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RESEARCH ARTICLE

How important is community to mathematics and statistics distance learners?

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Abstract

Being part of a community has been shown to support the development of academic resilience, promote retention and improve attainment. This paper discusses the findings of a study which investigated the importance and experience of student communities for distance learning students currently studying mathematics and statistics modules. It was found that community with students on the same module or on similar degrees was the most important, whilst community with students in the same faculty; at the same university; with similar characteristics and with students in general were less valued. The proportion of students that felt community was important was significantly higher than those that felt part of a community. Students near the end of their degree felt community within a module was more important than students who had recently started, but felt other community groups were less relevant. Equally, students near the end of their degree were more likely to feel part of a community with others studying the same module than students at the start of their degree. Qualitative responses reinforced the priority of community with students on the same module but indicated a significant proportion of students had no interest in community, and there was notable variation in student views on how community could be generated.

Keywords: Community, Sense of Belonging. Distance learning

1. Introduction and background

The importance of communities within education has long been established (Rogoff, 1994), particularly within online and distance learning environments (Kaufmann and Vallade, 2020; Kear 2011). A supportive community has been found to assist the development of academic resilience, (Barber et al, 2019), promote retention (Foster *et al*, 2012; Crossling et al, 2009) and improve attainment (Cançado et al, 2018). The importance of community for success for mathematics students is particularly marked for women and first generation students (Ellis and Berry 2012).

In a distance learning environment it can be harder to organise community interactions (Hilliam and Goldrei, 2019) and there are fewer opportunities for them to arise spontaneously (Chang and Smith, 2008), but there is a particular need for such support given the high proportions of non-traditional students studying in this way (Ludwig-hardman and Dunlap, 2003).

At The Open University (OU), students learn at a distance, using both online and printed material. They are supported academically and pastorally but providing this online can be challenging (Hilliam et al. 2021). Prior to 2007 all academic support was provided by face-to-face tutorials given in various geographic locations throughout the UK, which enabled students to meet other students near to where they lived and form communities that could support each other both academically and socially as their studies progressed. Since 2007, tuition support has been blended with a mix of face-to-face

and online tutorials and now is almost completely online. Whilst the move to online tuition has allowed the OU to support more students academically by offering a greater diversity of tutorials (Pawley 2022) it is noted that it is more difficult to encourage student interaction (Campbell et al, 2019), with tutorials often being in the style of lectures (Lowe et al, 2016) and this will reduce social interaction and the formation of meaningful communities.

Forming communities can be more challenging initially where students lack connection with the other students (Apps et al, 2022); this is particularly prevalent in an initial mathematics module at the OU. This module is the first module studied for 30-40% of the students taking it, and many of those studying it are not mathematics specialists. The module is often found challenging; the importance of supporting students' sense of belonging and developing structures for their interaction in this context is established in the literature (Lahdenperä and Nieminen 2020), and particularly so for underrepresented groups (Marzocchi 2016). In the final modules, there is less service teaching and most students will be studying a degree in mathematics and statistics. Towards the end of their degree, it is possible students may have encountered others on their module at a previous point, however forming a social community can still be challenging.

This paper examines the perceptions of students on mathematics and statistics modules about the importance of and their experiences of social communities. As many higher education providers move, in part, to provide a distance or online offering, the issues that emerge are more widely relevant, particularly with respect to the changes of perceived importance of community for fully online learners.

2. Methodology

In order to examine students' views on community, in February 2023, a large scale survey was carried out, gaining both quantitative and qualitative data. It was sent to a representative sample of 6926 students who were studying a Mathematics or Statistics module, supplied by the OU Data and Student Analytics team. A total of 402 students responded (245 male, 157 female).

At the OU students have the option to study part-time or full-time and can take anywhere between 3 and 16 years to complete a degree. Instead of using years to describe a student's progression through their degree, the OU uses stages, where roughly stage one equates to modules studied during the first year of a full-time degree, stage two equates to year two and stage three equates to year three. Participants were at various points of study with 204 studying at stage one, 97 at stage two and 64 at stage three; the remainder were either studying at postgraduate level or could not be reliably assigned to a stage of study due to a mixed study history.

The School of Mathematics and Statistics carries out a large amount of service teaching and so within the survey responses are participants from multiple degrees (152 studying either a single or joint honours mathematics degree, 54 studying computing, 42 science, 34 data science, 24 business and economics and 92 studying other degrees; the remainder were not registered for a degree, but studying modules in isolation). A majority ($n=342$) of the respondents identify as white. Within the respondents there was some overrepresentation of newer students and of those studying mathematics qualifications, and some underrepresentation of those studying computing qualifications. There was also a small over representation of white students in the respondents, however the low proportions of Black, Asian and Mixed Ethnicity students on mathematics and statistics modules make it impossible to draw firm conclusions about their feelings of community. Similarly, since the main topic of interest is mathematics students, rather than those taking a

mathematics module as part of a different qualification, the high representation of mathematics students is not problematic. It may also indicate a greater interest in “community amongst mathematics and statistics students” than those for whom mathematics is a small part of their curriculum. Apart from these caveats, the demographics of the respondents are representative of the students enrolled on modules within mathematics and statistics during the academic year 2022-2023.

The quantitative part of the survey focused on three areas: how important students felt community was; how much they felt part of a community; and whether their feelings of being part of a community had changed over time spent at the OU. Responses to the first two areas were given on a five-point Likert scale, however for clarity of reporting we have only shown on a three point scale, and the last area as increased/stayed the same/decreased.

Students were asked to consider 6 different communities:

- Students studying the same module (same module);
- Students studying the same degree at the OU (same degree);
- Students in the same faculty (In your faculty);
- Students with similar characteristics/interests (similar characteristics);
- Students at the OU;
- Students in general.

The qualitative part of the survey asked students to consider what has made them feel part of communities, and what more could be done to increase their feeling of being part of communities; this was analysed using thematic analysis.

Further insight into the views of individual students on community, including the existence of an academic community, whether it is required and how it can be developed was gained by brief interviews with 5 students. Due to the small number of interviews, they cannot be seen as indicative of all students, however through a narrative analysis they can offer insights into individual stories and offer perspectives on critical points established via the quantitative and qualitative data gained with the survey.

3. Findings

3.1 Importance of, and feeling of being, part of communities – overall picture

Students were asked how important they felt it was to be part of each community listed above and how much they felt part of each community. As can be seen from Figure 1a over half of the students that responded felt that it was important to be part of the same module and same degree communities, whereas significantly fewer though it was important to feel part of the wider communities. The communities highlighted as important are those most directly related to study; it is not surprising they are prioritised given the time-poor nature of typical Open University students, who are fitting studies around work and caring responsibilities. Also of particular note is that only 23% of respondents felt it was important to be part of a community with students in general. This may correspond to how removed an OU student feels from what they perceive to be a “standard” student.

Importance of being part of the following communities

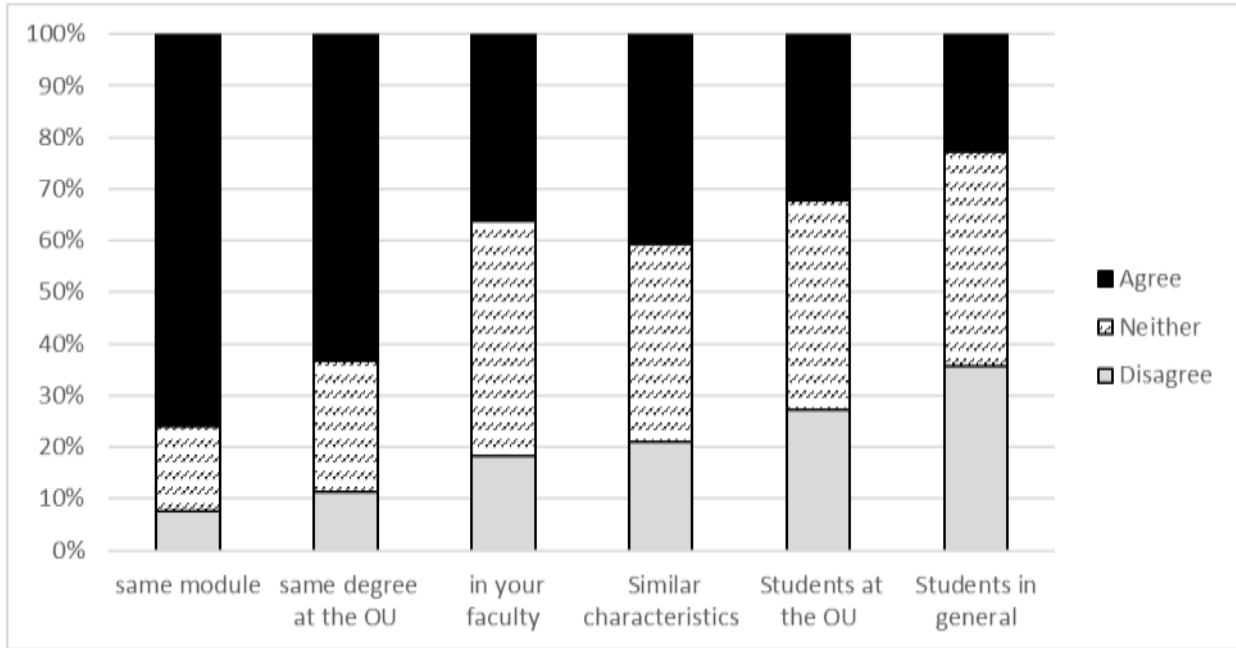


Figure 1a. Responses on importance of different communities

How much do you feel part of the following communities

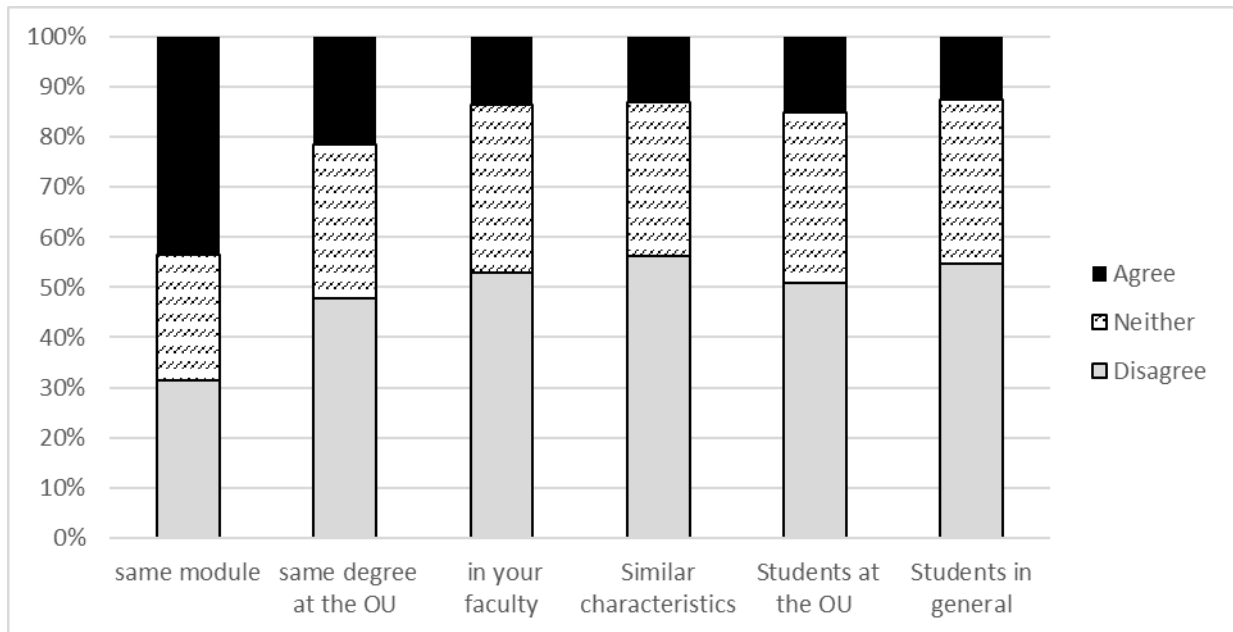


Figure 2b. Responses on feeling part of different communities

Figure 1b shows how much students feel part of the different communities. It can be seen that students are most likely to feel part of a community with students on the same module. This may be

because they have the opportunity to interact during online tuition and in module forums. 21% of respondents also felt a community with those on the same degree, however, very few students felt part of any other community. The difference between the proportions of students regarding a type of community as important, and feeling part of that community is very marked. For example, whilst not all students have a desire to feel part of any of these communities, approximately three quarters do wish to be part of a community with students on the same module, but under half do feel part of it. These differences are highlighted more clearly in Figure 2 which show the proportions of students giving a positive response to wanting to be part of a community and feeling part of that community; the error bars throughout indicate the 95% confidence interval for the proportion shown. Also of note is that many more students indicated it was important to be part of a community with students who had similar characteristics than had found that community.

Percentages strongly agreeing and agreeing that it is important to feel part of the given community/ who do feel part of the given community

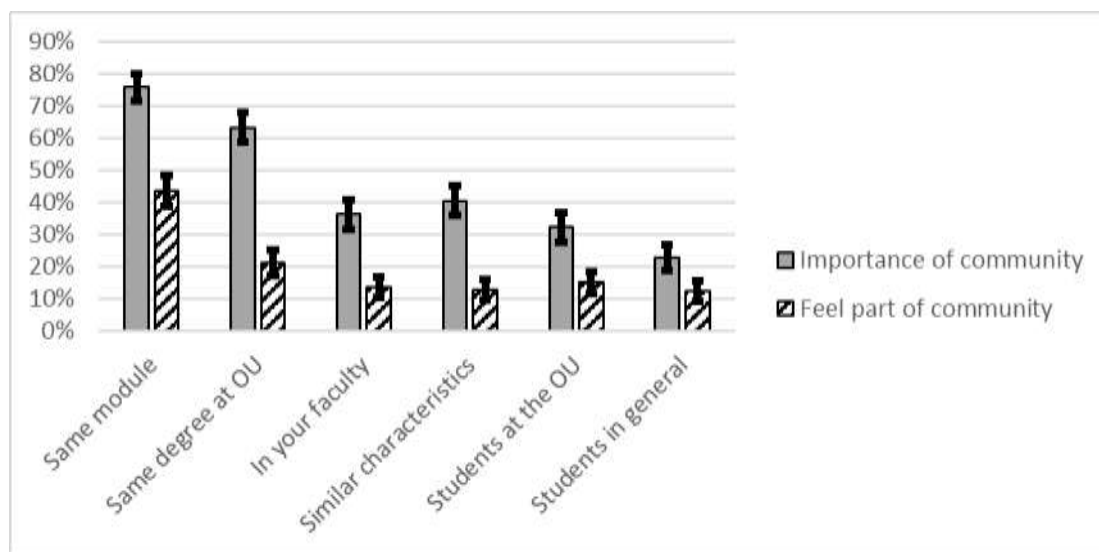


Figure 2. Comparison of proportions valuing each community and feeling part of it

3.2 Variation in perceptions of community

Figures 3a and 3b shows the differences between how men and women felt it was to be part of each community listed above and how much they felt part of each community respectively. At first sight, it appears that women felt all types of community were more important than men did, and generally also feel more part of that community. However, caution is necessary; the error bars show that considered individually, the differences between genders are not statistically significant. However, the figures for women being consistently higher than those for men means this phenomenon cannot be dismissed.

The exception to the trend is the same degree community; the male/female difference in valuing community is much smaller than elsewhere, and women feel less part of that community than do men. The reasons for this would benefit from further exploration; are traditional alignments of specific subjects with genders coming into play, leading to women identifying less with assumed “male” degree areas.

Gender variation in views on importance of communities

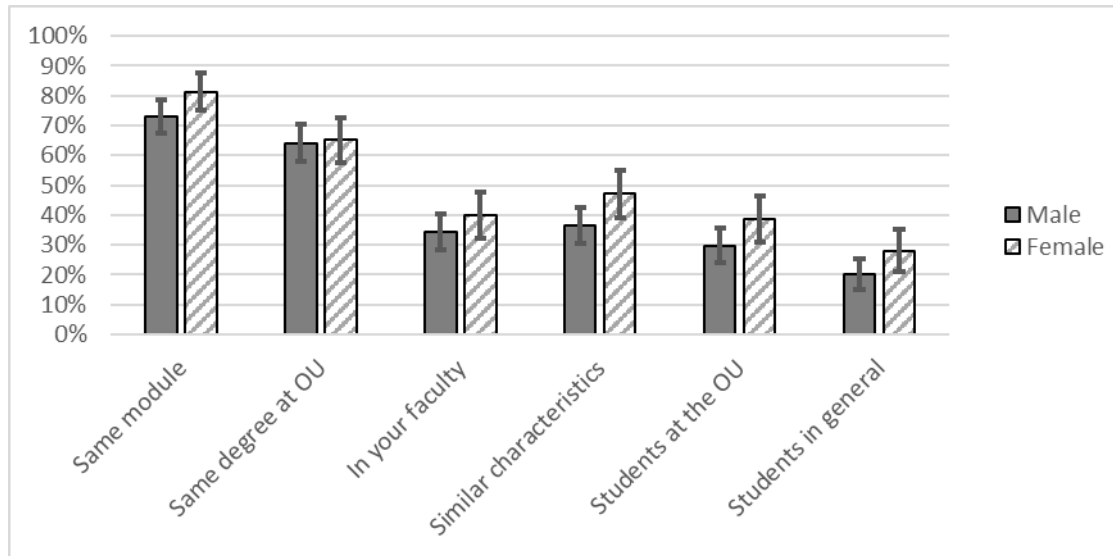


Figure 3a. Proportions of male and female students regarding each community as important

Gender variation in feeling part of each community

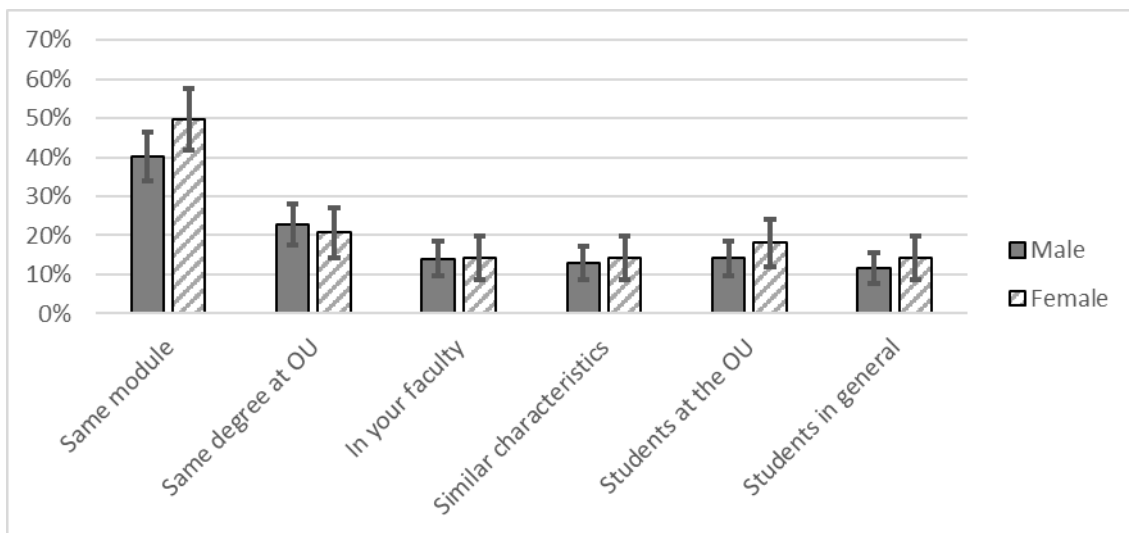


Figure 3b. Proportions of male and female students reporting feeling part of each community

There are also apparent differences between students at different stages of study. Students at The Open University can take anywhere between one year and four years to successfully pass each stage, dependant on the intensity of their study. Whilst the actual time period varies, all students moving up stages will have experienced a substantial increase in the demands of their studies, as well as having become more experienced and effective learners.

Figures 4a and 4b shows the differences between learners in stages one and three; stage two students were generally between these, but closer to stage one results, although interestingly they seemed to value, and feel part of, the in-module community slightly less than either stage one or stage three. It is notable that the value placed on all types of community decreases, except the same module community. This may be interpreted as a greater focus on study-specific support as the end of the degree approaches. Similarly, the perception of being part of each community decreases except for the same module community. The fact there are smaller numbers of students on the module at later stages may contribute here, as may the potential for experienced students to have developed effective ways for forming their own community, such as module-specific social media groups. But again, caution is needed given the overlap of the error bars here.

Variation by stage of study in views on importance of communities

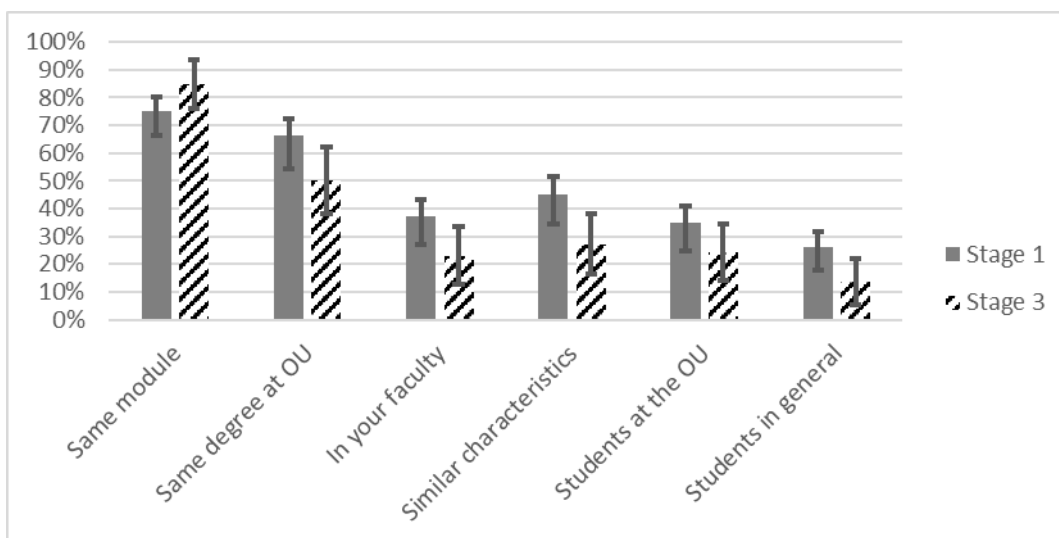


Figure 4a. Proportions of stage one and stage three students regarding each community as important

Variation by stage of study in feeling part of each community

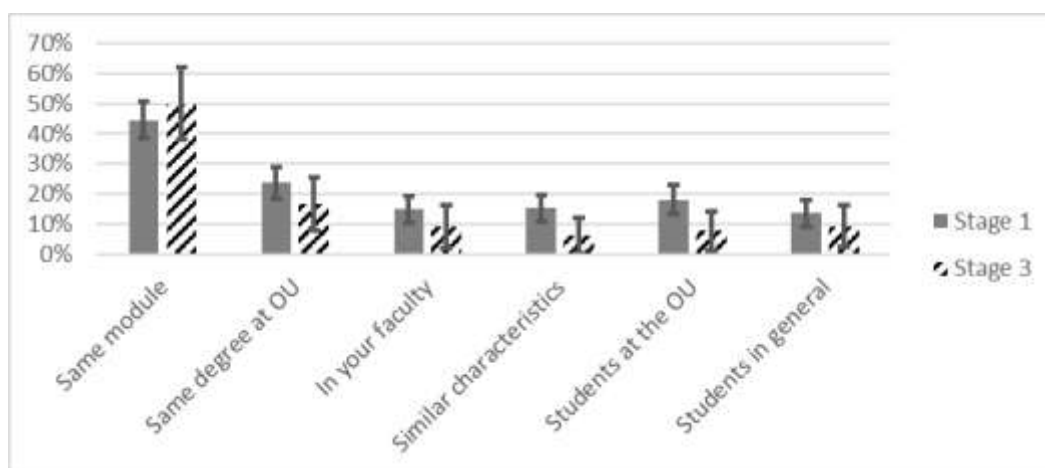


Figure 4b. Proportions of stage one and stage three students reporting feeling part of each community

In Figures 5a and 5b, Business and Economics students appear to place a comparatively higher value on the more extended communities. The figures also suggest substantially higher proportions of feeling part of each community; this raises the question of a potential difference in ethos in non-STEM areas, or perhaps simply a different student profile, though the comparatively low numbers of these students responding raises the possibility respondents are disproportionately drawn from those interested in the concept of community. Science students appear to give less priority than most others to same module community; potentially the focus at the OU on interdisciplinary science modules at an early stage deprioritises the module compared to the discipline area.

Variation by qualification in views on importance of communities

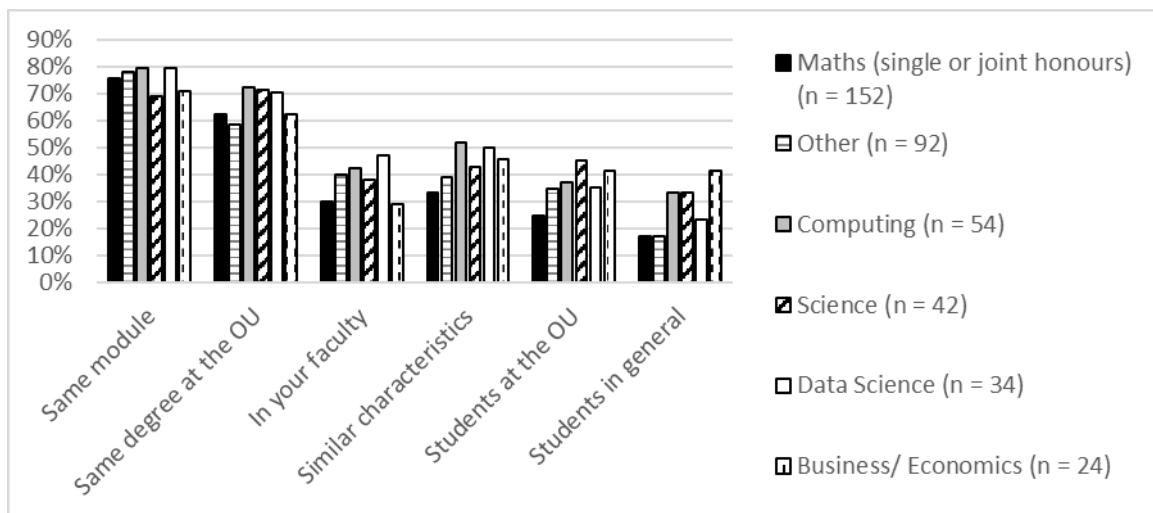


Figure 5a. Proportions of students on different qualifications regarding each community as important

Variation by qualification in feeling part of each community

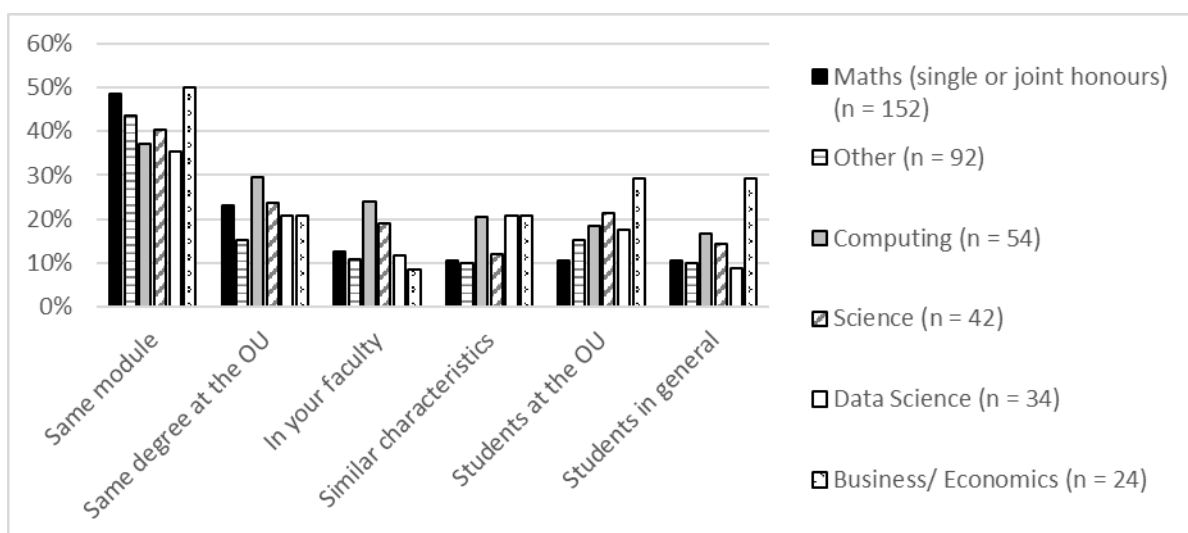


Figure 5b. Proportions of students on different qualifications reporting feeling part of each community

However, these differences are generally not statistically significant, with one exception. Testing for uniformity of proportions valuing each community and feeling part of each community across the subject areas gives $p > 0.1$ in all cases except for feeling part of the “students in general” community ($0.05 > p > 0.01$); the latter reflects the large discrepancy between the views of Business and Economics students and others here.

3.3 Change in feeling of belonging to communities over time

Figure 6 below shows the responses to the question on whether students’ feeling of being part of each community had increased, stayed the same or decreased during their studies. As can be seen, the “stayed the same” response was the most popular by far, with only the same module community showing any notable changes. This could be a partial consequence of having a relatively high proportion of Stage 1 students amongst the respondents, since these students would have had less time to experience a change.

Change in feeling of belonging to communities over time

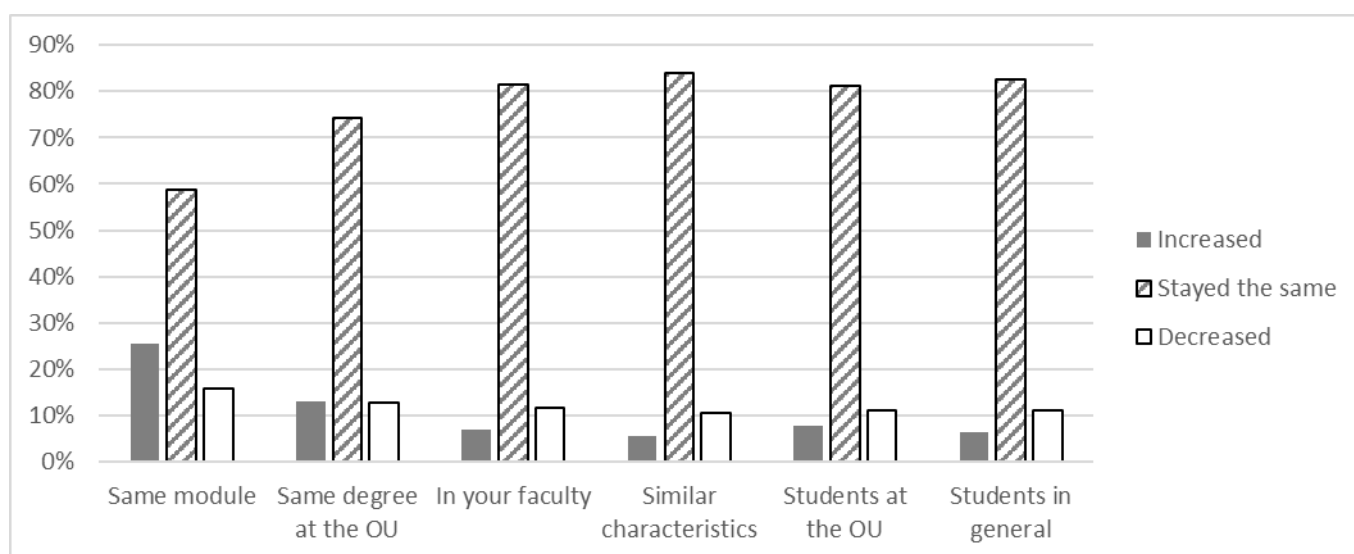


Figure 6. Changes in feeling part of communities since starting studying at the OU

Since the same module community is the most important community for students, the results here warrant further analysis. Table 1 below shows the proportions of various categories of student who felt that being part of the community on the module increased, stayed the same or decreased.

Table 1: Students’ perception of increased or decreased sense of in-module community during their studies, by gender, ethnicity and qualification

Response	Male	Female	White	Other ethnicity	Maths qualification	Other qualification	Overall
Increased	23%	30%	26%	29%	31%	23%	26%
Stayed the same	63%	50%	58%	55%	53%	60%	58%
Decreased	14%	20%	16%	16%	16%	17%	16%

Chi-squared tests for independence yield the following:

Table 2: Chi-squared tests for association for male/female, white/other ethnicity and maths/other qualification for responses regarding change in sense of community

Characteristic	Chi-squared statistic for test of association	
Gender	6.53	$0.05 > p > 0.01$
Ethnicity	0.19	$p > 0.1$
Qualification	3.23	$p > 0.1$

The z-values for testing the differences in proportions experiencing an increase or decrease in in-module community are shown in Table 3 below.

Table 3. z-values to assess differences in changes in sense of in-module community by gender, ethnicity and qualification

Characteristic	z-value for difference in proportions experiencing			
	increased sense of community		Decreased sense of community	
Gender	1.82	$0.05 > p > 0.025$	1.53	$0.1 > z > 0.05$
Ethnicity	0.41	$p > 0.1$	0.00	$p > 0.1$
Qualification	1.74	$0.05 > p > 0.025$	0.18	$p > 0.1$

The relatively small numbers of students with an ethnicity other than white mean that obtaining a significant result would have been unlikely, even had the differences been larger. However, it is reassuring that the “increased” figures for non-white ethnicity students are not lower than those for white students, though the lower response rates indicate caution is needed.

The results for mathematics students versus non-mathematics students could be impacted by the fact that all students were studying a mathematics or statistics module when surveyed; non-mathematicians could identify less with the same module community when it is not a module from their subject. But it is encouraging to see more mathematics students finding their sense of same module community increased than decreased.

The comparison between the experiences of women and men is particularly interesting. Most women and most men did not report a change in their sense of community. However, significantly more women than men reported an increase in their sense of community over time, but also significantly more women than men reported a decrease in their sense of community over time. This polarised result warrants further exploration; it could relate to the success or otherwise of female students in finding a specific community within their module versus identifying with the rather male-dominated general module community.

However, it should be noted that applying two tests (for increase and decrease) for each characteristic suggests that on a precautionary basis, the Bonferroni correction should be applied; this means the significance of the “decreased sense of community” should be considered more questionable.

3.4 Qualitative responses

The qualitative questions in the survey asked students to consider what has made them feel part of communities, and what more could be done to increase their feeling of being part of communities. The responses to the first question fell broadly into five categories, as shown in Table 4 below. Responses could mention multiple examples.

Table 4: Categorisation of student responses on what made them feel part of a community

Category	No of instances	Examples
Within module	121	Tutorials, Forums, Group activities, Tutor, University arranged peer supporters
Social media	38	WhatsApp, Facebook, Discord
Students Association	10	Societies and Clubs, Events, Student magazine
Other OU events	5	Organised day events, "Student Hub Live"
Nothing/ not interested	28	

The importance of activities within the module reinforces the primacy given to that community in the quantitative questions. Other points of note include the relatively high numbers of responses indicating a lack of interest in community; some students commented that they had chosen distance learning to avoid the need to interact with others, or that time pressure entailed their prioritising their own communities of family and friends. The importance of social media in the student experience is also of note; the importance of such unofficial channels warrants further exploration.

Interviews were also carried out with a small number of students. These primarily served to highlight the great variation in student views. Some illustrative quotes are given below:

"There is lots of there the module forums Facebook groups WhatsApp group there lots of clubs and societies. There is plenty of ways to get involved and they are easy to access."
[sic]

"There was the introduction talk where there was about I think 300 people and you could see them all asking questions and that felt very connected. And then there was the first tutorial with my tutor and there was eight of us and that felt very, I felt very connected then. But then I don't particularly need to be that connected"

"I visit the forum and I can see people's activity and so on... but it's not the same as one important thing for me, I think is people meeting in person. I think that's a very different feeling. You know, they talk about doing things online so you can be more inclusive. But I feel that in a way, you also exclude everyone by doing things online rather than doing local things where people can attend"

When asked what more The Open University could do to help develop community, 20% of students reported they were not interested in the university doing so, mirroring the "nothing/not interested" results above. A further 20% felt it was not possible for the university to develop student community; it was not clear whether this was with reference to a perception of attempts that failed, or a belief that community has to develop bottom-up rather than top-down.

The remaining responses fell into two categories. The first referred to what could be done within the module, and 80% of these responses were about tutorials, with students suggesting face to face events and more opportunities to interact. The remainder referred to the way the module online forums work, and the extent to which tutors promote a feeling of community. One interview quote illustrates the importance of the latter:

“I feel that’s where the tutors can help. If they can try and foster an environment where, I mean, some tutors try and invite it. One tutor is very good with that. She always has interactive survey thing. She always wants you to contribute. There’s another tutor... he always just starts off with a question like saying how you find it so far, which sort of sets the tone for this isn’t just me talking”

The second theme related to the university’s role in facilitating connection with other students. Points here included enabling students to contact each other directly, facilitating the formation of study groups, and official/sanctioned social media groups. One interviewed student highlighted the specific issues of variable intensity part time study:

“Well funny enough, I felt more connected in Stage one. But when there was the excitement of just starting studying again, I don’t know. And people are studying at different rates, so I mean I’m doing mine really slowly so cos some of the people that you were with have probably been and gone by now”

This shows the importance of connections beyond the module for some students who seek ongoing relationships with their peers.

4. Discussion and further work

It is clear that most, though not all, students want to be part of a same module community, and to some extent a same degree community.

Whilst it is gratifying to encounter students who feel there is plenty on offer for those interested, it is clear that a pluralistic approach is needed. In particular, whilst the existing opportunities for online connection are enjoyable and satisfying for some, others find them inadequate for developing genuine connection.

Some points for consideration when trying to improve the student experience of community are given below:

- How can online university-led text-based communication (forums) be made more friendly? Whilst some students are enthusiastic about forums and use them frequently, others have reported finding them intimidating or too formal. Could these be modified to harness the appeal of social media?
- How can we improve communication of what is on offer? Some students report being overwhelmed by the plethora of emails from the university and may miss events of interest because they don’t see it publicised. Can we make our communication more effective?
- What can be done on a module to help develop same module community?

Various types of events may be worth trialling, including in-module “fun” events and opportunities for students to work together on course-related problem-solving. But these will only reach some students, and possibly not those most in need of a community. Other initiatives such as university facilitated study groups could be investigated. “Student buddies” (volunteer peer mentors who have completed the module previously) have the potential to promote community, but their impact may be limited by the nature of the online forums.

- What training and support could be given to course tutors to help them to enable student community building?
Whilst many are aware of the value of student community, they will not automatically have the skillset or time to purposefully develop it.
- How can students be supported to make effective connections within their qualification?
There do exist opportunities for students to encounter others further along in their study path, but these are not always well signposted or well used.

This study also raises questions on women’s experience of community when studying mathematics modules; why does the feeling of being part of a community diminish for some women and how can this be addressed?

The experiences of Black and Asian students were not adequately described here due to the small numbers in the sample (which reflects the low proportions studying mathematics modules). The fact that such students will see their ethnic group underrepresented on a module both creates a barrier to community and highlights a particular need for that community support.

This paper highlights that the majority of distance learning students still feel community is important, even if that community is with the relatively small population of students that are studying the same module, but find that in reality most remain isolated and do not manage to form these communities. This could be improved with effective online educators (Barber 2019) or by a larger social presence (Kear et al, 2014). However it must be noted, that as found by McPherson and Nunes (2004) there will always remain a proportion of the part-time students that have neither the time nor inclination to form a social community.

5. Acknowledgements

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