies, which are more explicitly educational, provide a guided clinical approach enabling the development of capabilities. A study by Church *et al.* (1999, cited in Haq & Dacre, 2003) indicated that 45% of the medical registrars surveyed felt that problem-solving would be useful for assessment in an online educational programme.

With regard to where the site was accessed, 41% of the health professionals accessed JointZone from both work/library or at home while only 19% accessed it solely from home, suggesting a 'just in time' learning need. Since Internet

accessibility has increased significantly in the last five years, this makes this mode of learning indeed a viable option.

Acquisition of clinical knowledge and skills in musculoskeletal medicine

JointZone is not a formal training course and no assessment was undertaken of skills and knowledge before and after using the site so that objective assessment of improvement is not possible. Instead, we have relied upon users' own perceptions of their learning as a guide to the success of the site. User comments reported in the questionnaire provide some reassurance that we have succeeded, at least to some extent.

Since the site was designed to enhance both a user's knowledge of the domain and a set of skills, through the case studies we were interested to see how well they felt the resources helped in these areas. The qualitative data provided by the respondents was analysed in two ways. Firstly, all comments for perceived knowledge gained and perceived skills gained were matched against the three learning outcomes of the EULAR curriculum. Borrowing the concept of 'the mapping sentence' from facet theory (Canter, 1983) as a method of categorizing user comments, the headline sentences of the curriculum's learning objectives were used as mapping sentences (see the results, above). These sentences provided a mechanism to allocate respondent comments to one (or more) of the learning objectives. Although the facet theory could not be applied robustly as the learning objectives were not mutually exclusive, it was felt that the adapted technique was adequate for our purpose. Looking at the comments from the question regarding knowledge gained, we found that the majority of them mapped to Learning Objective B ('Knowledge of main characteristics and principles of management and rehabilitation of specific conditions') with the next best match for Learning Object C ('Core knowledge, supporting diagnosis and management'). From the comments in the question regarding skills gained, we found that, by far, most of the comments mapped to Learning Objective A ('Competencies in clinical assessment and diagnosis').

For a more in-depth look at the comments a word frequency was used to determine the content of the perceived learning. Eight words were identified with a frequency of use of 10 or more times. When this data was broken down across questions regarding knowledge and skills, we see there were more comments that discussed the perceived skills learned. This suggests that respondents were more actively engaged with the skills-oriented case studies. From Figure 4 we see that the rheumatologists and nurses did in fact rate the case studies highly; however, GPs did not.

An important feature of the case studies was history-taking and we were pleased to see that it did feature prominently in users' comments. There have been concerns that history-taking has not been taken sufficiently seriously (Ramani, 2004). A thorough history can lead to the correct diagnosis approximately 75% of the time, a physical examination 12% of the time and investigations about 11% of the time (Schmitt *et al.*, 1986; Peterson *et al.*, 1992, cited in Ramani, 2004). In addition, case studies allow students to learn in a safe environment, providing a useful addition to face-to-face contact with patients (Roesch *et al.*, 2003).

The perceived value of the multimedia resources

Overall, users did value the multimedia resources giving them an average score of 2.4 with a score of 3.0 being the maximum. Of the various professional user groups, rheumatologists and nurses rated the case studies most highly, and some of the comments reflect their need to confirm their own practice and gain new insights. This supports the notion of a 'community of practice' (Wenger, 1998) where our knowledge and capabilities are located (Smith, 1999) and which form an important element of informal learning. The case studies provide a virtual community that practitioners recognize through their daily work. If learners have no time to consult with those in their physical communities of practice, or feel their work context is not conducive to collaboration (Department of Trade and Industry, 2003) then at least the online environment allows some interaction at this level.

Interestingly, the case studies were rated the lowest (1.8) by the educational professionals and students (2.0). A possible explanation is that since these respondents were not practitioners, the case studies did not represent their 'community of practice'. However, the illustrations, library content, glossary and videos, which they rated well, are more easily identified with their educational 'community of practice'. A similar educational site for dentistry found that 91% of their students rated video sequences for surgical techniques highly (Schultz-Mosgau *et al.*, 2004) confirming the preferences of this user group.

GPs were most enthusiastic about the video clips and the illustrations, with the library content running a close third. This once again could reflect their daily practice and their 'community of practice' with patients as they present symptoms. In general the video clips, illustrations and library content were scored highly by all.

Although all the users were more than happy with the resources, the results do indicate the different needs of each user group beyond that of different learning preferences. However, we had not anticipated the role that 'communities of practice' might play in such an informal learning environment.

Adaptive features of the site: 'personalized learning'

When users were asked if they felt that the adaptive features were useful, with '4' being 'very helpful', the group most in favour of these features were the allied health professionals and nurses (score of 3.2 and 3.0 respectively). Since these groups also rated the case studies highly, it appears, from this data, that the adaptive features were helpful to those with less domain knowledge and they may have appreciated the supportive environment it offered. Rheumatologists also rated the case studies highly, but since they would have had a fairly well developed schema for the domain, the added adaptive features would, as expected, be less significant for this group. The average rating for this group was 2.8. These findings, although tentative, indicate support for Brusilovsky's (2001) view that adaptive educational hypermedia:

> … can be useful in any application area where a hypermedia system is expected to be used by people with different goals and knowledge and where the hyperspace is reasonably big.

> Users with different goals and knowledge may be interested in different pieces of information presented on a hypermedia page and may use different links for navigation.

Adaptive hypermedia therefore may be an ideal mechanism for informal learning where user competencies vary widely. For a more detailed evaluation of users' views of these adaptive features, see Ng *et al.* (2002b).

Conclusions

We knew from the site access statistics (which unfortunately do not tell us the precise numbers of visitors) that JointZone is visited frequently. This study was an attempt to define the profile of the users and gain information on their views of the resource as well as some impression of how effective this may be as an informal learning environment. Our user group was wide, ranging from medical students to career grade health professionals of all kinds, within and outside the UK. All visitors expressed approval of the resources and from their comments and activity on the site we know they are visiting to improve both their domain knowledge and skills.

The case studies, the dominant pedagogy, were favoured more by practitioners which tended to reflect their own 'communities of practice'.

The education group's responses suggest that they remain committed to accessing resources that improve their domain knowledge. This reflects the currency of domain knowledge in formal assessed learning. However, since clinical based learning is an important pre-requisite to a clinical practicum, it may be that students should be more encouraged to see this also as one of their 'communities of practice'.

The adaptive features, such as assessing the user's knowledge level initially, were appreciated by all, but favoured most by those from the allied health professions. It may be that such supportive features, especially within the case studies, helped to create a better learning environment for those who are newer to this subject. Adaptive hypermedia sites can also facilitate the production of 'educational receipts' for informal learning and contribute to CPD if necessary. These aspects of adaptive hypermedia warrant further exploration for informal learning.

In meeting the needs of such a varied user group, it seems important to provide multimedia resources that can be interactive (e.g., case studies) and illustrative (videos, illustrations, mind maps), a good bibliographic content and an efficient site search engine in order to meet the varied needs of learners with respect to their learning preference, knowledge of the subject and professional background.

The main points from JointZone that can be related to other subject areas offering informal learning are:

- Consider the range of your readership—it is probably wider than initially anticipated.
- Consider the communities of practice for your readership and devise resources that tap into those communities.
- Be prepared to be well informed about pedagogical approaches even though it is informal learning. Learning still needs to be effective.

- For those technically minded, consider how adaptive hypermedia techniques could be used to provide 'educational receipts' that provide evidence for CPD.

Needless to say, it was fairly costly to build JointZone and offer such a variety of resources and features. However, we feel that it has become an example of good practice in the delivery of an online informal learning resource to a wide range of user groups. The web site can be found at www.jointzone.org.uk.

Acknowledgements

We are grateful to the Arthritis Research Campaign for providing funding for construction of the JointZone web site and also for funding its ongoing updating and maintenance.

Notes on contributors

Pat Maier is an educational consultant working at the University of Southampton as Learning and Teaching Coordinator. She has written several books and articles on the pedagogical application of learning technologies within academia and is currently managing several in-house learning technology related projects including computer aided assessment and student support through an intranet.

Ray Armstrong is Lead Consultant Rheumatologist at Southampton General Hospital. He works primarily as a clinician but has been involved in the application of IT to education for some time. Current activities are in an application to monitor patients with chronic rheumatic disease and contributing resources to the National Electronic Library for Health.

Wendy Hall is Professor of Computer Science at Southampton University, the head of the School for Electronics and Computer Science and founder of the Intelligence, Agents, Multimedia (IAM) Research Group. Her research interests include the development of multimedia information systems and their applications in education, industry and commerce, open hypermedia systems and link services, digital libraries and multimedia databases.

Muan Hong Ng was born in Kuala Lumpur, Malaysia. She is a computer scientist and her work on JointZone formed the basis of her doctoral research within the Intelligent, Agents, Multimedia Research Group at Southampton University. Her research focuses on adaptive hypermedia, user modeling and evaluation.

References

Biggs, J. (1999) Problem-based learning and assessment in an aligned teaching system. Available online at: http://nt.media.hku.hk/pbl/book/keynote1_Biggs.pdf (accessed 22 March 2005).

Biggs, J. (2003) *Teaching for quality learning at university* (2nd edn) (Buckingham, Open University Press).

Brown, H. (2003) Netlines, *British Medical Journal,* 327(7421), p. 996.

Brusilovsky, P. (2001) Adaptive educational hypermedia, in: *Proceedings of the Tenth International PEG conference,* Tampere, Finland, 23–26, 8–12 June. Summary available online at: http://www2.sis.pitt.edu/~peterb/papers/PEG01.html (accessed 23 August 2005).

Canter, D. V. (1983) The potential of facet theory for applied social psychology, *Quality and Quantity,* 17, 33–67.

Church, R., Elves, A., Inman, R. & Scriven, P. (1999) Using the Internet and postgraduate medical education, *Hosp Med,* 60, p. 370.

Department of Health (2001) *Working together, learning together: a framework for lifelong learning for the NHS* (DoH, London).

Department of Trade and Industry (2003) *The impact of informal learning at work on business productivity,* University of Leicester. Available online at: www.dti.gov.uk/training_development/final_inform_rep.pdf (accessed 23 August 2005).

Doherty, M. & Woolf, A. (1999) Guidelines for rheumatology undergraduate core curriculum, *Annals of Rheumatic Diseases,* 58, 133–135.

Duchastel, P. (1992) Towards methodologies for building knowledge-based instructional systems, *Instructional Science,* 20(5/6), 349–358.

Eraut, M. (2000) Non-formal learning and tacit knowledge in professional work, *British Journal of Educational Psychology,* 70(1), 113–136.

Haq I. & Dacre, J. (2003) Computer-assisted learning in undergraduate and postgraduate rheumatology education, *Rheumatology,* 42, 367–370. Available online at: http://rheumatology.oupjournals.org/cgi/content/full/42/2/367 (accessed 23 August 2005).

Hmelo, C. E., Gotterer, G. S. & Bransford, J. D. (1997) A theory driven approach to assessing the cognitive effects of PBL, *Instructional Science,* 25, 387–408.

Johnstone, K. & Biggs, S. (1998) Problem-based learning: introduction, analysis, and accounting curriculum implications, *Journal of Accounting Education,* 16(3/4), 407–427.

Larkin, M. (2003) Web sites, *The Lancet,* 361(9635), p. 1309.

Mayes, T., Kibby, M. & Anderson, T. (1990) Learning about learning from hypertext, in: D. H. Jonassen & H. Mandl (Eds) *Designing hypertext /hypermedia for learning* (Heidelburg, Springer-Verlag).

Ng, M., Hall, W., Maier, P. & Armstrong, R. (2002a) Using effective reading speed to integrate productivity into web-based learning, paper presented at *The Second International Conference on Adaptive Hypermedia and Adaptive Web-based Systems,* Malaga, May 2002.

Ng, M., Hall, W., Maier, P. & Armstrong, R. (2002b) The application and evaluation of adaptive hypermedia techniques in the based medical education, *Association for Learning Technology Journal,* 10(3), 19–40.

NHS Education for Scotland, Newsletter No. 1 (2003) Postgraduate GP education, NES North East Scotland, Forest Grove House.

Peterson, M. C., Holbrook, J. H. & Hales, D. V. (1992) Contributions of the history, physical examination and laboratory investigation in making medical diagnoses, *Western Journal of Medicine,* 156, 163–165.

Ramani, S. (2004) Promoting the art of history making, *Medical Teacher,* 26(96), 374–376.

Roesch, A., Gruber, H., Hawelka, B., Hamm, H., Arnold, N., Popal, H., Segerer, J., Landthaler, M. & Stolz, W. (2003) Computer-assisted learning in medicine: a long-term evaluation of the Practical Training Programme Dermatology 2000, *Medical Informatics and The Internet in Medicine,* 28(3), 147–159.

Round, A. (2001) Introduction to clinical reasoning, *Journal of Evaluation in Clinical Practice,* 7(2), 109–117.

Schmitt, B. P., Kushner, M. S. & Wiener, S. L. (1986) The diagnostic usefulness of the history of the patient with dyspnea, *Journal of General Internal Medicine,* 6, 386–393.

Schultz-Mosgau, S., Zielinski, T. & Lochner, J. (2004) Web-based, virtual course units as a didactic concept for medical teaching, *Medical Teacher,* 26(4), 336–342.

Smith, M. K. (1999) Informal learning. Available online at: www.infed.org/biblio/inf-lrn.htm (accessed 23 August 2005).

Washington, E., Tysinger, J., Snell, L. & Palmer, L. (2003) Developing and evaluating ambulatory care: problem-based learning cases, *Medical Teacher,* 25(2), 136–141.

Wenger, E. (1998) Communities of practice. Learning as a social system, *Systems Thinker.* Available online at: www.co-i-l.com/coil/knowledge-garden/cop/lss.shtml (accessed 23 August 2005).