CASE STUDY

Designing and using informal learning spaces to enhance student engagement with mathematical sciences.

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Abstract

By helping create a shared, supportive, learning community, the creative use of custom designed spaces outside the classroom has a major impact on student engagement. The intention is to create spaces that promote peer interaction within and across year groups, encourage closer working relationships between staff and students and support specific coursework activities - particularly group work. Such spaces make better use of time since students are motivated to stay and work during long gaps in their timetable, provide a sense of 'home' within the institution and can lead to a cohesive community of practice. We describe how this has been achieved and currently delivered in Mathematics at Sheffield Hallam University and provide evidence for its success.

Keywords: Mathematics, learning community, student engagement, peer support, partnership learning.

1. Context

At the outset, it is important to be clear about what we mean by student engagement in the mathematical sciences. We are suggesting the following (based on Duah and Croft, 2011):

"The time, energy and resources that students devote to the study of mathematics, including (but not limited to) active participation in directed study tasks such as coursework and revision as well as participation in relevant extracurricular activities, learning to become part of the community of practising mathematicians".

Student engagement, satisfaction and academic success is built upon this sense of belonging – of being part of a professional community that provides, amongst many other things, comprehensive support. Croft and Grove (2015), discussing reasons for the 'sophomore slump' - a common and well documented dip in achievement suffered by many students in their second year of study - stress the importance of a sense of belonging and inclusion in a peer or departmental mathematical community and the learning and teaching relationship between staff and students; alienated students refer to lecturers' lack of interest in them, existing on the margins and not being part of the learning community. This can be achieved through a culture of expectation and behaviour, the provision of appropriate support structures and the effective use of carefully-designed physical and virtual learning space. It is self-evident that active participation is more likely to happen in an environment that learners are happy to study in.

In the Student Experiences of Undergraduate Mathematics (Brown et al., 2005), feeling part of a mathematical community emerged as a crucial factor in the student experience; in SEUM this community focused on one physical space where students could work together and also meet academic staff in an informal way. A critical factor identified was the opportunities provided for interactions with other students and staff.

Suitably-designed open learning space facilitates staff-student and peer interaction by supporting new patterns of social and intellectual behaviour (Oblinger, 2005); providing spaces where faculty

and students can ‘run into’ each other increases engagement and learning (Hunley and Schaller, 2009). Learning is an active, collaborative and social process, hence ideal learning spaces should be designed to encourage personal interaction; they also need to be IT-enabled to encourage virtual interaction. Working in close proximity to friends or peers to create a sense of community, for co-support and for someone to take a break with was a key learning preference expressed by learners (Harrop and Turpin, 2013).

Another aspect of community is the feeling of a common purpose. Many learners reported that working in a shared learning environment is motivational. It seems that students are aware of what makes a space feel like a place. Place is about environment, but also about people and what is going on inside.

Incorporating a disciplinary focus in the design helps learners identify with that discipline and feel they belong to a professional community; this, together with a managed peer-support network, helps create a partnership learning community within which student engagement can flourish (Boys, 2011; Healey et al., 2014). New students can ask questions of students from later years of the course that they may not feel comfortable asking of academic staff, increasing confidence and self-efficacy (Walker, 2015). There is clearly wider recognition of this; as pointed out by Harrop and Turpin (2013) *"across the higher education sector worldwide, in particular the UK, Australia and the US, you do not have to look far for examples of new or redeveloped learning spaces, with particular growth taking place in what are termed informal learning spaces."*

As part of a major refurbishment project at Sheffield Hallam University the Mathematics Subject Group were offered the opportunity of relocating to a new area, and because of having achieved excellent staff-student relations - as evidenced by the National Student Survey - were also given the chance to design the layout of this space.

For some years we had observed our students gathering to work in whatever open space was available close to staff offices. Although their principal reason for doing this was so they could more easily call upon staff for help, a supportive network - involving all year groups - began to develop naturally as a result. In addition to academic support, cross-level Peer Support Groups underpin an effective learning community. We knew of supplemental instruction (University of Missouri-Kansas City, 2015) and were familiar with Manchester’s Peer-Assisted Study Sessions scheme that evolved from it (University of Manchester, 2015). Such supportive ‘spaces of influence’ provide additional value from existing structures with low resource implications (Vygotsky, 1978; Ladyshewsky and Gardner, 2008) and are highly valued by students (Croft, Solomon and Bright, 2008). Recognising that students will look first to each other for support (e.g. Waller, 2012), we were keen to further encourage this, and set up a Peer-Assisted Learning (PAL) scheme (Waldock, 2011) in which final year volunteer PAL Leaders facilitate a first year group task both helps embed links across year groups and also supports induction into University for new students by creating friendship groups. Although the PAL initiative in mathematics at Sheffield Hallam University runs for just one semester in year one, these groups normally persist naturally throughout students' entire course and sometimes beyond forming a powerful peer-support mechanism - a phenomenon also identified by Croft and Grove (2015) and Inglis et al. (2012). These factors informed our thinking when considering the design of the new space.

Based on this experience, a core principle in the design was that staff offices and student workspace would be co-located; the University's initial recommendation of a large open-plan staff office behind locked doors was rejected in favour of an open shared learning space. This was to encourage informal contact between staff and students, seen as a vital element in a successful learning partnership. We also wanted to provide a place that facilitated both individual and group work where students could work productively in between classes. Part of the space therefore was given over to six group-working tables for 4-6 students each equipped with a PC and large plasma

screen (see Figure 1). The importance of providing mobile IT support was also recognised and hence a high capacity wireless network was installed.

Figure 1. Illustrating two of the IT-enabled group working tables. This is also the Maths Arcade area - the grey games cabinet can be seen on the back wall next to the printer. Note also the provision of wall-mounted whiteboards wherever possible.

Other parts of the space were used for informal seating allowing group discussion, and two small meeting rooms were provided where interviews, private discussions or practice presentations could take place (see Figures 2 and 3). Altogether there is room in the open learning space for up to 60 students at any one time.

Figure 2. Illustrating some of the group working space, including fixed PC provision, easy seating and staff offices.

Figure 3. Illustrating further fixed PC provision and one of the two small meeting rooms.

The SHU Mathematics programme aims to deliver employable graduates. As indicated in the QAA benchmark statement (QAA 2015) mathematics programmes vary across the spectrum from being practice-based to being theory-based but all should focus on developing graduates with good study skills, being able to work independently or in teams, being adaptable, comfortable with IT and good at communication. The benchmark statement for mathematics (QAA, 2015) recommends that *"teaching spaces have appropriate facilities that allow both the development of extended mathematical arguments (requiring space) and effective projection equipment"*. The group working areas provide these facilities. We also installed wall-mounted whiteboards wherever possible - clearly a popular feature as students were using them before the fitter had even finished installing them!

Further modifications to the space are taking place soon as part of the University's 'Expressions' project, in which newly refurbished space is customised to enhance the identification of the space with the academic discipline. These will include large designs on the interior and exterior of the curved meeting room walls, additional posters of work carried out by students while on industrial placement, 3-D designs on some vertical pillars and a frosted panel adjacent to staff doors with section heights determined by twin Fibonacci sequences (the room number in binary will be engraved on a centre section).

As the SHU course has a practical focus we want graduates to be proficient in putting theoretical concepts into practice. There is strong evidence (e.g. Kolb and Kolb, 2005) that experiential learning, involving an interactive and immersive approach, stimulates interest and engagement and helps students become more aware of the practical applications of the theoretical concepts they are studying. This was a strong influence on the model adopted for the teaching room, which has space for 50 students to work around small group tables (see Figure 4). A large teaching wall was provided for lecture presentations and a set of 50 laptops in lockable cabinets allowed the room to be used for IT enabled sessions. The cohort size is around 100 per year, and one planned use for the room was to redesign delivery from the 'standard' large lecture followed by four group tutorials to two doubly-staffed sessions of 50. This would allow the session to be a mix of lecture and tutorial/seminar activity - involving elements of experiential learning - and although there is an additional cost of delivering part of the material twice we judged that it would be more than made up for by the benefits in enhancing the student experience. We also plan to employ the SCALE-UP

approach to developing student-centred active learning in this teaching space (Nottingham Trent University, 2015).

Figure 4. A view of the teaching room, with movable group working tables, a large teaching wall and one of the two laptop cabinets visible.

Figure 5. The teaching room has been used for a variety of activities, such as the Sheffield Royal Institution masterclass series, shown here.

2. Measuring the benefits

The new space has been designed to achieve a range of objectives, as discussed in the previous section. In order to identify the extent to which these objectives are being met, a short online survey of staff and students comprising three questions was carried out. These were:

1. What do YOU feel the benefits are of this new space?
2. Is there anything you feel better able to do now compared to before?
3. What else should this space provide?

An open space for free text comments was also provided.

Responses were received from 9 staff and 27 students (full details available at https://maths.shu.ac.uk/staff1415/poll/poll_results.php). The student responses are categorised as follows (with representative comments shown).

Improved availability of staff

"*Having such a wealth of knowledge just a knock away is brilliant - it is so much easier to approach staff than previously.*" (Second year student)

Developing a mathematical community

"Having a home for the discipline makes the maths department seem more united." (Final year student)

"Working around people studying the same subject - a sense of 'home'." (Second year student)

"As the area is purely maths it is easier to find someone who also studies a module you do and promotes students to help one another and interact." (Final year student)

"There are always people to ask if you are stuck, even ask other years for help." (First year student)

Facilitating work

"It's a very bright, open space with good modern features - three things for me that make working easier." (Second year student)

"Big round tables are excellent for team work and sharing ideas." (First year student)

"Whiteboards and pc TVs promote group work and problem solving." (First year student)

"It is also open and tidy and I can think better in spaces like that. The meeting rooms and group booths are great for when you want to work with friends as well." (Second year student)

"It's conducive to group work since there are tables we can huddle around and whiteboards." (Final year student)

Additional benefits. Students also identified some specific benefits of working in the new space that offered a significant advantage to them:

"I can get to work much faster due to the computers being very good." (Second year student)

"I can also use gaps in the timetable to do work before going to lectures which may be right next to the main PC area." (Second year student)

"Before I only came into university for lectures and worked at home, which isn't always effective with the distractions of student life. Now I can spend all day in the maths department meaning that I work much more efficiently and get to spend more time on my studies." (Final year student)

"I feel better able, and more willing, to do work at uni now I know there is a good chance of getting workspace whenever I need it. It means I'm more inclined to stay at uni (and be more productive) instead of going home after lectures." (Final year student)

Other student comments

"Really like this idea, it's made everything generally a better atmosphere rather than being lost within the uni not having a home."

"Overall I feel this space is a great for all mathematicians. Its spacious design has led to a great social atmosphere as well as providing excellent study facilities. Intermingling between year groups has also been created and the extra interaction between student and staff will no doubtably (sic) aid in the provision of work and assignments. The space has been a great addition to the university."

"A great space to be in and I enjoy going there to study!"

"It's great, I love it, haven't been to Library all semester."

Staff Comments

"More inter-year communication. Conversations between year groups is happening more."

"Events can be held. Within a classroom they might have not been appealing."

"Interactions with students. This includes saying just saying hello. It also includes things like being able to introduce students to people in other year groups who are struggling with making elective choices and would like more info about what the modules are like."

"Course cohesiveness. There is a definite feeling of belonging. Proximity between staff and students seems to encourage approachability. It seems like a really nice area to work in and is well used."

"Really friendly good atmosphere amongst all maths students of different years in particular Maths Arcade and the de-stress day have both taken off because of it."

"I feel like I am now more approachable!"

"Sense of identity and community for both staff and students. A little bit intangible but important and ties in very well with our ethos."

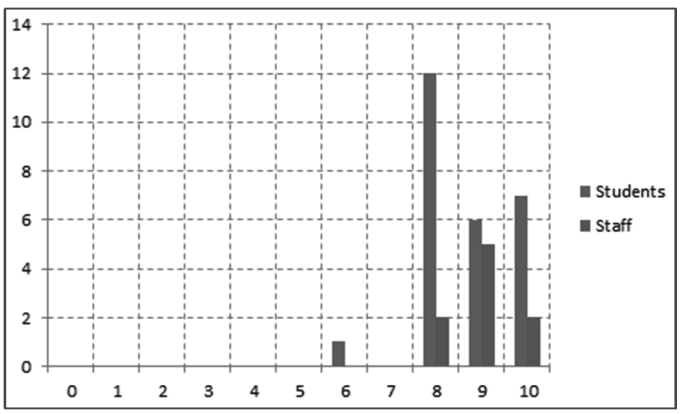

Figure 6. Frequency of subjective ratings of the new learning space

Staff and students were also asked to rate the new space on a scale of 0 to 10 (Figure 6). This illustrates the extent to which all users of the space are satisfied with it. Ratings less than 10 are associated with comments along the lines:

"There are lots of students from other courses coming in to do their work making it sometimes harder to find spaces to sit as peak times."

The University mistakenly advertised the space as available to all, but this was corrected and signs put up stating it was for maths students only, and the problem has been resolved.

3. Commentary

A new mathematics 'hub' space for mathematics at Sheffield Hallam University has been created, designed to encourage students to engage in course-related activity outside scheduled class time, improved staff and student partnerships to build a supportive discipline community.

It has been in use since the start of 2015, and early indications are that expectations of the benefits of its design are being met, with more students engaging proactively in group work outside taught sessions and feeling better supported by staff and peers. There is a clear discipline specific focus to the space and participation in regular events it hosts such as the Maths Arcade, a national project set up by the University of Greenwich in which logical thinking is developed through the use of strategy games (Bradshaw, 2011), have risen significantly; situating the activity in an open space has the effect of drawing in additional participants who might otherwise either not know it was happening or be deterred because it was taking place behind a closed door.

Student comments indicate that the provision of custom designed discipline space in which they have had an active part to play in the design leads to increased motivation to use the space to engage with curricular and extra-curricular activity, to take part in group work and to form an active learning community.

Not to be neglected is the added benefit of staff motivation, engagement and participation in forming this active community. Focus is often placed on building an engaging and dynamic student experience without explicit recognition that this is equally important for staff. Staff responses to the survey indicate that initially at least, fears that they would be inundated with requests for support have not been realised; students recognise that to become an independent autonomous learner they need to call upon staff for support after first working on a problem either alone or in groups, and respect the fact that staff also have other demands on their time.

There will be future difficulties to be faced, such as finding room for expansion to support increased levels of undergraduate recruitment. We also recognised our good fortune in having an institutional estates strategy that has allowed us to take a leading role in the design of this new space. Across the sector, the central involvement of academic teaching staff in planning and design is not the norm, however perhaps the successful experience reported in this case study may help support a case for a similar involvement of colleagues when planning redevelopments elsewhere.

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