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How do we build sustainable e-learning tools to meet the needs of engineering educators?

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Abstract: There are a range of e-learning tools available to current engineering educators to assist in supporting teaching practice. Many of the tools developed previously have been transitory, only existing for the period in which they were funded or failed to be transferable, only adopted by the host institution. Funded e-learning tools are usually expected to have a sustainability plan to ensure ongoing support and adoption, past the life time of the funding, however in practice this is hard to deliver once funding has ended and staff have left.

This paper will look at a number of issues which can affect transferability and sustainability including:

- *why academics pilot such tools in the engineering discipline?*
- *what consideration is given to sustainability when adopting a new tool or system ?*
- *who are the key stakeholders for these resources and why?*
- *what factors can encourage a community of users to develop and stay engaged?*
- *how can the community of users assist with ongoing sustainability?*

Particular attention will be given to the experiences and the lessons learnt by the WebPA team in trying to build a community of users, both academic and support staff, around the tool in the search for a sustainable future. By examining the user groups which have developed around the open source WebPA tool the paper will highlight what does and does not work in developing a sustainable community within engineering academia.

The history of funded projects

Over the past 15 or more years there have been hundreds of nationally funded projects in the field of e-learning, many aimed at engineering educators. An early initiative launched in 1992 and funded by all of the UK HE funding bodies was the Teaching and Learning Technology Programme (TLTP) with an aim to make teaching and learning more productive and efficient by harnessing modern technology. It commissioned 76 projects in its first two phases, covering a wide range of subject areas and costing over £40M. By the third phase in 1997, there was already recognition that simply funding development did not guarantee uptake and use by the sector and this phase focussed on supporting institutions in embedding the use of TLTP materials developed in the earlier phases. The Fund for the Development of Teaching and Learning (FDTL) initiative ran from 1995 to 2009, funding 164 projects aimed at stimulating developments in teaching and learning in higher education and to encourage the dissemination of good teaching and learning practice across the higher education sector and many of them were either focused on or contained elements of e-learning. There have been numerous other sources of funding for technology based projects over the years, but now most new projects are developed through internal initiatives at universities or funded through the Joint Information Services Committee (JISC) who "inspire UK colleges and universities in the innovative use of digital technologies, helping to maintain the UK's position as a global leader in education". In 2009 JISC funded over '300 projects and within 24 programmes' (JISC Annual Review 2009) where a small proportion were tools for e-learning.

Of the many funded e-learning projects, very few of the outputs now remain and, of those known to the authors, where they do remain they are often restricted to the university or universities which undertook the original development. Frequently projects existed only for the duration of project funding. For many of these projects, this could be expected as technology has changed dramatically in

the period under consideration, for example, most of the TLTP phase 1 and 2 projects were funded before the internet was considered as a possible learning environment. Project outputs therefore have been simply overtaken by technological developments.

Other factors which contribute to projects not surviving beyond the funding period include developing the materials in a closed environment, making it impossible for other potential users to adapt content for their own purposes; project staff moving onto other jobs; not enough time given to dissemination during the project lifetime; lack of support or vision in how to maintain the fruits of the project past the initial funding (Paulsen 2003, Project Managing eLearning). With every project the onus of maintenance and longevity falls to the lead education institution, although there is little incentive once the funding has been spent especially if the tool is not used after the funding has finished.

In an attempt to overcome these problems, all projects have, for the last five years, been expected to detail how they will make the project outputs sustainable. The Higher Education Funding Council for England (HEFCE) detailed in their 2005 'Strategy for e-learning' that they would aim to 'embed e-learning in a sustainable way'. In 2009, HEFCE identified that one benefit of funded e-learning was 'efficiency' which was further expanded to include the term 'sustainable'. When JISC issue calls for funding, it is stated that all bids must 'comment on sustainability issues when the project funding ceases'. However, there is no clear definition of what is meant by sustainability and there is little guidance from the main funders as to how an e-learning tool may become sustainable once funding has ceased. As a result, the plans of funded projects usually contain fairly generic statements related to sustainability and what happens beyond the funding period to satisfy the funding body's requirements. These include placing the report on the project's website; adding links to the funder's most appropriate repository; making the development code available via an open source repository.

WebPA

WebPA is an online automated tool that facilitates peer moderated marking of group work. The tool was initially developed for internal use by Loughborough University but was then funded by JISC to develop a pedagogically sound open source version that could be offered to the wider academic community. Building a community which could inform the development of the tool and seek out adopters to try to use it in practice was part of the main project aims, and not an afterthought about sustainability in the bid document. The original aims anticipated collaborative development with the University of Hull and adoption in at least 3 further institutions.

WebPA achieved these aims by working closely with the Engineering and Physical Sciences Higher Education Academy Subject Centres (national UK centres that deliver subject based support to promote quality learning and teaching) who were project partners and able to provide their significant knowledge and expertise to the project. As the project progressed, the level of interest and adoption far exceeded expectations with over twenty eight institutions becoming involved. This resulted in WebPA having to give serious consideration to the future sustainability of the tool at an early stage, thus changing the direction of the project and focus on community building.

Even with thoughts of transferability very much in the project's everyday plans, sustainability has been hard to achieve and the project's continued success is heavily dependent on individuals, especially support of new users by a technical expert from the original project team.

Stakeholders

Before moving on to discuss sustainability and how WebPA has worked in this area, it is worth defining the stakeholders - individuals or groups that affect the project or are effected by it. Frooman (1999) highlights that research into stakeholders has allowed a classification of attributes to be developed and show the role they play in influencing the success of a project. This argument is then taken further to explain the power that the stakeholder has on a project. The concept of power (often influenced by the amount of and source of funding according to Frooman) is why the identification and management of stakeholders and their influence is key to project success and sustainability.

The experiences of the WebPA project are in agreement with this and much of the following discusses the roles of different stakeholders at different stages of an e-learning resource project. The main stakeholders have been identified as:
- the academics (innovators and early adopters),
- the project team,
- IT and learning technologist support and
- senior management within an institution.

These groups can be broken down into internal and external stakeholder groups. Internal stakeholders for an e-learning project are the innovators; the project team and senior management at lead and partner institutions. External stakeholders will initially consist of the early adopters, IT and learning technologist support, and senior management at institutions that are considering adopting the tool.

WebPA's approach to achieving wider adoption

Initially, as for most projects, the WebPA project team intended to disseminate the tool to other 'institutions', to obtain departmental adoption at another institution as a minimum, with the overall aim of achieving institutional adoption in three HEIs. Institutional adoption had already taken place at Loughborough University.

Both at a departmental and institutional level the expectations of a new system are high. There is a need for there to be a high level of system autonomy through integration with other university systems, for example, the Student Information System or the VLE, which can be difficult to achieve. Rossiter (2009) describes this same barrier to adoption. There is also an expectation that the e-learning tool will have been proven to work on a large enterprise scale and be mature enough to support the whole institution. Even with WebPA's proven history of expansion and use at the lead institution it could not match these expectations at the initial stage of introduction, although this history has helped considerably once successful pilots have been undertaken at new institutions.

The project team identified how influential the original academics who originated the project (the innovators) had been for wider adoption at both Loughborough and Hull. At Loughborough, the tool was developed in engineering for one user in one department and gradually spread as its benefits became clear to other engineering departments. It was then picked up by an innovator in the Business School at Loughborough and the proven success in another discipline helped it to spread further. Eventually the university had to make an institutional installation and provide support due to pressure from the number of users. A similar approach worked in Hull, beginning in Physical Sciences which has subsequently expanded to encompass eight different subject disciplines.

The project team therefore decided to change tack and focus on dissemination to and, support of, individuals, encouraging them to then 'champion' wider adoption within their institution themselves with the team's support. Often, these individuals brought on board dedicated IT support or learning technologists who themselves have helped to both develop WebPA and achieve wider adoption. These factors are some of the main reasons why the project has attracted so many new users.

This approach also had the benefit of enabling the team to offer enough personalised support to individuals which helped ensure success. This became harder as demand exceeded resources. Achieving successful adoption first time is important for tools such as WebPA as once abandonment occurs then that academic or institution will lose faith in the e-learning being offered and may never revisit the tool in the future (the teaching practice adopted may continue but in a less technologically supported way). Stage by stage individualised dissemination and continuous development has also helped avoid the well documented 'hype cycle' (Kruse 2004, Fenn and Time 2008) which characterises the over-enthusiasm and subsequent disappointment that typically happens with the introduction of new technologies.

WebPA innovators and early adopters

During the JISC funding period, WebPA had both 'innovators' and 'early adopters' working with the core project team. Both groups have been crucial to the project's success.

Innovators are the academics who had the original ideas for the development of the tool and informed its early direction. These academics are based at Loughborough and Hull universities, have always sat on project steering committees and have helped disseminate the project through numerous publications, presentations, user groups and email communications. The innovators have ensured that the tool is pedagogically sound, is flexible and customisable, have contributed significant academic knowledge and gave credibility to the tool at a crucial stage. The key benefit of involvement for the innovator is having substantial influence over the development of the tool; other benefits include the associated pedagogic research and being able to attract teaching awards etc. Involving innovators from different disciplines has prevented the tool from being limited to a single discipline or teaching practice which has helped adoption, although its roots within engineering are still very visible.

Early adopters are a wider group of academics tutors who have become involved as the tool has been disseminated widely. They are drawn from many UK universities, overseas and also other education

sectors such as schools. Getting early adopters on board can often be one of the hardest things for a project to achieve. In WebPA's case, there were four clear reasons for success:

1. The active commitment of dedicated innovators.
2. The varying disciplines of the innovators.
3. The obvious need for a tool such as WebPA.
4. The flexibility and possible customisation of WebPA.

Group work is currently becoming more prevalent in the curriculum and WebPA can be particularly helpful in both solving issues relating to the assessment of group work and saving staff time. In a recent government funded report 'Engineering Graduates for Industry' (Lamb et al 2010) about enhancing engineering education, where group work was highlighted as being important, WebPA was noted as being a useful tool.

However, even with a clear need identified, the potential adopters often have an uphill struggle to convince their institution to allow them to install and use it, especially when considering open source software which is still under development. This resistance can come from all areas – management, IT support, and learning technology support. The early adopters have seen that WebPA offers them an advantage that they cannot obtain elsewhere and this has given them the desire to overcome any initial obstacles, supported by both the innovators and the project team. As WebPA has spread and become more and more widely used, then it is much easier to convince others to have confidence to use it – the cascade effect.

Project sustainability

Sustainability of a project needs to be considered from the perspectives of the different stakeholders - users who have adopted the tool for use in their university, the lead institution who originally developed the tool and institutions who allow its use or wider installation.

For the wider users, at the time they adopted the tool, they probably gave minimum consideration for the sustainability of the project, focusing instead on the individual e-learning benefits that they wished to achieve. Existing usage, history, credibility, reliability and so on would have all been important factors but in the authors experience it is fairly unusual for potential users to give much thought to what would happen to the tool once the funding ran out. For those who do give it thought, then they are probably unlikely to have seriously considered its use, although the nature of it being open source does help with this issue as users know that they can continue to develop the tool themselves if they have or can obtain the necessary skills. Sustainability therefore only becomes an issue once they realise that their support has disappeared and the development has stopped.

At an institutional level, sustainability can be about lasting value (efficiency) and over the last decade, more emphasis has been placed on the student experience and pedagogic values. Senior managers are looking for more areas where effective practice can be shared. This is placing pressure on the delivery of e-learning tools. No longer can tools fit a need in just engineering education, now there is the expectation that an e-learning tool will have to work across disciplines and therefore across an institution. This will add to the sustainability potential of the tools, but at the same time perhaps stifle innovation or dilute the effectiveness of a tool.

Achieving sustainability for a project is approached differently dependant on the role of an institution during the funded project phase. A lead institution may have differing attitudes to that of the partner institution, but a common theme is that an institutions are, unsurprisingly, unwilling to commit real money for staffing to support the use of a tool across the education sector (Coen et al 2004). A major problem for sustainability is therefore that once project funding ceases, the project staff often have to leave for a new job elsewhere or at the best, stay but work on different projects (Smart 2006).

The third phase TLTP project, EASEIT-Eng (see http://www.easeit-eng.ac.uk/), was concerned with the development of a practical methodology for the production of engineering learning technology case studies. This methodology has been adopted and adapted by the Engineering Subject Centre for use with their teaching awards and is now used by a number of subject centres; the case studies have also been promoted through the Engineering Subject Centre – hence the project outputs achieved a level of sustainability. The project's reflective commentary (Barker et al 2005), suggested a survival guide for future projects. Below are listed the headings from this guide:

- *Hook! Hook! Hook!*
- *Get yourself some dedicated administrative support*
- *Plan ahead and then double it!*
- *Recognise the value of contributions*

- *Publish – now!*
- *Get connected!*
- *Money is power!*
- And finally… *a problem shared is a problem halved (or at least reduced)*

More recently, the JISC report "Sustaining Digital Resources: An On-the-Ground View of Projects Today" (Maron et al 2009) suggests the following factors for influencing sustainability:
- Dedicated and entrepreneurial leadership
- A clear value proposition
- Minimising direct costs
- Developing diverse sources of revenue
- Clear accountability and metrics for success

These have been adapted below for this paper to form a suggested approach for working towards sustainability.

1. Build a strong team

This sounds obvious, but it is not always easy to run a project and having a strong team is important for success and for enjoyment as well. If possible, ensure that at least part of the team has worked together successfully on previous projects. Over time, effective team members may emerge and add to that partnership but to have a guarantee of mutual support from the outset is extremely helpful.

2. Make as many connections as possible

For WebPA, the initial project team was formed from the innovators and the Engineering and Physical Science Subject Centres, together with a second university (Hull) who became a partner on the JISC project to help broaden the tool beyond Loughborough. Other key people were identified and involved as the project progressed, for example, the Open Source Software Advisory Service (OSS Watch). Barker et al cautions against over-reliance on a single contact "Bodies like the professional institutions are only as committed to your project as the individual contact you have. Don't be too reliant on a single contact or even a single institution" but feels that the connections made are key to the sustainability of projects.

3. Open source your code

Often this is a funding requirement, but making your code open source does help to attract users and to potentially achieve sustainability. The WebPA team feel that it has been a significant factor for their developing sustainability. However, just making a project open source will not in itself make is self sustaining – so it cannot stop there! (Dalziel 2006)

4. Decide an approach to achieving wider adoption

Achieving wider adoption is essential for future sustainability. As discussed above in relation to WebPA, agreeing an approach for attracting and retaining users is very important. WebPA focused on individuals – building stronger relationships with the innovators and attracting early adopters.

5. Raise awareness

Before any external stakeholders such as early adopters of the e-learning resource can be identified and brought on board, the project team needs to tell the wider community that they exist. There are many different methods: tapping into established networks such as the subject centres, use of mailing lists, newsletters, conference attendance, workshops, seminars, word of mouth, online opportunities, awards, publications and so on. All are useful to help raise awareness of a project to potential users and future community members.

Research by Phipps (2009) identified that running a number of smaller workshops or seminars might be better than conference attendance for disseminating projects. Dissemination will be carried out for different reasons at different stages in the project lifetime (dissemination for awareness, dissemination for understanding, dissemination for action) and different methods might be appropriate at each stage.

The concept of changing the dissemination for a project is backed up by work undertaken by Fincher (2000) who considered that only targeted and effective dissemination leads to the adoption of practice.

Regardless of which method might work best for a particular project, the most important thing for any project is to plan their dissemination, start it early enough and to commit enough time to it. As already stated, bringing external stakeholders on board is crucial, without them the project cannot succeed and will not become sustainable.

For the EASEIT-Eng project, Barker et al (2005) reported "Early publication and presentation of each project output as it occurred … proved vital in securing both short term and long term success for the project. Academics are more likely to get involved if they can see an example case study, methodologies are more likely to be successfully transferred if you've written it down in a manual, the people you'd like to promote your project for you are more likely to take you seriously if you have related publications to your name." Finally, encouraging uptake will be easier if the website is up to date and clearly shows who else is getting involved. The WebPA team made a significant effort to keep a list of adopters up to date and easily available from the website.

6. Ensure you can offer support

Again from Barker et al (2005) "There is no point in successfully engaging the interest of your community if you do not have the time to turn it into real involvement". Once awareness has been raised and people begin to come on board with the project, the team must look after these people and this takes significant time and effort which needs to be planned for. Again, as stated previously, there is probably only one chance to retain the early adopters, the new users. Ongoing support and maintenance is also needs to be continued for the original innovators in order to keep them on board with the project in both the short and long term.

Some of the early adopters will make themselves known to the project by direct contact. Initially, this is often when they come across a problem with installation or similar. Others may want more information about how the tool can be adapted, where it is available and what support they may need at their institution. A significant number of early adopters will never make themselves known – simply downloading and using the software successfully. In the case of WebPA, we often stumble across peoplewho have been using WebPA for a year or more.

7. Recognise the value of contributions – work with your stakeholders

There are many ways to achieve this - invite innovators and early adopters onto steering committees; get them involved with dissemination, publications, and events and so on. Simply providing a voice through special interest groups helps.

Academic innovators, usually considered to be part of an internal stakeholder group, have an interest in both the project's initial success and sustainability beyond the project's funding. The academic tutor will often gain recognition within the department for obtaining the funding (either real or in-kind) which could strengthen the department's role within an institution (Salancik and Pfeffer 1974) as well as having a tool that they can use in their teaching practice. The power of the academic innovator may diminish over the lifetime of the project and into the future sustainability. This is in part due to more voices joining the project, but can also be attributed to the role that the individual wants to take. It is possible that the innovator becomes a champion for the project and subsequently the tool.

Early adopters are the most important external stakeholder group for any project – without early adopters the project will not succeed. They are the users who will take on the tool in its raw state and attempt to use it. This group form the bedrock of knowledge about the teaching practice that surrounds the need for the tool. Each early adopter holds a limited influence to the project but together they are crucial and when early adopters are invited to join the steering committee of a project then they generally become more committed in the long term. By the time the funding ends the early adopter has embraced the tool and invested time in getting to a point where it works for them. IT support and learning technologists should be nurtured and brought on board in a similar way to early adopters, once identified; their views are valuable and come from a different viewpoint to the academic one.

8. Develop your community

There are a number of documented ways in which communities can be built around a project. In the academic arena the most common method appears to be by developing a Community of Practice

(CoP) (Wenger 2006, Wenger 2001, Bacon 2009). In the open source community the practice is to build the community around a management structure with either a benevolent dictator or a consortia (Mascord 2008, Raymond 1999). Often, neither the CoP nor open source routes are an entirely good fit for higher education learning technology projects if it is not possible to meet the challenges described below.

One of the most challenging aspects is for the project team to effectively manage contributions and ideas from early adopters and other interested parties. New people must be brought on board but the project also has to be able to stick to its aims and objectives, both in the short and long term. Getting this right is key to forming a community. Through the support offered, it is usually easy to identify the most active early adopters and invite them to get more involved.

By developing a CoP of the early adopters, academics who use the tool, it is possible to begin to develop a user group. Users involved will then be able to start sharing teaching practice, carry out pedagogic research into the tool and identify and report bugs in the tool. Initially this may just be the academics using the tool within the lead institution, or where there are a number of academics interested in the tool at an adopting institution.

In the open source community, community building has traditionally been achieved through a community of developers rather than academics. However, for the UK HE sector, this does not always work as it is nearly always the academic who will identify a need for a new tool. Developers will then be brought on board through the academic and their contribution will often be determined by senior management. So, while it is important (even crucial) to include staff who get actively involved with supporting installations or modifying code in the CoP, then it is unlikely that this group of staff would themselves be able to ensure sustainability for an e-learning tool.

The focus of the CoP should therefore remain with the academics. In the long term, these are the people who will drive the need for resource release and future development, and who are able to draw in other potential future stakeholder groups to aid the sustainability of the project.

9. Timing

It is almost guaranteed that time is against a project, both within and beyond its lifetime. In particular, it is important to consider the academic timetable as it is easy to lose an opportunity to do something for a whole year. Also because of the academic timetable, it can sometimes be difficult to see the true impact of a project within the funded period.

10. Funding

It is relatively easy to keep a project going while the funding is still coming in. When the funding ends, then without additional income, it becomes much more difficult. This is backed up by examinations carried out by Moser (2007) on project funding within Europe and the US showing a number of projects cease to exist after funding has concluded.

The project team normally have leverage for the length of the funding period, although this can last longer if they operate from centres who have a remit for support and dissemination (as in the case of WebPA).

Senior managers at institutional level play a crucial role when project funding is being sought, but otherwise generally play a minor role until a project is finished. Once this occurs, they often have significant influence on a project's sustainability – either shutting it down or assisting in securing extra resource for a project or carrying weight in the push for wider adoption at an institution (Smart 2006).

At this point, the senior management at an adopting institution can also become a vital stakeholder for sustainability of a project. They are able to inhibit or support wider adoption of the tool beyond a successful pilot. This stakeholder group also have control of any available resource in terms of development and time for achieving wider adoption in that institution.

11. Plan for continuity of staff

Overlapping with both building a strong team and getting connected, it is important that staff will be in a position to provide at least some continued support for the project once funding has ended. Otherwise, there might be no support for the resources and in some cases no one left to contact for

any information about the project. However successful a project might be, it will not be sustainable if this happens.

For WebPA, the following set up, purposely achieved while funding was ongoing, has helped it to survive and even develop while further plans are made and funding sought:

- The running of the JISC project through Loughborough's engineering education unit, the engCETL, which has ensured some continuation of both senior management and project officer support and input even after the funding has finished.
- The involvement of the innovators who continue to commit time and energy towards WebPA.
- The active involvement of two subject centres at an early stage who are now able to provide a minimal level of support for both WebPA users and the project through Higher Education Academy initiatives and through special interest group (SIG) funding. The new WebPA SIG of the Engineering Subject Centre is already attracting significant interest and will help ensure sustainability for WebPA.
- The numbers of users of WebPA world-wide who are now themselves disseminating WebPA and developing new code, forming a fledgling community of users that is being nurtured.

Involving the people outlined above, WebPA has been able to continue to hold mainly virtual project management communications. This is particularly important as responsibility for the sustainability lies with the lead institution and project team – if these cannot continue to be involved then a project is unlikely to survive. However, without long term funding, the original project team from the funded JISC WebPA project will inevitably eventually disperse as they move onto new roles.

This is an area where funding bodies could consider a change in policy, perhaps continuing to provide a limited amount of competitive continuation funding for proven projects to allow them to continue to work on sustainability issues.

12. Look forward

For guaranteed long term success and true sustainability, the project needs to bridge the 'chasm' between the early adopters and early majority as described by Moore (1999), a weight of users behind the project who make it self-sustaining, requiring only minimal support from the lead institution. Over time a project may then be further developed but by the adopting institutions that have stayed with the project. Only through this method does a project have a chance of success. WebPA has yet to achieve this, but the project team are determined and are continuing to strive for this aim.

Conclusion

In order to achieve sustainability, a project needs to start thinking about it from the outset – something that is easy to say, not so easy to do. It is hoped that the areas outlined above will help ongoing projects.

The present economic climate makes it even more desirable that funding bodies are able to both select the right projects to fund and help successful projects to achieve wide scale adoption and sustainability. However, it is the authors' view that achieving true sustainability of even the most successful projects relies too heavily on the commitment, determination and persistence of key individuals, supported by forward-looking senior management within an institution. Finding a good way forward is acknowledged to be tricky, but currently, too many good projects fall by the wayside, effectively squandering the money put into developing them in the first place.

Future work

The WebPA project was funded by JISC between 2006-09 and so the sustainability reached at the time of writing (January 2010) has yet to stand the test of time. A fledgling community has been created following the principles discussed in this paper and the WebPA team are working to maintain and develop the momentum achieved. It would be interesting to review this paper in 12-18 months time to see the progress made and what further lessons could be learnt.

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