The role of informal learning spaces in enhancing student engagement with mathematical sciences

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The role of informal learning spaces in enhancing 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, can provide a sense of 'home' within the institution and can lead to a cohesive community of practice. In this paper we describe how this has been achieved and currently delivered in Mathematics at Sheffield Hallam University and provide some detailed analysis of the student usage of the space.

Keywords: Learning spaces, engagement, mathematical sciences, peer support, collaborative learning

1. Background

This paper analyses the impact of an intervention carried out in the Department of Engineering and Mathematics at Sheffield Hallam University in the UK to enhance the engagement in their study of students on the BSc Mathematics course. The course recruits approximately 100 students per year and is a three year programme, or four years for those students who choose to take an optional one year industrial placement after the second year. It is promoted on the basis of developing employable graduates for careers in business, industry and commerce by focusing strongly on practical application of mathematics, making extensive use of technology where available. The Mathematics subject group, which currently comprises 26 staff (24.5 FTE), has a long history delivering strong student support and regularly receives excellent results in the annual National Student Survey of final year undergraduates, which has been in operation in the UK since 2007. The group also has a strong reputation for research in teaching and learning of HE mathematics. To sustain and develop a team that can deliver all of these ambitions, key criteria in the recruitment of new staff include a strong interest in teaching and learning, an ambition to engage in pedagogic research and a willingness to contribute to a supportive staff-student learning community.

This intervention concerns the creation of a new shared staff-student learning space, building on the above strengths to enhance student engagement. The design of the new learning space for mathematics at Sheffield Hallam University is described in detail in [1].

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 [2]):

> "*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 practicing 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. Reasons for the 'sophomore slump' – a common and well documented dip in achievement suffered by many students in their second year of study – are discussed within [3], which stresses 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 in which learners are happy to study.

In the Student Experiences of Undergraduate Mathematics (SEUM) project findings, feeling part of a mathematical community emerged as a crucial factor in the student experience [4]; in SEUM this community focused on one physical space where students could work together and also catch 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; providing spaces where faculty and students can "run into" each other increases engagement and learning [5, 6]. 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 preference expressed by learners [7].

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 [8, 9]. 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 [10]. There is clearly wider recognition of this; as pointed out in [7] "*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*."

2. Context

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.

The Mathematics group previously occupied a set of offices along a narrow corridor, with no space specifically set aside to allow informal staff-student interaction. For some years, however, we had observed students gathering to work in whatever open space was available close to staff offices.

There was a wider section of the corridor allowing us to support this by adding some tables and chairs, and we found that students naturally gravitated towards working at them. 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 [11] and were familiar with Manchester's Peer-Assisted Study Sessions scheme that evolved from it [12]. Such supportive 'spaces of influence' provide additional value from existing structures with low resource implications [13, 14] and are highly valued by students [15]. Recognising that students will look first to each other for support (e.g. [16]), we were keen to further encourage this, and hence set up a Peer-Assisted Learning (PAL) scheme [17, 18] in which final year volunteer PAL Leaders facilitate a first year group task. This both helps embed links across year groups and also supports induction into University for new students by encouraging the formation of 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 in [3] and [19]. These factors informed our thinking when considering the design of the new space.

The new space, informed by what had already been seen to work, was designed around the principle of co-location, with an open learning space surrounded by staff offices to encourage informal contact between staff and students. It was designed to facilitate both individual and group work so that students could work productively between classes, through the provision of group working tables, IT equipment and wall-mounted whiteboards. Figure 1 shows the design of the whole floor; this paper concentrates on the open learning space in the centre.

Figure 1 - Mathematics area floor plan.

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. Altogether there is room in the open learning space for up to 60 students at any one time. Office space is available for 22 staff; three of the remaining staff are in an additional office immediately outside the new learning space, and one is in an individual office further away. The new learning space was available from December 2014.

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

3. Identifying immediate benefits

In order to identify the extent to which the objectives of the new space design were being met, a short online survey of staff and students comprising three questions was carried out during March 2015 - 3 months after the move to the new space. The questions used were:

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

An open space for free text comments was also provided. Responses principally fell into the following categories (emphases added by us):

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*"

Developing a mathematical community

*"Having a home for the discipline **makes the maths department seem more united**"*

*"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**"*

Facilitating work

*"Big round tables are **excellent for team work** and sharing ideas"*

*"Whiteboards and pc TVs **promote group work and problem solving**"*

Additional benefits

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

> *"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"*
>
> *"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***
>
> *"**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"*

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. It's 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 aid in the provision of work and assignments. The space has been a great addition to the university"*

To investigate the extent to which it is the space that supports these improvements, a further study was carried out of the usage made of the space, described in the next section.

4. Methodology

Observation of the open learning space

Observations of the space were used to investigate (a) the extent to which students make use of the space and when, (b) student use of the different facilities within the space and (c) whether use changes at a time when academic workload increases (as measured by the number of coursework deadlines).

Two week-long observations were undertaken. These involved counting the number of people present and at what position in the open learning space, hourly from 09:30-16:30 Monday-Friday. Half past the hour was chosen to be a fairly settled time, without students coming and going from classes in the adjacent teaching room. The first observation was of a typical mid-term week (January 2016). The second was in the last week of the teaching term (April 2016), chosen as a particularly busy time when more students would be working to assignment deadlines.

Positions in the space were labelled, as shown in Figure 3. The following key applies: PC work areas are labelled PC1 - PC3; general tables are labelled T1 - T4; group work areas with plasma screens are labelled P1 - P5; coffee tables are labelled C1 - C2; and meeting rooms are labelled M1 - M2. Where a person was in the space but not at one of these points, their approximate location in the space was noted. In the results section, these are recorded as numbers either at the printer (near T4) or as 'Other – walking, etc.'.

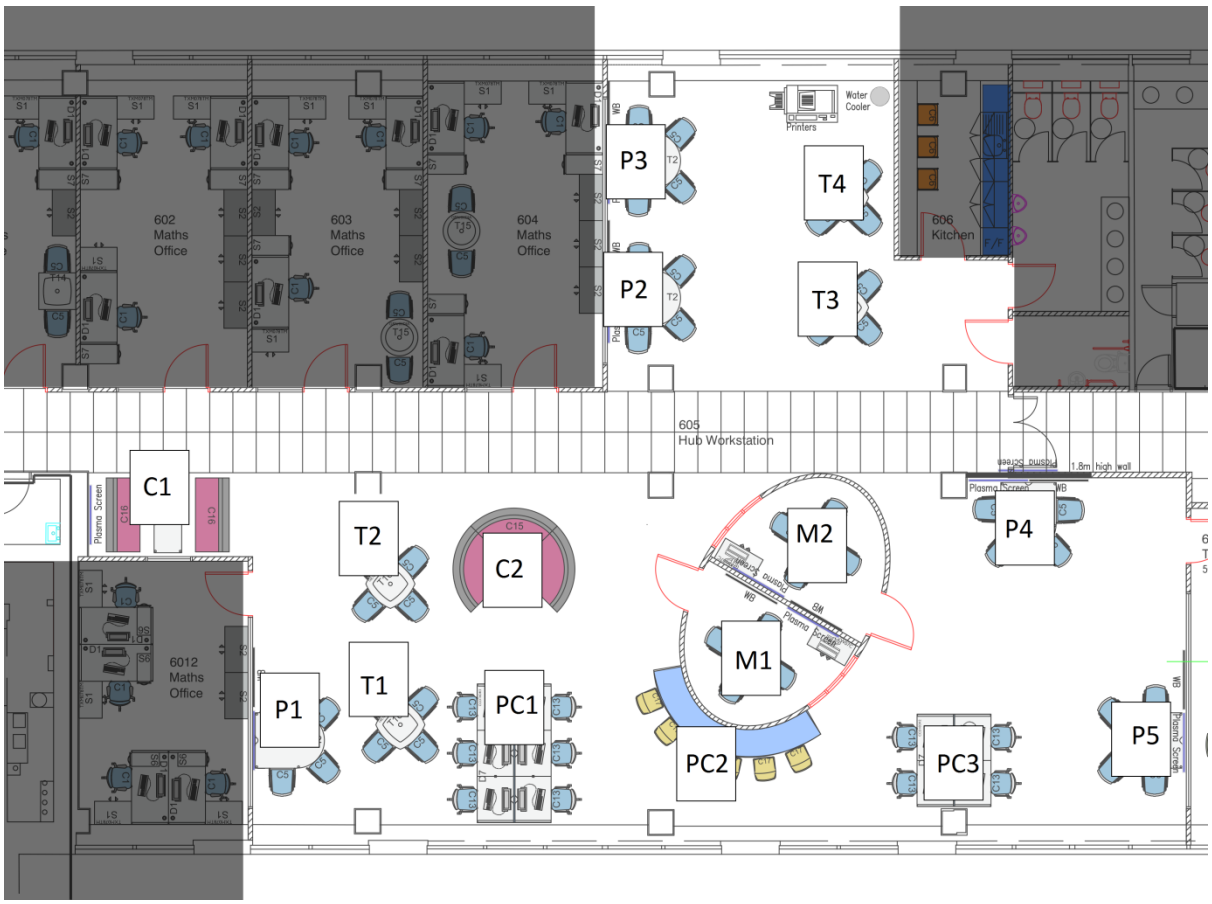

Figure 3 - Mathematics open learning space showing positions labelled for observation.

Timetable gap analysis and questionnaire

One aim of the student learning space was to provide somewhere for students to work during periods of time when they are on campus with no scheduled teaching activities. This benefit was clearly identified by the students in the earlier survey. Timetable gaps were defined as periods when students are not in a scheduled teaching session but had classes both before and after the gap. So a student who has classes at 11:00-12:00 and 14:00-15:00 would be considered to have a gap 12:00-14:00 but would not be considered to be in a gap prior to 11:00 or after 15:00. Such students may of course choose to use the learning space prior to 11:00 or after 15:00.

Timetables were analysed to identify periods when students had gaps. A short questionnaire was completed by students in three teaching sessions which followed timetable gaps in early April 2016. This is late in the teaching year, so we might expect students to have a good awareness of the places on campus where they could spend time and to make an informed decision about where to do so. The questionnaire asked students how long their gap had been, where they had been during that time (from a list) and how long they had spent working during that time. As well as investigating what the students did between sessions, part of the analysis involved looking at the use of the space at times when the students did not have gaps.

Interviews with students who moved to the new space

Short interviews were conducted with final year students after the end of the teaching year. This particular group had experienced studying mathematics at Sheffield Hallam University both before and after the Mathematics group moved to the new space.

The interviews were semi-structured, comprising one opening question – "*You are one of the students who moved to the new space part-way through your studies. Can you tell us what difference this has made to you, if any?*" – after which the interviewer asked any follow-on questions they felt appropriate.

5. Results

Observation of the open learning space

During the first observation week, 39 observations were made and one (Monday 10:30) was missed. To approximate the missing data, an observation recorded on Monday at 10:30 the following week was included in the results presented here. This approach is considered reasonable because this observation was intended to take place in a normal teaching week, which both weeks were. During the second observation week, 36 observations were made and four were missed (Wednesday 15:30 and Friday 09:30, 12:30 and 14:30). Since this was an unusual week, no opportunity was available to recover these missing data, and they are marked as missing in these results.

During the first observation week, 652 non-unique individuals were observed using the space, 21 of which were staff. Note that if a student stayed in the space for, say, three hours, this was counted as three non-unique individuals since no record was made of individual student identities. During the second observation week, 982 non-unique individuals were observed using the space during observation week 2, 18 of which were staff.

Figure 4 shows the total numbers (staff and students) using the whole space at each observation time and Figure 5 shows the cumulative numbers (staff and students) at each position across the whole week. During the first observation week, there is a structure to the week which follows the academic timetables, with more students using the space on Tuesday and Thursday and few students on Wednesday. During the second observation week, this structure is not apparent, with the numbers of students decreasing each day as the various assessment deadlines passed (there were big deadlines on Tuesday and Wednesday). There were more students observed making use of the space during observation 2. During both observations, PCs were the most popular positions, and meeting rooms and coffee tables were less popular. In observation week 2, the group working spaces (plasma screens, marked P1 - P5 in the data) were more popular than in observation week 1.

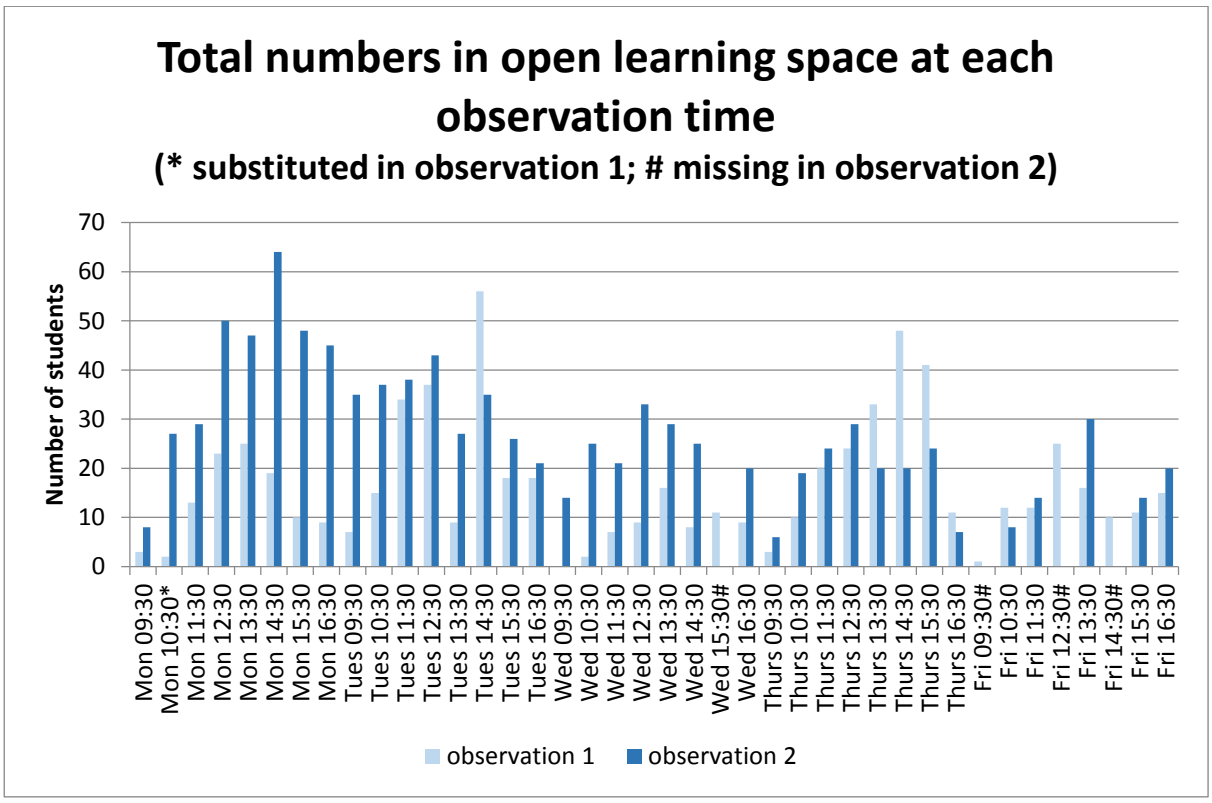

Figure 4 - The total numbers in the open learning space at each observation time.

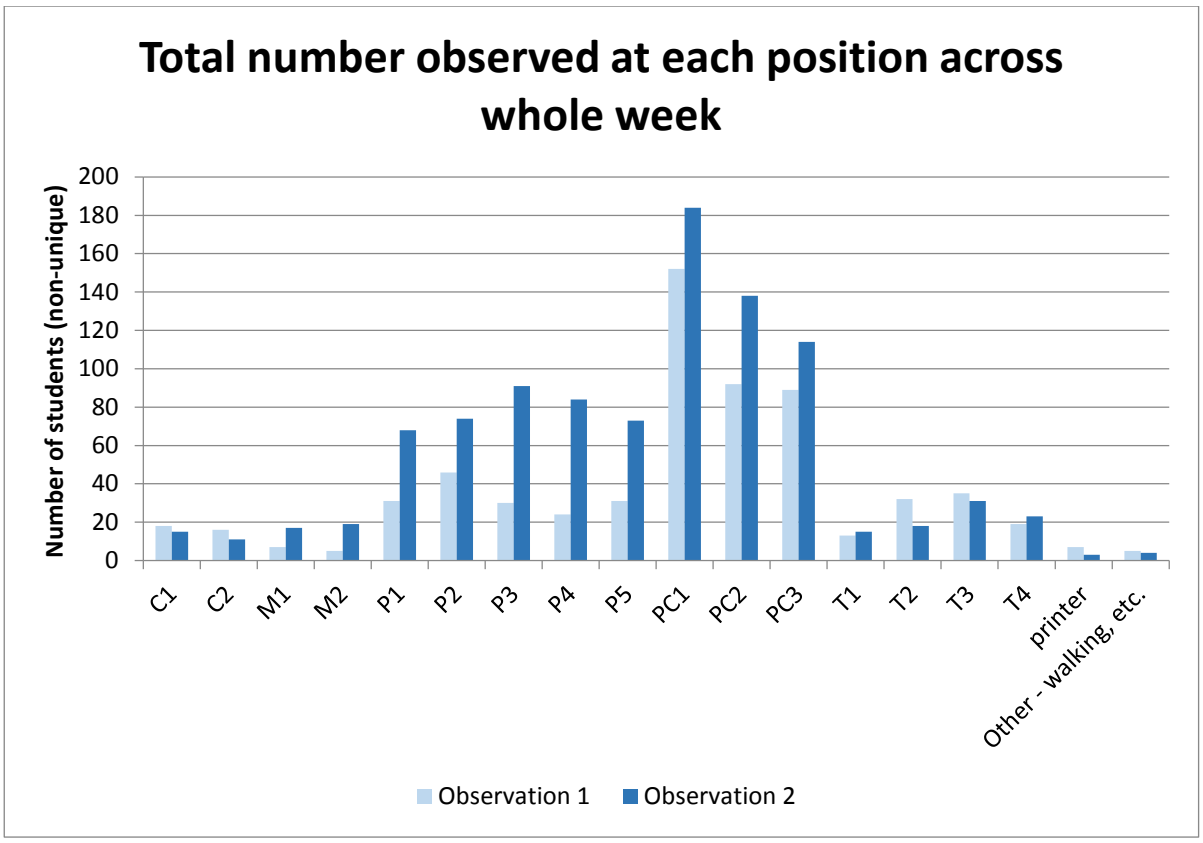

Figure 5 - The total numbers observed at each position during the whole week.

Timetable gap analysis and questionnaire

An analysis of timetable gaps during observation week 1 revealed that students were using the open learning space even when no students had timetable gaps. Figure 6 illustrates the numbers of students with a timetable gap against the number who were using the open learning space. The line y=x is shown, to highlight the fact that there were times when more students were using the space than had a timetable gap at that time, including several times when students were observed using the space when no student had a gap (i.e. before or after their teaching for the day had started or finished).

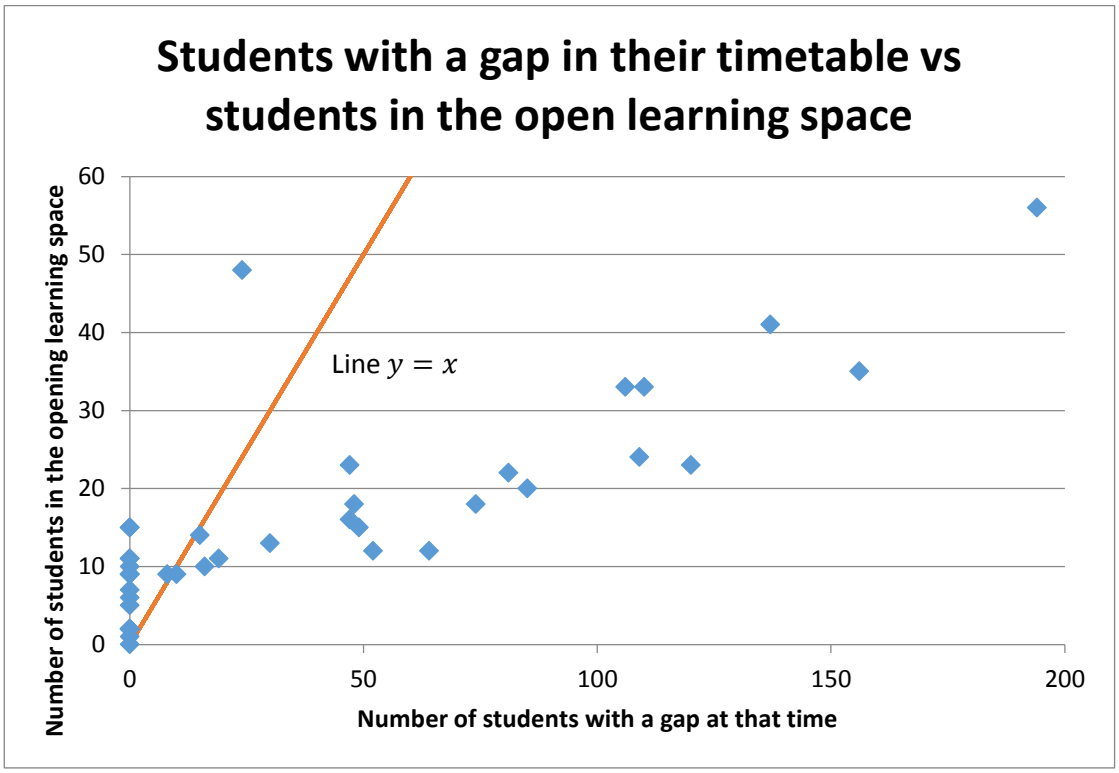

Figure 6 - Chart comparing the numbers using the open learning space with the numbers who had a timetable gap at the same time.

After identifying the times when many students had gaps in their timetable, the questionnaire was administered in three surveys. Survey 1 took place in a teaching room adjacent to the mathematics open learning space, survey 2 took place in another university teaching building and survey 3 took place in a lecture theatre near the library. All three observations took place immediately following a time period in which we might expect students to eat lunch, potentially reducing the amount of time we might expect students to be working.

Table 1 shows the number of responses for each survey, the numbers of respondents with a timetable gap and the length of those gaps. Table 2 shows where students spent time during the gaps preceding each survey if they had one. Students were given a list of locations which was similar to the first column of this table only using university building names rather than the generic terms used here. Students could have spent time in more than one space during the gap.

In survey 1, of the 28 students with a two-hour gap, the mean time spent working in the gap was 52 minutes (43% of the gap). In survey 2, of the 27 students with a two-hour gap, the mean time spent working in the gap was 53 minutes (44% of the gap). In survey 3, of the 34 students with a

one-hour gap, the average time spent working was 34 minutes (57% of the gap) and of the 32 students with a two-hour gap, the average time spent working was 74 minutes (62% of the gap).

Survey	Year group	Number scheduled for teaching session	Number of responses	No gap (first teaching session of the day or immediately following another)	1 hr gap	2 hr gap	3 hr gap
Mon 2pm	1	60	39	6	1	28	4
Tues 1pm	1	49	31	3	0	27	1
Tues 2pm	2	98	72	5	34	32	1

Table 1 - Numbers of students with gaps for three post-gap surveys.

Space used	Number using that space			Total number (all three surveys)
	Survey 1	Survey 2	Survey 3	
Mathematics open learning space	18	9	22	49
Level 5 (one floor below)	3	0	25	28
Library	2	1	6	9
Learning space in another university building	1	6	11	18
University café	8	2	3	13
Home	10	12	2	24
The shops	6	5	12	23
Other	3	3	8	14

Table 2 - Spaces used by students in three post-gap surveys.

Interviews with students who moved to the new space

Short interviews were conducted with twelve final year students, all at the end of their final year on the BSc (Hons) Mathematics degree. Eight of these students were female and four were male. One student spent two years studying when the Mathematics group was based elsewhere, was away completing a year-long work placement during the year when the move to the new space took place, and returned for their final year of study with Mathematics based in the new space. The other eleven students spent 1.5 years studying when Mathematics was based in the new space, and had all spent at least 1.5 years studying when Mathematics was elsewhere, longer if they had repeated a year. All interviews were less than three minutes long.

Eleven of the twelve students were positive about the new space. One student was neutral, saying the space had made little difference to him: "*I don't come in a lot, personally, I just stay at home, so it doesn't really affect me that much. It's better than the old place I think*".

Analysis in this section therefore focuses on the eleven students who said the new space had made a difference to them. Initial analysis looked only at the students' responses to the opening question. This identified three themes in the responses:

- access to staff,
- having somewhere to work and
- feeling part of a community of learners.

The rest of the interviews comprised students' responses to follow-on questions. Some of these follow-on questions were quite neutral, e.g. "h*ow have you used the space, personally?*" while others were more leading, e.g. "*does it make any difference to how you work with other students?*". Student responses during these follow-on sections of the interviews could also be categorised into the three themes listed above. In the analysis that follows, quotes are labelled 'spontaneous' if they were responses to the opening question or 'prompted' if they were responses to further discussion and follow-on questioning. If a student mentioned one theme in response to the opening question but gave further detail in response to questioning, quotes from the former response are marked 'spontaneous' and those from the latter are marked 'prompted'. Quotes below are marked S1-S11, with 'S' for 'student interviewee', with S12 the student reported above as neutral.

Access to staff

Seven students' responses to the opening question mentioned a positive impact on access to staff and an eighth student mentioned this under follow-on questioning.

Six students focused on the practical convenience of access, e.g.: "*I like how the teachers are a bit more close, you can get to everything on one level*" (S8, spontaneous). One student compared the convenience of working near staff to working elsewhere on campus, saying: "*if I was in [the library] and say I needed to speak to you I don't have to walk all that way, you're just there*" (S6, spontaneous). Four students made comparisons to the previous location of the Mathematics group, e.g.: "*being able to work in an area and then being able to, if you've got any problems, you just walk to one of the offices and just quickly ask the lecturers for help, instead of walking round all of [the old location] trying to figure out which office is whose*" (S4, spontaneous); "*you can just pop into their office whereas before it were emailing and arranging a meeting or whatever, whereas now I can just knock on the door and see if they're in*" (S5, prompted). Regarding the second quote, it is worth pointing out that staff operated the same open-door policy in both locations, so it is interesting that some students feel more able to "pop into" staff offices now they are co-located with student work space.

Beyond simple practicalities, two students' responses suggest they feel staff are more approachable since the move: "*you feel more that you can speak to the teachers more now because it's more open and you can just come in*" (S9, spontaneous); "*it was always a bit intimidating walking round [the old location] to find people because we never had classes in that area and we never worked in that area ... This year, we've got a dedicated space in and around where lecturers are, so we can be doing our work and think 'oh, I'm stuck' and go and talk to the lecturer directly*." (S10, spontaneous).

Having somewhere to work

Eight students spoke in response to the opening question about the value of the space as somewhere to work, with a ninth mentioning it in response to follow-on questions.

Two students compared the availability of space for mathematics students to that in the old location, e.g. "*in [the old location] there was nowhere to work*" (S8, spontaneous); "*you've actually*

got somewhere to come and work. Like, whenever you were in the old place, you couldn't really go there and work" (S9, spontaneous).

Four students compared the space favourably to the library, e.g.: "*it's probably made me do more work. I'm not a fan of going to the library to find a computer, but if you know you can almost guarantee that there'll be space to work here.*" (S2, spontaneous); "*when you come here it's only maths students allowed to use the computers, whereas when you go to [the library] it's obviously anyone at all. Sometimes if we're working together, there's a couple of us, we'll struggle to get somewhere in [the library] whereas when we come here there's quite a lot of tables*" (S6, spontaneous); "*I avoid going to the library, I just come here*" (S9, prompted). One student went as far as to say in relation to working in the new space this year rather than working elsewhere in previous years: "*I prefer working in here than working at home, whereas in the second year I preferred working at home than coming in*" (S1, prompted). However, one of these students did prefer the library on occasions because of the availability of bookable quiet rooms (S6, prompted).

One student compared the open learning space to the university cafe, saying: "*In first and second year you really had, well we'd sort of hang around in the cafe downstairs in the atrium, but this year you can just come straight up here and it's quieter"* (S7, spontaneous).

Two students referred to the quality of the IT equipment in the new space, e.g.: "*I'll always come here or level 5 now, because the computers are a lot faster than the library, and you need that, especially for using Excel*" (S1, prompted).

One student highlighted the convenience of having a space near to where teaching takes place, saying: "*because we had an hour gap we'd start doing the tutorial work together normally at one of those computers and then go to tutorial because it was just across there*" (S6, prompted).

The noise level in the open working space clearly varies (supported by the observation data presented above, which recorded widely different numbers of students at different times), with two students complaining of noise levels in the new space (S6, S8) and three saying it was a quiet space to work (S1, S7, S9).

Feeling part of a community of learners

Five students' responses to the opening question referred to being part of a community, and five more mentioned this in response to follow-on questions.

Eight students mentioned the advantage of having access to a community of other learners for peer support. For some, this may be planned: "*when I'm doing assignments I like to meet up with other coursemates to do group work*." (S2, prompted). For most, however, it was useful to have a location where they knew they could find others would be working on similar work: "*because it's an area for maths students if you come here there's people you can talk to if you get stuck so you know where everyone is*" (S9, spontaneous); "*if you're working on something there'll be someone on another table in the area who's working on a similar sort of thing, so I mean the odd word here and there can be thrown back and forth, which wouldn't have happened before*" (S10, prompted).

This peer support was even available when the students didn't know each other, e.g.: "*I don't feel as stupid going up to people that I might not necessarily talk to and asking for help*" (S5, prompted); "*you didn't really see anyone before. I would do my work in the library or something like that, and it was really hard to find anyone. So it does help with peer learning, it's easy to say 'he's in my lecture, I'll just quickly ask him a question'*" (S4, prompted). One student included communication between year groups in this, saying: *"I know that a lot of the lower years ask the higher years for help with stuff*" (S7, prompted).

This peer support environment can be an advantage over speaking to staff, especially out of working hours: "*you can always ask for guidance on questions you've been stuck on instead of waiting and going to see teachers*." (S1, prompted).

Two students specifically mentioned that the proximity of staff offices enhanced this feeling of community, e.g. "*I don't know whether it's because it's all open space to where all the offices are, I just think it makes you feel more part of a maths community*." (S3, spontaneous).

Four students referred to social aspects of working in the same space as other mathematics students, e.g.: "*I've made a lot more friends with people who are coming in at the weekends*" (S1, prompted); "*I find myself talking to people that I weren't talking to before*" (S5, spontaneous); "*before all we saw was each other in the seminars and lectures*" (S4, prompted). This can help keep in touch with students who you no longer see in formal sessions: "*this year we all do different modules so you don't see everyone that you used to see, so it's nice just to see people*" (S7, prompted). One student said "*I feel like we are a family, you know? We are very close*." (S11, prompted).

5. Discussion

Observations of the new space

More students were observed using the space when academic workload, measured by the number of deadlines, was higher. During the first week of observations, there were definite connections with the timetable, but very few in the second week. It was found in both observations that the PCs were popular, with the coffee tables and meeting rooms being less so. Significant deadlines in the second observation included a second year group project (Tuesday) and the final year project (Wednesday). The group work spaces were more popular in the second observation, which is likely to be due to the group task.

A limitation of the observations were that they were only carried out once per hour and only provided a snap shot of the activity that takes place. Activity that happened between the recordings was missed. Also, the collected data did not include records of any students who had used the space all day or for a long period of time. The observations were only over two weeks. It can be argued that there is no such thing as a typical week and the two observations show how different some weeks can be.

The observations only took place between 9am and 5pm between Monday and Friday. We found that students at 4.30pm reported that many would stay late into the evening, and some interviewees spoke about the use of the space at the weekend. This supports our finding that students were using the space when they did not have a gap on their timetable and were coming into the university specifically to use the space, but we did not carry out observations on either evenings or weekends.

Timetable gap analysis and questionnaire

On closer inspection of the timetable, we found that even during a 'normal' teaching week, we observed students using the space who did not have a timetable gap. This may have been happening throughout the week, but there were particular times during the week when no students had gaps, but there were still students observed using the space. This means students were using the space before or after teaching sessions, or when they had no timetabled activities at all.

Unable to identify students with a gap during the observations, the questionnaire provided information that students were indeed using the space in between taught sessions. This was

indicated by the connections between the number of students who had gaps and the first observation, and was confirmed by the results of the questionnaire.

Ideally gaps of one or more hours that were not near lunchtime would have been best, but there were no suitable gaps for a significant number of students apart from just after lunchtime. It was found that students on average spent around half of a timetable gap over lunch working, but we are unsure of what would happen if these gaps were not near lunchtime. On the basis of this finding, more gaps have been built into the timetable for the next academic year to encourage informal working.

Interviews with students who moved to the new space

It was found that eleven of the twelve students interviewed were positive about the new space, with the twelfth being neutral. The students interviewed were approximately 18% of the cohort, with the limitation that the interviews were of little depth. However, some interesting results did emerge. The students commented about the accessibility of staff, a goal of the design. They found that it was practically easier to find staff and they also felt that staff were more approachable. The students liked having somewhere to work, more so than the old space or the library. For one student, this made the difference between coming into campus and staying at home. One student liked the bookable meeting rooms in the library, yet we observed little use of the meeting rooms in the Mathematics space. In one case, students seem to be doing tutorial preparation work because they have a space to work near to where the tutorial takes place.

There were several comments to suggest students feel part of a community of learners whilst being within the space, another key goal of the design. However, more responses here were prompted than in other sections, meaning at least that it doesn't necessarily occur to students so readily to talk about this. Amongst the prompted responses, there were several mentions of peer support, sometimes involving students they do not otherwise know. In one case, this included inter-year group discussion, a particular goal of the design. There are social aspects, as students are getting to know more coursemates and seeing other students they would not otherwise see. There are indications that the students feel like a community of learners working near staff, forming a whole mathematics community.

Overall there was a strong indication that the students are using the space and the increased accessibility of both staff and other students means the space has contributed to students feeling that they are part of a mathematical community.

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 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. Staff responses to the March 2015 survey demonstrate a view that any disadvantage of interruption is outweighed by the benefits in terms of student support. No negative remarks were made, the following being typical:

"*Nice being available to students and for me it works well keeping my door open if they are welcome to pop in just for a chat, and having it closed if I am busy and they come in if they have something definite to ask*".

"Easy access for student support (a mixed blessing, sometimes, but more positive than negative)".

"*Proximity between staff and students seems to encourage approachability*."

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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