P78

Engaging and retaining distance learning engineering students: the development of effective engineering communities

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Abstract: *Distance learning is becoming an increasingly attractive education option for the engineer. It is the prime delivery method of the UK Open University which has an established Engineering Programme. This paper is an investigation of the provision of generic student support within the Open University's programme. The specific focus is the nature and development of a supportive engineering community within the electonic environment. Such an entity, involving both students and staff would serve to enhance student support throughout their total university experience, be independent of modules and facilitate general professional development - requirements of professional engineering institutes.*

The investigation looked at trends in the use of existing electronic forums by engineering students, whose opinions were solicited by qualitative and semi-quantitative survey methods. It is found that students require an identified purpose for participation, are pragmatic with a low tolerance of 'social chatter' and are more inclined to engage in non-mandatory activities after some personalised contact with their peers.

The above surveys also identified student opinion on the purpose, content, use, format, and perceived benefits of a proposed community. This, along with similar data from other potential stakeholders and information from published literature covering community building and community behaviour were all used to develop an organisational description of an effective community model. This is described (strands, content and delivery) and its initial evaluation discussed.

Background and context

Student identity, support and community concepts

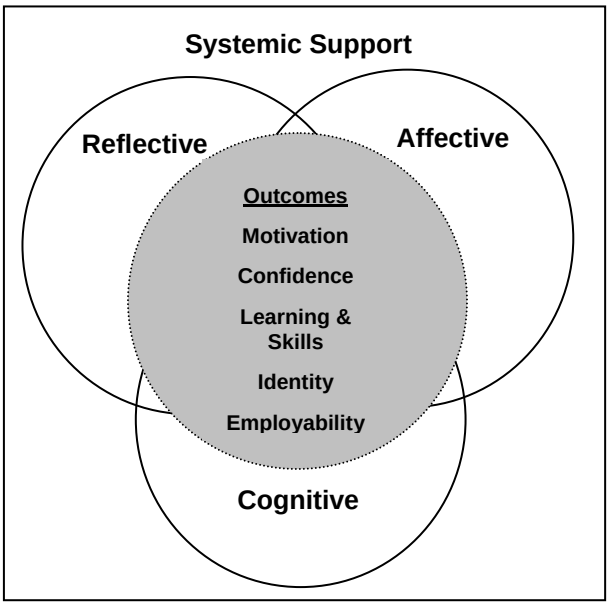

Figure 1.The ARCS model of learning support (Atkins & Beard 2008)

Student support has many elements. Within distance learning, Atkins and Beard (2008) propose an Affective (emotional), Reflective (motivational), Cognitive (academic skills) and Systemic (practical) ARCS model for provision of effective generic student support (Figure 1). Their work suggests that establishing student identity and their sense of belonging is one outcome of integrated support.

A subject grouping within a faculty can be described as a community, i.e. a group or loose affiliation of people with common interest (engineering) or identity, especially if its members comprise all subject group stakeholders, i.e. students and academic staff. On-line communities (or e-communities) have the potential to overcome difficulties arising from geographic dispersion of their members. They are widely explored and debated in education research. Their definitions range from a general yet prescriptive definition with four high level criteria, namely participating people, shared purpose, unified policies, i.e. some form of governance, and computer systems (Preece, 2000), through to a more conceptual view that on-line communities are relational communities of mind (Brook & Oliver, 2003). These last authors have emphasised that the construct of an on-line community is a sense rather than a tangible entity comprising the four elements of; membership, influence, fulfilment of needs and shared emotional connection, as first suggested by McMillan and Chavis (1986). Nevertheless, an e-community with a structure appropriate to the needs of its members has potential to provide a sense of identity for all its members, including students.

Other previous and relevant observations regarding community aims and structure are summarised in Table 1. Within the rest of the paper the term ‘community’ is used to describe an e-community.

Table 1. Literature on Communities.

Subject area	Main Findings	Comments / discussion points relevant to project purpose
Community aims and outcomes.	Support provision needs to cover ARCS spectrum (academic, reflective, cognitive and systemic) generic student concerns (Atkins & Beard, 2008). Sense of belonging derives from a range of broad ‘subject glue’ activities. (Atkins & Beard, 2008). Sense of belonging derives from welcome and interaction within communications. Sense of belonging derives from perceived added value of and from interactions / engagement. (Wenger and Lave, 1991)	Need to have all support elements within a robust model.
Community structures and their design.	Relative higher importance of sociability design c.f. usability design. *(Sociability = policies and plans for guiding social interactions. Usability = software / communication tools selection and use).* Sociability governance will need to have some guidance to allow reification as the community develops. (Preece, 2000). Strategies and content mix required to encourage and retain community member engagement (Preece, 2000). Communities reify as they develop (Lave and Wenger, 1991)	Need to consider model as a holistic grouping of sub-communities, with members able to select and migrate between each according to needs at any point in the learner experience.

Institutional Context

The Open University (OU) in the UK is an established leading institution for the delivery of distance learning. A paramount concern of the university is provision of holistic support to the remote student body. Engineering is a growing professional subject area of the university with named degree profiles and a defined programme of study pathways options. Many students enrolled on the modular BEng / MEng programme aim to attain professional recognition via a range of professional institutes after completion of their studies. The Institutes all use common generic criteria for professional recognition,

as defined by the Engineering Council of the United Kingdom (ECUK, 2008). These students, who have common professional and academic goals, do not have any formalised grouping or continuity of contact within the university other than sporadically 'meeting' the same students on some common modules during their student experience.

The University is increasing innovating in the uses of asynchronous and synchronous electronic discussion facilities and greater interactive collaboration, with potentially significant influence on the learner's experience and their sense of identity. This study reports on an action research project that has investigated the concept of an engineering subject on-line community, or e-community, within the distance learning environment of the Open University.

An engineering community which included both student and staff stakeholder groups, would expect to:

- enhance student support throughout their total university experience,
- be independent of the modules selected by the student,
- facilitate general professional development activities that align with requirements of the professional engineering institutes.

These are all factors that should be influential in retaining students within the subject area and within distance learning whilst developing them as engineers generally.

The project identified, by student survey consulation, the existing forum participation habits of distance learning engineering students. Other research methods established the aims, content and format preferences of all potential community stakeholder groups. All this information was used to define a model for an engineering e-community within the Open University. The findings are relevant outside the context of this particular case study.

Current student support.

The Open University's BEng programme contains two mandatory modules *Personal and Career Development in Engineering,* module code T191, and *Key Skills for Professional Engineers,* T397. These cover; general engineering competencies, professional recognition and continuing professional development issues and provide some compliance with ECUK requirements (ECUK, 2008). Other compulsory requirements are completion of one project module and two practical residential modules.

Extant learning support is offered to the student in two areas, module specific academic teaching support and generic study skills support. These are organised at module and university-wide levels rather than at subject or faculty levels. Module academic support generally comprises individual correspondence tuition provided by a part-time specialist, an Associate Lecturer (AL), and opportunity for e-collaboration mainly by asynchronous discussion groups, forums, on a FirstClass conferencing system. However the OU is in the process of piloting new university-wide models of student support.

A forum can be classified as structured, intermediate or basic, depending upon participation requirements, levels of staff facilitation or moderation, structure and purpose (Shenck, 2008). The university has completed many module specific evaluations of participation and resultant teaching and learning benefits for different forum types (e.g. Kear, (2004)). National reviews exist within a wider technology subject area for a range of social software deployments (Minocha, 2009). However, the trends in the use of forums by engineering students in a distance learning context, as within the OU, have never been characterised.

Research questions

The two main research questions were:

1. What are the on-line engagement and existing Open University forum participation characteristics of the main stakeholder group, the engineering student?
2. What are the perceived purpose, content and format preferences of all stakeholders for a potential engineering community?

The findings were intended to inform the development of an engineering community model that could be of general use in auditing tactics used in community formation.
The study has relevance for three immediate stakeholder groups:

- Engineering students. This is the recognised main group as it is potentially the largest group with the greatest range of benefits derived by its members.

- Academic staff - central full time staff member in the engineering subject area.
- Associate lecturer staff (AL) assigned to modules covered by the BEng / MEng programme.

Research methods and framework

Different survey instruments were used for each stakeholder group. The largest resource was allocated to the main stakeholder group, the engineering student. Approximately 2200 students are registered as engineering students with the OU at any one time.

The research questions required a mixture of qualitative and semi-quantitative information. Therefore, direct survey instruments and a grounded theory approach to data analysis were appropriate (Strauss and Corbin, 1990). Guidance on survey methods within the field of human – computer interactions (Adams and Cox, 2008) dictated the use of a student questionnaire followed by individual in-depth structured interviews.

The questionnaire comprised a mix of factual and opinion question types, grouped by four themes.

1. Student use of e-communications within a social context in time outside the OU and their employment.
2. Student access to communications technology.
3. Student engagement with and their opinion of forums commonly available within engineering modules. Examples were included of each of the forum types; structured (compulsory), intermediate (voluntary participation e-tutorials) and basic (general module forum).
4. Student opinion on the purpose, content and format of a proposed engineering community.

Note that data from 1 and 2 provide information on the extent to which the engineering student can be categorised as a ‘digital native’ (Dutton & Helsper, 2007).

Criteria used to generate a minimal bias sample population were:

1. The student had studied at least two engineering related modules, i.e. modules covered by a maths (M), science (S) or technology (T) coding.
2. The student was studying either of two Level 2 modules; T207, *Engineer as a Problem Solver* and TXR220, *Engineering in Action.*

The survey was completed on-line. Of the 260 students surveyed, 43 (16.5%) responded.

Semi-structured in-depth student interviews were used to explore opinion responses more fully. The interviewees, a sub-set of seven from the questionnaire sample population, were representative of the questionnaire respondents in age, and study experience. 4 interviews were face to face and 3 via telephone; all were recorded and transcribed.

For the two staff groups, information was collected from each on the second research question. For both, evidence was in the form of notes and / or transcripts of recordings obtained during directed group discussion events. One extended and recorded discussion was facilitated for 10 central academics during a meeting of the faculty’s Engineering Programme Committee Working Group. Notes of set discussions with a total of 18 ALs during sessions at two separate technology / engineering AL staff development events formed the data for this group.

The findings from both research questions alongside those from the literature review were applied within the development of a model for an engineering subject e-community for supporting distance learners.

Results.

Student questionnaire.

The student questionnaire contained thirty-four questions. The key statistics from the survey are shown in Table 2 and Figure 2.

Table 2. Student preferences for community features

Perceived Benefits		Rank	Potential Content	
%	Benefit		Theme	%
60	Source of help for engineering study skills	1	Careers information and links	65
57	Useful source of careers advice	2	Updates on engineering modules and program development	57
55	Obtaining experience and knowledge opportunities aligned to Engineering Institutes professional development and competency requirements.	3	Professional institute news and module approval developments	50
52	Links to news on engineering developments	4	Engineering study skills and links	48
45	Learning and updating beyond formal module boundaries	5	Advice on gathering evidence for professional development	42
40	Opportunity to meet other students, OU staff and others with an interest in engineering	6	'Current affairs' in Engineering	42
32	Establishing a larger network of contacts.	7	Student experiences of dealing with professional institutes	35
30	Exposure and contributing to general engineering themed debates	8	Advice on generic professional competencies	22
25	Source of help during transition between different levels of study	9	Interest group forums for defined engineering sectors	22
22	Sense of faculty group membership	10	Professional ethics	22
12	Maintaining contact beyond module presentations.	11	Experiences of OU alumni	13
1	No benefit	12		

(Percentage totals exceed 100 as students permitted to select up to 5 preferences)

Student interviews, Academic Staff inputs

The qualitative data from these sources were combined and sorted into themes aligned with the research questions. As over seventy data items exist, only those key to the findings are embedded in the discussion.

Discussion of findings

The main findings for both research questions are considered in turn.

What are the on-line engagement and existing Open University forum participation characteristics of the main stakeholder group, the engineering student?

Technology access and external use trends: Access to the technology required for social communication appeared not to be a problem. However in their time outside both the OU and any employment roles, the student tends to be an infrequent and probable circumspect user of social communication software.

Overall, a student must not be assumed to be a digital native, as defined within the recent review of internet usage in Britain (Dutton and Helsper, 2007)). Further, the reasons for not using such social software also aligned with these general national trends as 39% of non-users within the group cited lack of time as their main reason (c.f. 41% nationally). Structured interview responses revealed more detail, as those who did participate opted to limit their number of contacts and noted either direct experience or awareness of the dangers of such uncontrolled and unmonitored communications as significant reasons for electing not to use them.

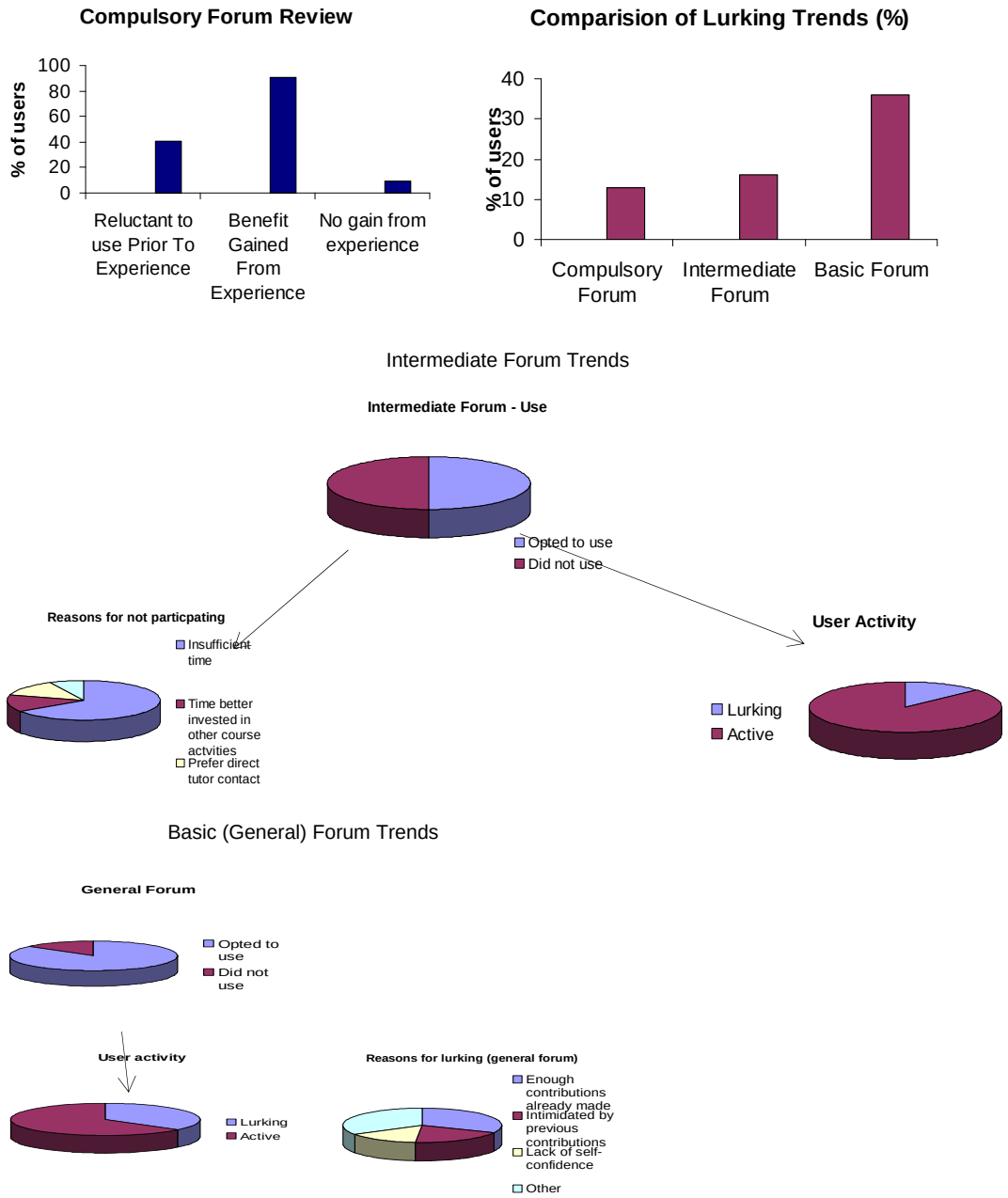

Figure 2. Key statistics: student use trends for different types of forum types

Use Trends within OU FirstClass Forums: Once engaged with either structured compulsory communication or intermediate forum (e-tutorials), the student acknowledges derived benefit from peer communications. This is also implicitly supported with a comparison of lurking behaviour, i.e. reading but not contributing (Figure 2). With intermediate forums, where the student opts to engage, benefit is derived and the student is more proactive and less likely (only 13%) to lurk, than within basic forums where lurking behaviour is higher at 36%. This difference also suggests that students are more likely to commit to, and derive benefit from, a more structured intermediate forum where aims are more clearly defined. Further, a 'lack of purpose and structure' is given as one of the main reasons expressed by the student for lurking behaviour within the larger general (basic) forums.

However, the low level of any engagement in the optional intermediate forum, at 50%, aligns with the view of some educators that unless some intensive conferencing / community communication is central to a study unit, students will not use it and so not derive any benefits (Salmon, 2000).

Overall, the engineering student is pragmatic with a low tolerance of social chatter, as shown by low take up of the social areas (e.g. coffee bars) and reasons given for non-participation in general forum.

It is noteworthy that more students had some level of participation (active or lurking) within the larger basic forum (70-80%). This is in line with rates for modules where conferencing is not compulsory (Mason & Bacsich, 1998). A suggested reason for this difference in participation rates between forum types is that the structured interaction demanded within smaller e-tutorials (intermediate forum) is quite demanding of time for a time-poor student, who may find direct tutor contact more time efficient.

Interview students commented that general forums often lacked discipline in sorting information by use of threads and that a student can often be fearful of their contributions appearing or being treated as inferior. These two specific findings align with those reported by Kear (2004) within an in-depth study of two OU modules in the systems curriculum. It is suggested that for these larger and less structured forums, read-only 'legitimate peripheral participation' behaviour, i.e. lurking, (Lave and Wenger, 1991) is unlikely to develop into more active community engagement at a later date, as suggested by McAteer et al, (1997) due to both their large sizes and short existence times (one year duration of a module).

Finally, several interviewees revealed that they are more likely to take part in on-line discussions after some formal personal contact with their peers.

What are the perceived purpose, content and format preferences of all stakeholders for a potential engineering community?

The expressed preferred themes derived from the student information also illustrated their preferred aims (Table 2). In descending order of importance for the student, they are:

- Professional development support.
- Career development advice.
- Study skills support throughout the whole time of the learner experience.
- Items covered by the term 'Subject Identity Glue', i.e. those that contribute to a sense of belonging (Aitkins and Beard, 2008).
- Project related enquiries. (A majority of engineering students complete a project module that covers competency requirements for ECUK Professional Engineer registration.).

With the exception of the final theme, they all imply a need for support for non-technical or non-cognitive issues. One student interviewee emphasised the need to have different types and quality of information at different stages in the student learning experience, commenting that this was neither currently nor consistently available for the higher levels of undergraduate study. The students' evidence contained specific content suggestions e.g. lecture podcasts, interest group forums for defined engineering sectors, professional ethics exemplars, etc.

The aims and content suggestions from both of the staff stakeholder groups broadly aligned with the themes from the student study group. The staff evidence provided more depth within their perception of drivers for community /activity participation by students, e.g. students require tangible personal benefit prior to participation as they are perceived to be time poor. Such tangible benefits could include technical methods common to different modules (e.g. approaches to stress analysis or systems review) and softer skill sets (e.g. effective communication or critical thinking). Within suggestions from ALs, careers progression and professional development information guidance were prominent, as these were noted as frequent and common non-module related dialogue points between ALs and students.

Central academic staff appeared to be more aware of the broader study context and subject/programme level, rather than module specific community support issues, dominated their suggestions. This awareness is almost certainly linked to the university's ongoing reforms of student support. Central academic staff also provided opinion regarding community format and delivery preferences, namely that activities should have delivery, time and access limitations, for example, to offer a time limited (but asynchronous) resource / activity followed by an archive after its closure. The associated benefits noted included offering the often time poor student a restricted commitment (i.e. a limited and effective time investment). They suggest that transient but active participation inspires student engagement around chosen 'themes and subjects' at appropriate times within their learner experience.

Both staff groups noted the need to have ranges of content to address identifiable but different student requirements at different stages in their learner experience.

Application of findings: developing of a model for an engineering community.

The findings were considered within the development of a model for an engineering community appropriate to the student, the teaching and learning approaches and the organisation within the OU's engineering subject area.

Community Aims

The research findings established that the aims of a student vary at different times of their study: this has resultant implications for the design of a community. Eight generic aims were identified. They are of two types: *support* and *belonging / identity*.

The *support* aims relate to the following:

- Professional development and acquiring professional Institute recognition.
- Careers and employability.
- Academic transition (i.e. study skills support for transition between different levels of academic study).
- Project advice.

As noted in Figure 1, effective *support* should have a blend of *ARCS* elements aimed at different points in the student experience in order to attract and retain student engagement. Within the support areas noted above, *A*ffective support can be embedded within all suggested support areas, *R*eflective mainly within Careers and Academic Transition areas, *C*ognitive within the Academic Transition area and *S*ystemic within the Project advice area.

The aim of *developing identity* and a *sense of belonging* is less easy to either define or categorise. Considering both literature review evidence and the above findings, it is suggested that a model should include:

- *Engineering engagement opportunities* beyond the boundary of a module, i.e. opportunity for students to discuss, and also suggest, topical engineering or interest themes.
- *Awareness* of the engineering research activity within the university, with opportunities to learn about and comment upon progress.
- *Direct dialogue opportunities* with members of the academic staff within the subject area.
- *Explicit socialisation opportunities* with peers. Note, that these are predicted to be a low uptake option, as the direct research findings characterise the engineering student as having low tolerance of unstructured socialisation. Nevertheless, it should be available as part of a welcoming ethos of the community. Implicit socialisation between students developed by group working has not been examined within this research because group working within engineering distance education is not yet in widespread use within the OU.

The term 'Subject Glue' or 'Subject Identity Glue' is used to describe 'socialisation' content. The aim should also be partially fulfilled through the blend of benefits derived from the participation in some or all of other content offered within a community structure. The welcome and style of communication promoted and adopted within the community will also contribute to successful delivery of a sense of student identity and belonging.

Community Organisation

Members of the community have overlapping experiences and requirements which evolve for the student stakeholder with progression through their studies. This imposes a constraint on the model in that it should be considered as a holistic grouping of sub-communities, with members able to select and migrate between them according to their needs at any point in the learner experience. To accommodate this, a model must specify usability and sociability parameters (Preece, 2000). As proposed by Preece, usability covers structure, i.e. format and organisation of resources / opportunities, whilst sociability covers governance.

Structure.

A set of 'hubs', each based on one of the five generic aims of the community, is proposed as the most appropriate way of envisaging or designing a community. The hub model accommodates stakeholder aims and the diversity of stakeholder's individual needs. The proposed structure is illustrated in Figure 3. A navigation and guidance (governance) hub would be a central 'pivot' for other hubs.

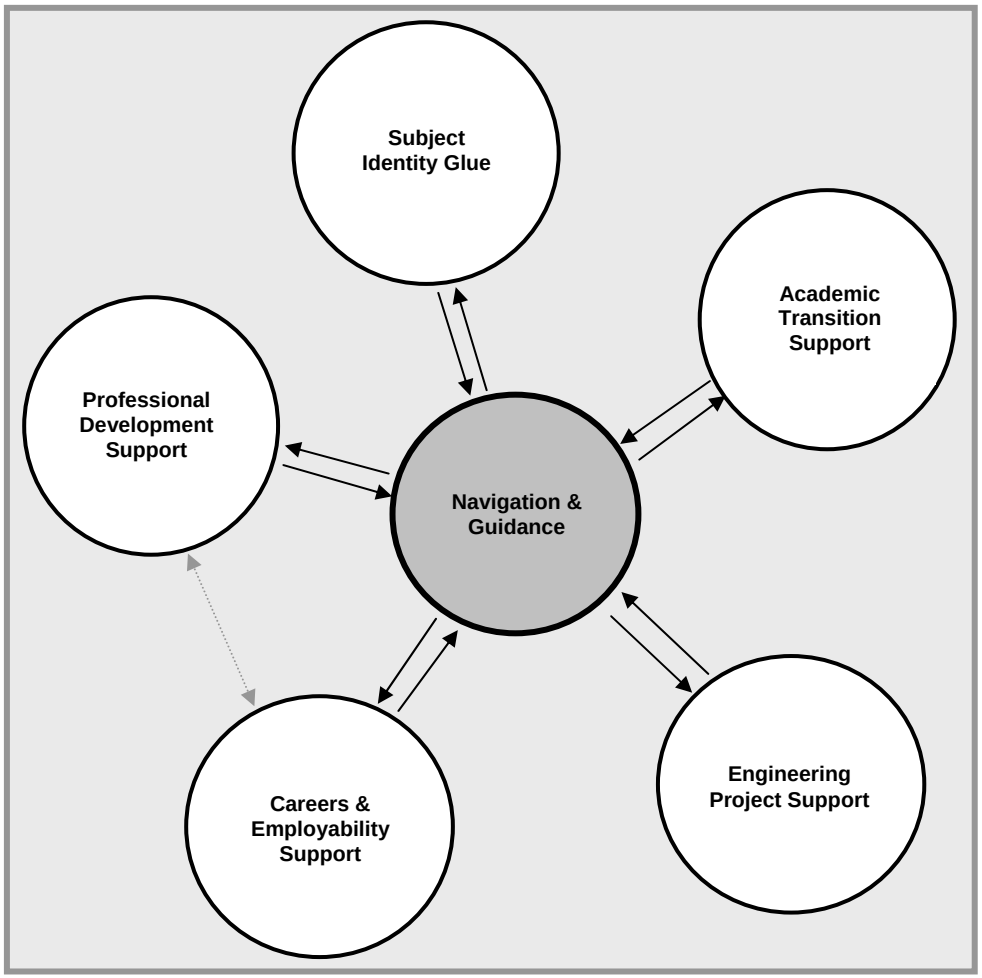

Figure 3. Engineering community model: outline of structure

To progress community design, format definitions will be required for each content / resource area within the community. It is proposed that a format statement would include an access mode / type plus the level(s) of interaction possible for the user. Within the model the actual technology has not been selected or defined. Two reasons support this deliberate decision. Firstly, literature review evidence suggests that, provided options selected have good ease of usability, the technology option is not of high importance with regard to both community development and engagement outcomes (Preece, 2000). Secondly, the technologies' functionalities (and progress of their evaluations for use in teaching and learning) available within a Virtual Learning Environment (VLE) are likely to change with time.

The formats considered appropriate for the community are:

- Read only information, live and updated.
- Read only information, archived material.
- View only podcast.
- Asynchronous discussion facility.
- Synchronous discussion facility (either audio only or visual and audio).
- Self study module.

Governance

Three areas are identified as key governance requirements.

- Community etiquette – rules. These might be different for different stakeholders.
- Reification mechanisms - practical procedures for initiating changes.
- Navigation - recommendations of the relevance of sub-communities at different times within the learner experience.

Management timeframes

Timeframe management would define the different community elements' time horizons and synchronise them with the university's academic calendar. Such management is not generally included within a community format definition as it is considered to be a constraint to its 'organic growth' or reification (Lave & Wenger, 1991). However, time constraints will be included within this community model in order to accommodate diversity and evolution within its main, student, stakeholder group and to enable limitation on the availability of a resource, a strategy suggested within this project's research data.

Timeframe management is expected to; provide appropriate and relatively easy access points for students, maximise their engagement (by accommodating both legitimate peripheral participation and the capture of information), minimise repetition of material, and maximise the scope for reification. The different time horizons considered appropriate for the community are:

- Specified synchronous engagement (e.g. interactive tutorial) fixed time, date and duration, typically hours.
- Asynchronous discussion open for a specified number of days or weeks, then closed.
- Archive material, read only available to view for fixed time period.
- Open access material, no time frame constraint.
- Asynchronous discussion, no time frame constraint.

Community content.

Initial content and resource selections for the community are indicated in Figure 4. Selection criteria used included alignment with the aims of each hub and the requirement to ensure a balanced provision of the support types, previously discussed.

Figure 4 is only an outline of the full model: for every content area with each hub, the full model definition specifies format and timeframe management suggestions and also indicates the type of support (ARCS) each is expected to provide.

Evaluation and further work.

An audit of the proposed community content and formats identified has been completed. The types of support provided relative to the general competency requirements i.e. 'soft skills' for professional institute membership, as defined by Engineering Council of the United Kingdom (ECUK, 2008), is the next planned audit activity.

Community development is a major aim of the ongoing reform of student support within the university. When a community, as defined within the model, is launched it will be necessary to have associated activities that promote engagement of student stakeholders. Suggested options for investigation include:

- Mentoring by support advisers who guide their mentees to the community resources.
- Mandatory modules within the programme that integrate community activity.
- The use of engineering residential schools to publicise and draw on the resources within the community.

Reprise

This short project produced a characterisation of engagement trends of the OU engineering student with electronic discussion forums (social communication). This, and results of reviews of the support and identity needs of such remote students, were incorporated into a model proposal for an engineering e-community for the university. It has yet to be deployed within the university-wide student

support improvement strategy. Nevertheless, it is offered as part of a framework for improving the development of a professional engineer within distance education by engaging students in a community dedicated to their specific needs.

PURPOSE	CONTENT	DELIVERY COMMENTS
Professional Development Support	**Professional Portfolio Guidance** **Soft skills' workshops.** **ECUK & Institute site links.**	**FAQ resource.** **Accreditation news / updates.** **'Ask the Eng. team site' (Asynchronous & archived).** **Self-study resources for 'soft skills'.**
Career Development Support	**Exemplar engineering options, degree profiles & alumni career progressions.** **Sources of career advice.**	**Asynchronous Careers forum open at fixed time(s) of year.** **Themed industry sector review forums (time-bound).** **Links to Careers Service.**
Academic Transition Support	**Reflection skills development.** **Eng. related study skills library.** **Module choice advice & hints.**	**Workshop tutorials on eng. related study skills themes.** **Links to study skills resources.** **Links to study support resources.** **FAQ resource.**
Provide Subject Identity 'Glue'	**Themed general seminars.** **Showcase for OU Engineering Research.** **Subject news and views.**	**Podcasts Seminars (by ALs & academic staff).** **Synchronous debates / archives.** **Links to OU Eng. Research Sites.** **'Ask the team' events.**
Engineering Project Enquiries / Support	**Advice on project:** **Subject selection,** **Preparation,** **Process.**	**FAQ resource.** **Asynchronous forum open at fixed time(s) of year.** **Comments archive from past students.**

Figure 4. Overview of engineering e-community model

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Acknowledgements

The author would like to acknowledge the contribution of research staff at COLMSCT CETL at the Open University and also colleagues from the Engineering Group within the Faculty of Mathematics, Computing and Technology.