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.

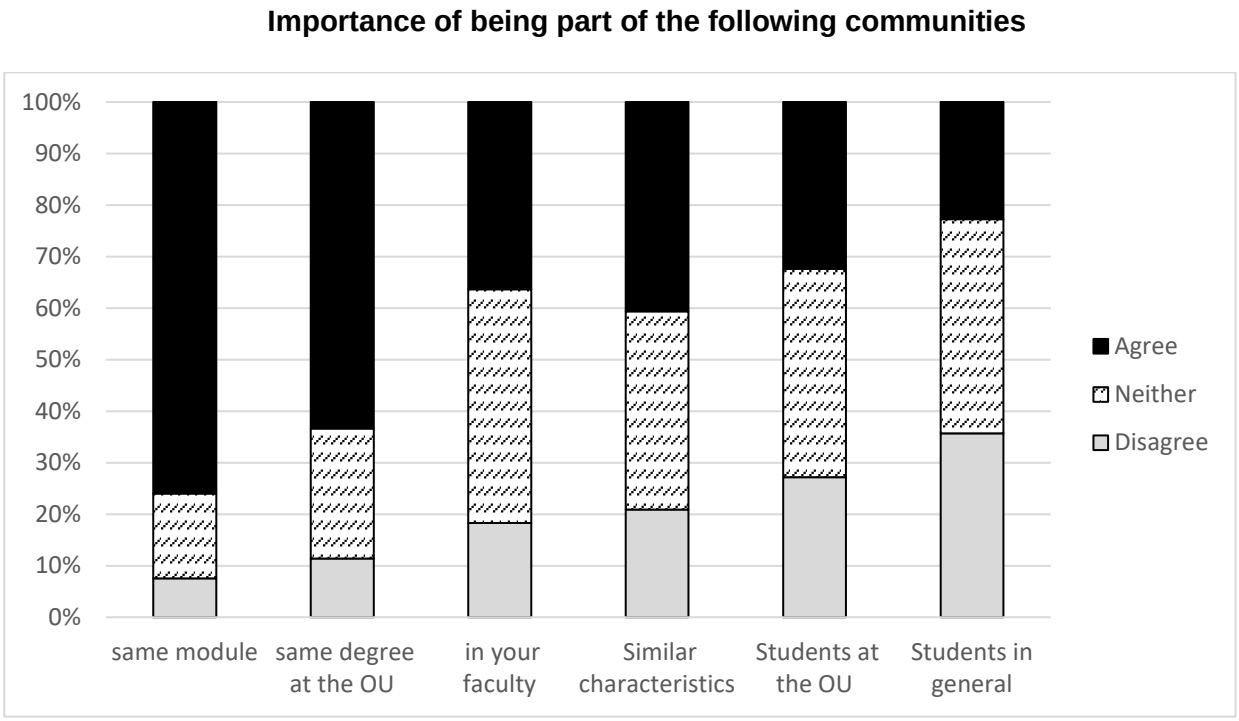

Figure 1a. Responses on importance of different communities

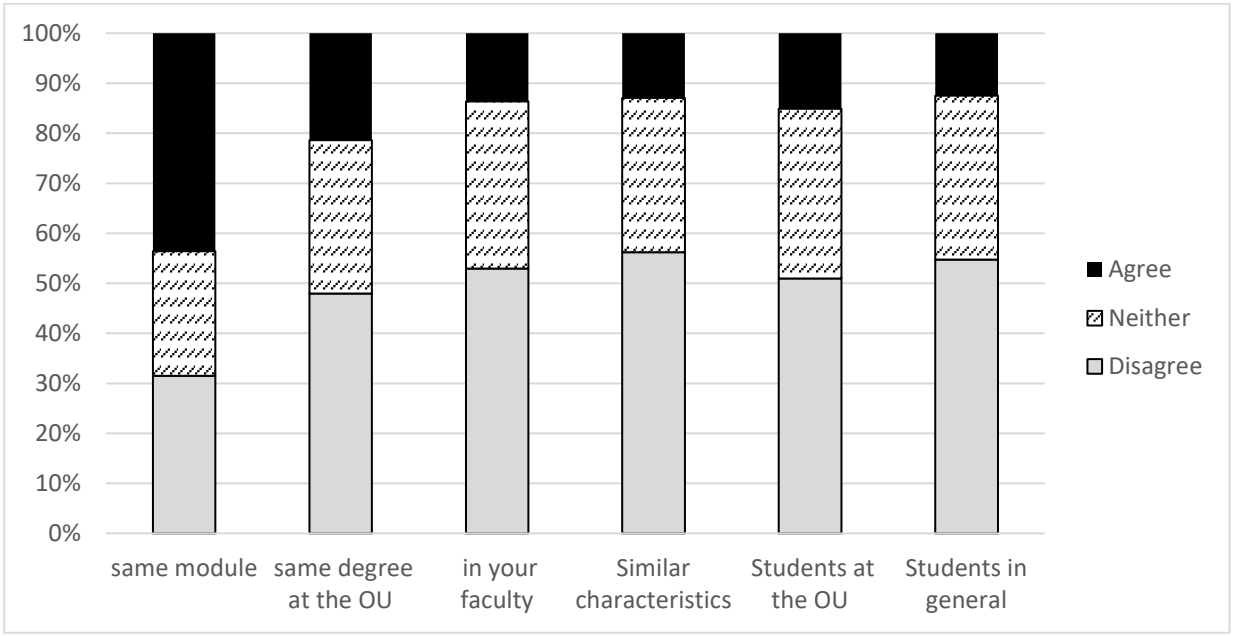

Figure 2b. Responses on feeling part of different communities

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

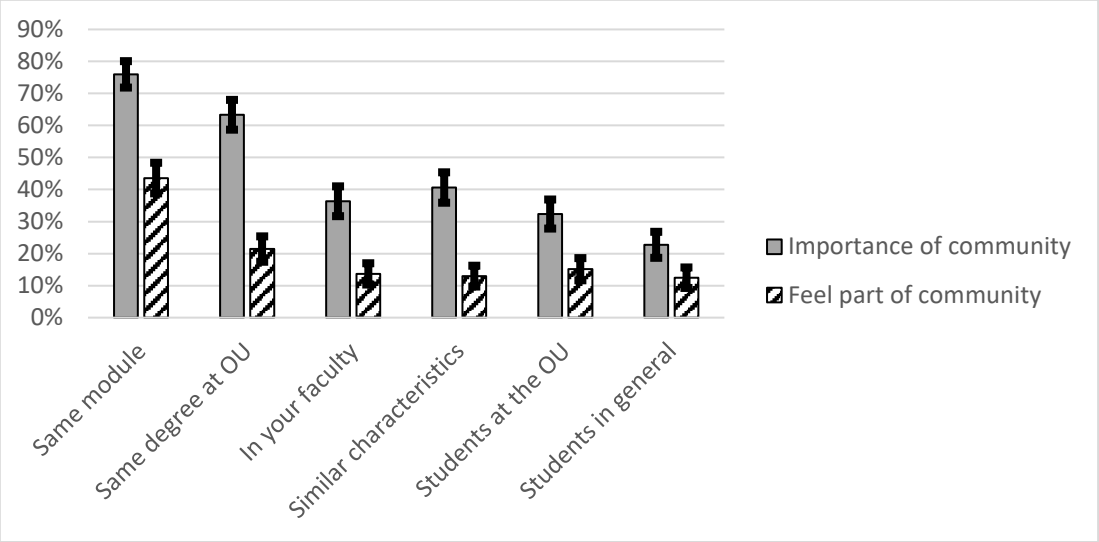

Figure 2. Comparison of proportions valuing each community and feeling part of it

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.

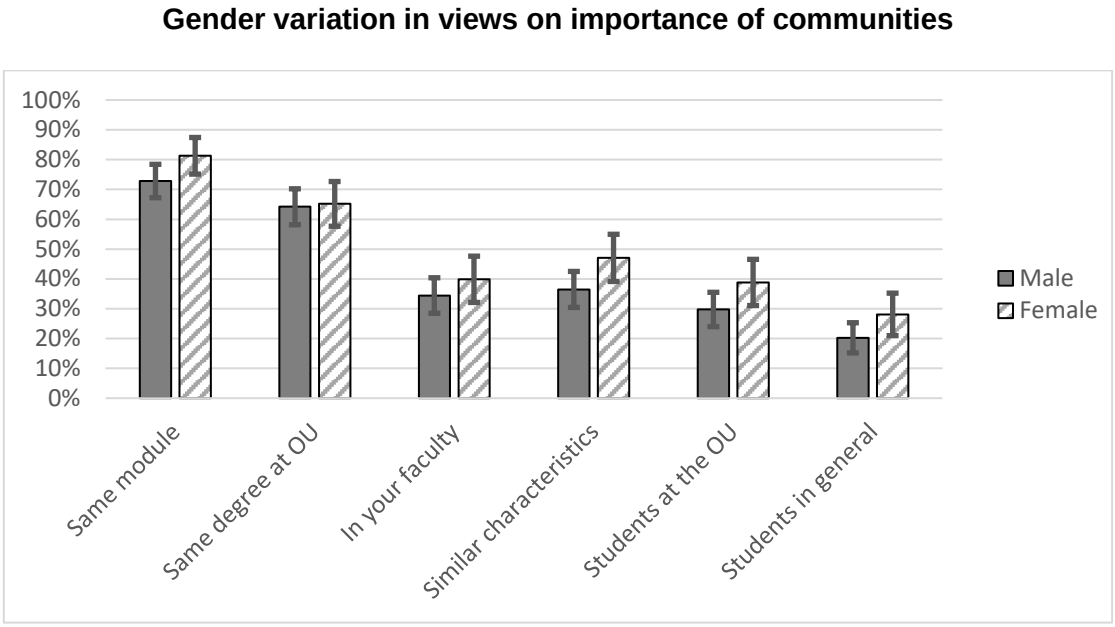

Figure 3a. Proportions of male and female students regarding each community as important

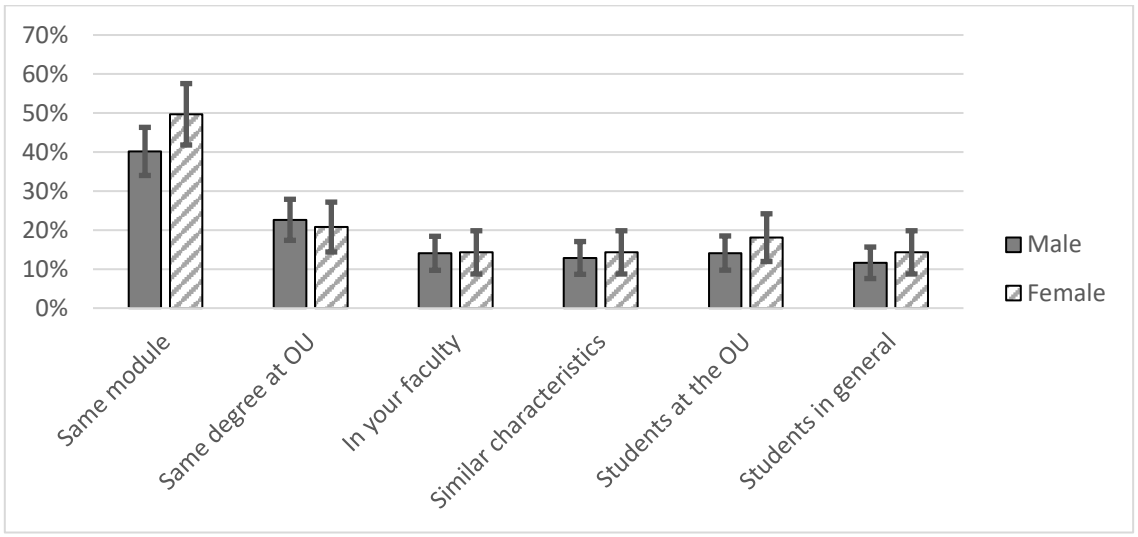

Figure 3b. Proportions of male and female students reporting feeling part of each community

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

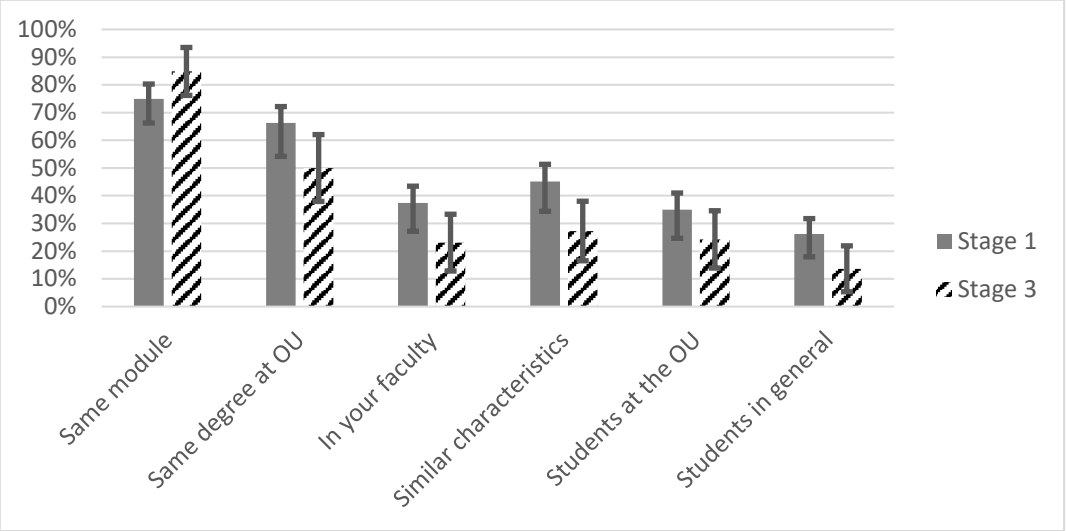

Figure 4a. Proportions of stage one and stage three students regarding each community as important

Variation by stage of study in feeling part of each community

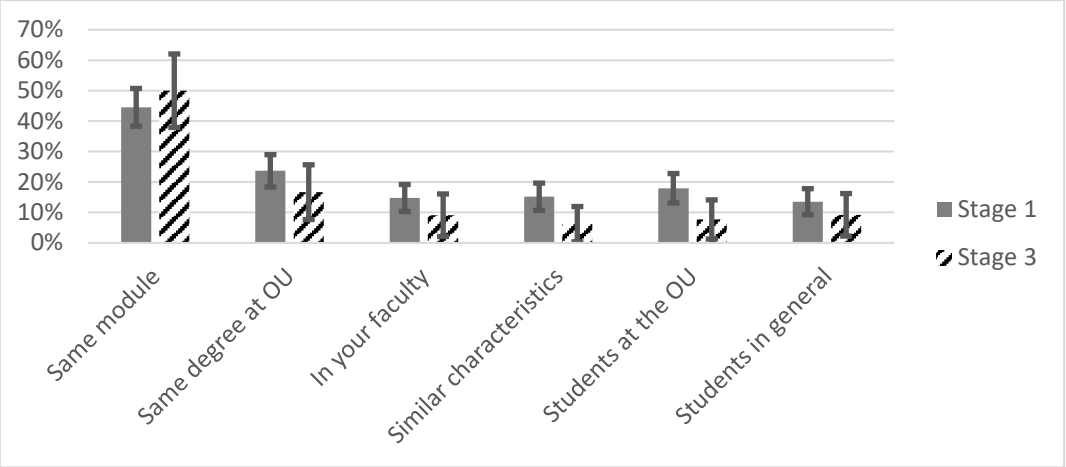

Figure 4b. Proportions of stage one and stage three students reporting feeling part of each community

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

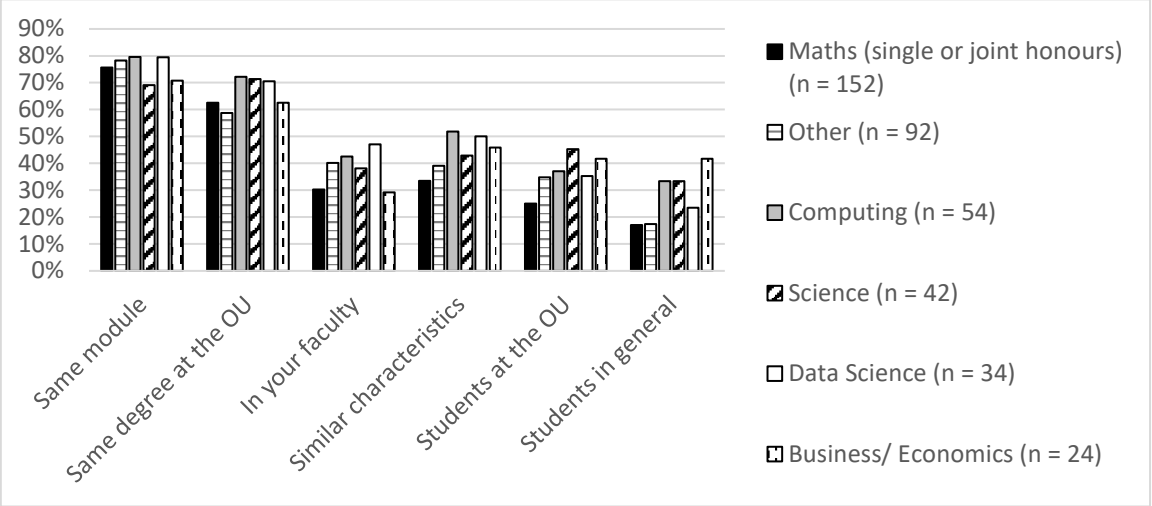

Figure 5a. Proportions of students on different qualifications regarding each community as important

Variation by qualification in feeling part of each community

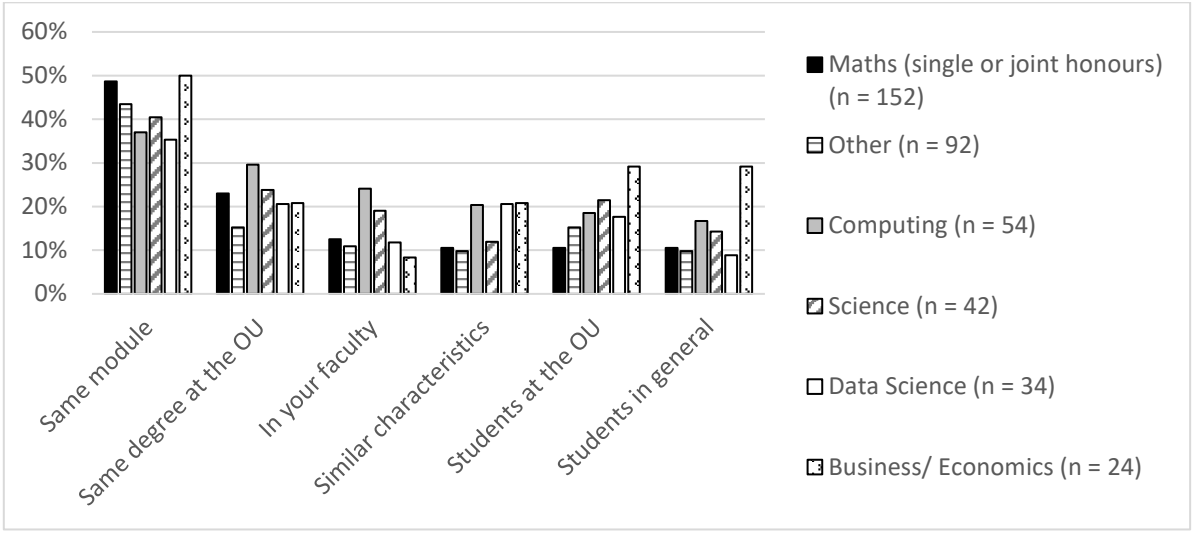

Figure 5b. Proportions of students on different qualifications reporting feeling part of each community

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 discrepency 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

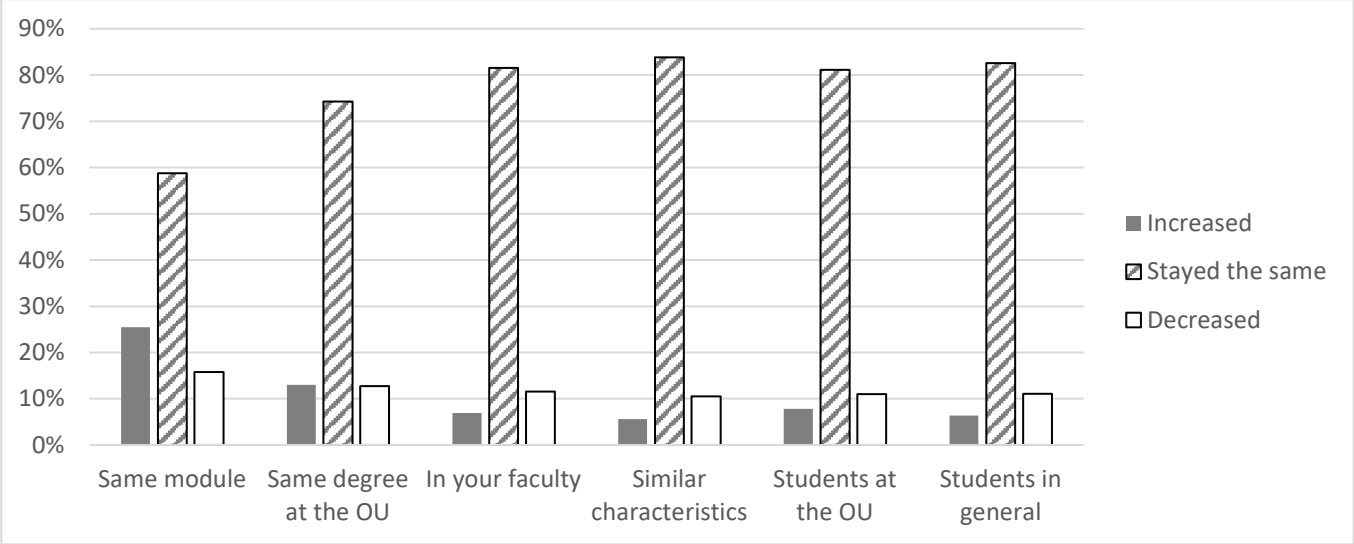

Figure 6. Changes in feeling part of communities since starting studying at the OU

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 questionnable.

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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CASE STUDY

Student Co-Creation of Resources in a Second Year Linear Algebra Course

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Abstract

In this project, we investigated how designing their own tutorial questions could help students negotiate the often-challenging transition to university mathematics. One student from the first linear algebra course at the University of Aberdeen volunteered to create practice questions on topics of linear algebra they selected. Through analysis of the participant's interview, we showed, in accordance with the literature, that the activity benefited them in terms of study skills (motivation, focus, independence), and in terms of mathematics learning (deep learning and mathematical knowledge construction). We also found that the activity had contributed to improving the volunteer's resilience to learning mathematics, and their sense of legitimate participation in the mathematics community. This has not been discussed in the literature and is a significant finding considering the known difficulty for mathematics students, in particular women, to feel they 'belong'. This research further suggests that if the activity took place in groups, it could also help develop a peer-support community which students could rely on to negotiate the transition to university mathematics.

Keywords: mathematics education; co-creation pedagogy; community of practice; zone of proximal development.

1 Pedagogic Context

The transition from level 1 to level 2 mathematics in Scottish University mathematics and natural sciences degrees is known to be challenging. In the literature, this corresponds to the transition from school to university mathematics (Martin, 2016a) due to the difference between the English and Scottish University curricula (level 2 Scottish university courses are SCQF level 8 corresponding to RQF/CQFW/EQF level 5). The consequences of this transition are measured in terms of retention and progression in mathematics and mathematics-heavy degrees (Solomon, 2007; Martin, 2016a).

There is a wide range of reasons why students may find this transition difficult, some will be true for any disciplines, such as the difference in culture between school and university, personal and financial difficulties, or lack of feeling of belonging to the university community (Martin, 2016a). There are some specificities to mathematics courses though (Martin, 2016a; Martin, 2016b): extensive use of formal notation, and a high number of definitions and systematic use of proofs (Solomon, 2007; Alcock and Simpson, 2009; Iaonnone and Simpson, 2020). Students find proof particularly disconcerting (Cronin and Stewart, 2022), as they must prove properties they feel are 'obvious' (Alcock and Simpson, 2009), and also because proofs often rely on one own's intuition and the use of tricks (Alcock and Simpson, 2009; Iaonnone and Simpson, 2020; Cronin and Stewart, 2022).

At the University of Aberdeen, we are also observing that students find level 2 mathematics courses difficult. Staff in the Mathematics department as well as the Maths Support Adviser are aware that students in level 2 can feel overwhelmed by the course content. Focusing on the level 2 linear algebra course, we decided to investigate whether creation by students of linear algebra examples

and tutorial-style questions could increase the authors' understanding of, motivation for, and commitment to, linear algebra, and more generally mathematics.

The linear algebra course is a pure mathematics course, but with applications relevant to a wide range of sciences. The details of the course curriculum can be seen in Appendix 5.1. In 2022, 74% of students registered on the course were on Natural & Computing Science degrees (Maths, Applied Maths, Maths-Physics and Computing-Maths), but a wide range of disciplines were present, including humanities (see **Error! Reference source not found.**). It is important to highlight this, as the present project investigates how to support the transition from level 1 to level 2 mathematics, and the discussion which follows will examine this in terms of a community of leaners of mathematics, resilience in learning mathematics, and legitimacy of participation. Readers must keep in mind that the group of students that is concerned is very diverse, and not all intending to be pure mathematicians, but they have in common a certain will to do, and an interest for, advanced mathematics. This is a consequence of mathematics being an academic discipline as well as a tool for many others.

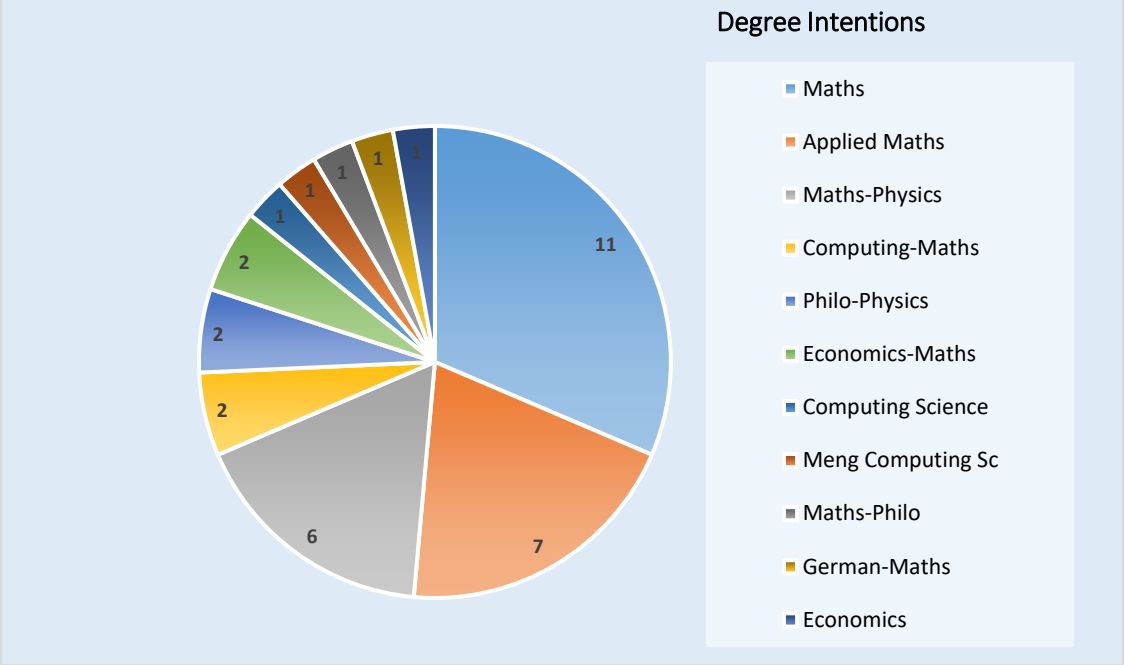

Figure 1: Degree intention breakdown for the MA2008 class register, academic year 2022-2023. 'Maths' and 'Applied Maths' combines BSc and MA degrees. Philo=Philosophy, Sc=Science. 74% of students were studying Maths, Applied Maths, joined Maths-Physics and joined Computing-Maths degrees.

The creation of mathematical examples by students is a very powerful tool for deep learning in mathematics (Watson and Mason, 2002; Bills, et al., 2006; Cornock, 2021). It is a form of co-creation pedagogy (Mercer-Mapstone, et al., 2017; Kukulska-Hulme, et al., 2021) and has been shown to enhance engagement and motivation for learning, and to encourage students to become independent and self-regulated in their studies (Bovill and Bulley, 2011; Bovill, et al., 2016; Weller, 2019). In the context of mathematical education, the creation of mathematical examples by the students will help strengthen the concept definition and concept image of mathematical objects

(Alcock and Simpson, 2009; Martin, 2016b; Iaonnone and Simpson, 2020). The concept definition is the formal definition of a particular mathematical concept, and the concept image is the set of applications, examples, and imagery that a mathematician will associate with the concept definition. When doing mathematics, expert mathematicians will constantly draw from both their concept definitions and concept images, possibly unconsciously (Alcock and Simpson, 2009; Iaonnone and Simpson, 2020). The difficulty for novice mathematicians, including students, is that their concept images may be limited to non-existent, or skewed because some mathematical objects have a meaning in common language, which can imply a wrong mathematical interpretation (Alcock and Simpson, 2009). It is therefore essential to help students develop sound and rich concept images of the mathematical concepts we are teaching them.

The plan was to recruit volunteers amongst students on the first semester linear algebra course of the University of Aberdeen and form pairs of students to discuss and create examples, and code them in the e-assessment tool NUMBAS (Lawson-Perfect, et al., 2002). The significance of group work could then have been assessed. However, only one student volunteered, so the benefits of peer-support could not be investigated. Through analysis of the interview of the participant, however, using Interpretative Phenomenological Analysis (Eatough and Smith, 2017), we show that the activity has contributed to the participant's motivation, confidence, and resilience. Furthermore, the participant's interview suggests that working in groups would have given them the opportunity to be part of a community of newcomers to the community of practice of mathematicians. Consequently, student creation of mathematical examples in groups may be an answer to the problem raised by Solomon who showed that in mathematics, students, and in particular female students, commonly feel they do not 'belong' (Solomon, 2007).

2 Methodology

2.1 Ethics Considerations

Ethics approval was obtained from the School of Education of the University of Aberdeen Ethics board 28/11/ 2022.

2.2 Participants and recruitment

Participants were recruited during the first semester, in the level 2 linear algebra course MA2008, which had 35 registered students. Working groups would work on designing and coding questions in NUMBAS (Lawson-Perfect, et al., 2002) during January and February 2023.

We designed a video using the software Panopto to explain the project to students and call for participants. It was made available on the University of Aberdeen VLE course site on 28/11/2022 and 3 emails were sent to students to call for volunteers (on 29/11/2022, 20/12/2022 and 16/01/2023). Only one student volunteered to participate, and on the 24th of January 2023, the participant and I decided to start the activity even though no other student had expressed interest.

2.3 Protocol design

Two short individual questionnaires of 5 questions each and a semi-structure interview protocol of 15 questions were designed using Microsoft Forms (see Appendices for a link to the three questionnaires). The choice of questions was loosely based on Cornock's study on student-generated examples as a mode of assessment (Cornock, 2021).

The individual questionnaires were aimed at gathering feedback on participants' perceived confidence in mathematics in general, and in linear algebra specifically, and expectations from the

activity prior to the activity and feedback on activity and perceived benefits after the activity. We used Likert scales and open text questions.

The semi-structured interview aimed at generating discussion amongst participants about what they found enjoyable or challenging in the activity, how participating in the activity had changed their motivation for learning of linear algebra and mathematics, and how they saw their roles as students.

2.4 Analytical Strategy

Because we had only one volunteer the project results are therefore qualitative. We held the interview on the 15th of March 2023, and it lasted 40 minutes. The interview was recorded using the software Audacity and we transcribed the interview recording on Microsoft Word and analysed it in paper copy using Interpretative Phenomenological Analysis (IPA) (Eatough and Smith, 2017), which is well-suited to analyse case studies. IPA consists of characterising a participant's experience by generating themes and subthemes in their interview transcript.

3 Results

The participant's answers to the pre-activity questionnaire are summarised below (Table 1). The post-activity questionnaire was not completed, because the same information was gathered from the semi-structured interview given there was only one participant.

Question	**Answer**
Degree intention	Mathematics
How confident did you feel you were with Mathematics at the end of last academic year?	Not very confident
How confident do you feel you are with linear algebra?	Not very confident
I look forward to attending linear algebra lectures and tutorials.	Agree
What do you expect to gain from engaging with this activity?	*"I'd like to focus on things I found difficult and improve on them."*

Table 1 Participant's answers to the pre-activity questionnaire

Table 2 provides a summary of themes and subthemes which we generated from the interview transcript. We detailed in the following sections the main themes and subthemes that we have extracted from the participant's interview.

Themes	Subthemes
They would have liked a group work experience	Exchanging knowledge with peers Feeling safe amongst other novices Belonging to a community
How they see teaching and learning	Wishing to revisit difficulties to consolidate knowledge Learning something unexpected Becoming a critical learner
How they see themself	They can do mathematics They are a legitimate student of mathematics They feel well

Table 2 List of themes and associated subthemes identified from the participant's interview transcript.

3.1 Theme 1: 'They would have liked a group work experience'

This seems to be very important for the participant and they mentioned it first.

- **Exchanging knowledge with peers**: the participant recognises that everyone is good at different tasks, and that learners can gain from each other *"we have like different gaps in our knowledge"*, *"we do actually help each other or teach each other".* It is interesting in the context of maths, as the belief that some would be naturally good at maths and others bad at it is common.
- **Feeling safe learning amongst other novices**: the participant explains that *"it is easier [ ] asking maybe like stupid questions"*, *"easier to ask sometimes a fellow student [ ] to going to a professor and ask something which you probably should have known".* The participant makes a distinction between the staff and the other students, with whom informality and imperfection are allowed. This is indeed quite common amongst students.
- **Belonging to a community**: *"it would be great [ ] to actually do a group project [ ] be with other people"* and expect *"it would have been quite fun [ ] you know talking about maths with other people who are interested in it [ ] to … have a chat yeah of the subject".* The project would have been an opportunity to create a connection amongst participants, a sense of group, which is more difficult to create at university.

3.2 Theme 2: 'How they see teaching and learning'

- **Wishing to revisit difficulties to consolidate knowledge**: the participant mentioned this as one of the main reason to participate *"to actually go deep into the areas which I am actually not really good", "to go back and identify those gaps", "there are some gaps in my knowledge and hopefully that will help me learn a bit which it did meet hum and it was fantastic", "I think it is really beneficial to go back and identify mistake and so on".* This is probably quite uncommon, and indeed the participant reports that other people in the class *"weren't really keen to go back and do more of something that is already kinda past"*, which would suggest that most students see courses as compartments of their degree rather than a progression in acquiring expert skills.
- **Learning something unexpected**: the participant says that they did not expect NUMBAS to require so much programming *"I just actually wasn't quite aware [ ] to the extend it actually going to involve a bit of coding in NUMBAS"*, however, they do not see this as a *"bad thing"*, but something *"actually gonna be really beneficial for me in the future"*, and something they actually enjoyed *"I just got hooked, and I feel like, like yeah that's something I am quite interested in".*
- **Becoming a critical learner**: *"[the project] has given me a little bit of a different eye for tutorial questions" "I am actually thinking a bit more about behind like OK what this question actually teaching me"* rather than *"just like trying to get through them".* The participant has re-gained control over the tutorial, which they are no longer seeing as a painful experience, which needs to be done. They are taking ownership of the tutorials – this is what we would want for all students, but that they are indeed finding difficult in this level 2 transition.

3.3 Theme 3: 'How they see themselves'

- **They can do mathematics**: when asked about how their confidence may have changed, the participant answers that *"definitely give me a little bit, yeah, a bit of a confidence yes"*, and that they realised *"like actually yeah I am doing this so definitely*" and that they *"can actually learn new things".* The project has given the participant a sense of ability.
- **They are a legitimate student of mathematics**: The participant does not see themself as a mathematician yet *"I would not introduce myself as a mathematician, I feel like I am a student"*, but is becoming one *"hopefully like maybe from next year"* and the *"project has helped me to gain a little bit more confidence this why I am doing it and I am enjoying it so I should"*. The participant weights this against them having *"this imposter syndrome"* and how *"sometimes I have like nooo idea what I am doing here"*. This is possibly common in mathematics, where, as mentioned above, there is a widespread view that some are good at maths and others bad. There seems to be two conflicting views for the participant: on the one hand, everyone has different mathematical strengths and has something to contribute to the community of learners, and on the other hand, there are some imposter students of mathematics.
- **They feel well**: throughout the interview, the participant describes the project experience in 'good-feeling' and well-being terms: they state that *"I am really happy actually I did go"*, this was "*overall definitely positive*" and that they "*did enjoy that*", with a strong emphasis on motivation "*my attitude definitely it helped me let's say hum the project to kind of keep me focused and motivate me to do these things, so that's like a big plus*".

4 Discussion and Conclusions

The IPA (Interpretative Phenomenological Analysis, see section 2.4) of the interview with the participant shows that they found clear benefits to having taken part in the activity: improved motivation, focus, and independence. These benefits have been noted in the SaP (Student as Partners) literature across a range of co-creation activities (Bovill and Bulley, 2011; Bovill, et al., 2016; Weller, 2019). We will categorise these as *benefits for study skills,* and they would be transferable to any course or discipline.

Furthermore, it appears that the project has been a space to continue improving and consolidating the participant's understanding of linear algebra, through revisiting difficulties and testing what they thought they understood. This agrees with findings from the literature that the creation of mathematical examples by learners provides an opportunity for knowledge construction and consolidation (Bills, et al., 2006; Cornock, 2021). Consequently, these benefits are particular to the exercise of creating mathematical examples and applicable to the learning of mathematics. We will call this: *benefits for learning mathematics*.

We have identified an additional category of benefits that transpires in the discussion with the participant, which, to our knowledge, has not been discussed on the literature of SaP or exemplification in mathematics education. We call these *benefits for the student resilience and legitimate participation*. In this category, we include the (re)gained feeling of being capable, feeling a legitimate student of mathematics, enjoying learning new concepts, increased confidence, sense of being in transformation and becoming a mathematician, having a space to grow and learn from mistakes and failures. In other words, the activity was an opportunity for the participant to be a *legitimate peripheral participant* in the *zone of proximal development* (ZDP), as defined by Lave and Wenger (Lave and Wenger, 1994; Lave, 2008). Solomon shows that it is particularly difficult for girls to feel rightful mathematicians (Solomon, 2007), so given that the participant is a female, the finding that co-creation of mathematical examples has benefits for resilience and legitimate participation is significant.

The range of benefits that were identified suggests that implementing creation of examples by level 2 students in mathematics would be a powerful strategy to help the level 1 – level 2 transition. What the project failed to implement, however, is group work in co-creation, because only one student volunteered to take part. The main reason for low interest amongst students seems to be that the activity was not synchronised with the course but was taking place after the course had finished. This suggests that students do not see their degrees as a progression towards becoming an expert through inter-dependant courses, but as a linear set of independent modules to validate. Yet, in the case of linear algebra, there is an obvious progression, from the level 1 algebra course to the linear algebra 1 and 2 courses in level 2.

According to the participant, the group experience would have been an opportunity to discuss mathematics with peers in an informal, safe, and friendly environment: it would have been a way to create a *community of practice of newcomers in the community of mathematics* (Lave and Wenger, 1994; Wenger, 2008). Solomon showed that students in mathematics have difficulties in developing a feeling of belonging to a community of practice, and this research implies that group co-creation of mathematical examples would help developing this feeling, however, this would need further investigations. In collaboration with the lecturer of the level 2 linear algebra courses, the creation of exercises has been implemented as a core, mandatory, group activity of the course in 2023-2024, and we are collecting students' feedback. The analysis of the results will continue to inform the benefits of this pedagic approach.

5 Appendix

5.1 MA2008 linear algebra course curriculum

The MA2008 linear algebra course is coordinated and tought by the Maths Department, School of Natural and Computing Science. It is a mandatory course on the single and joint honours maths degrees, and open to all other degrees. The course curriculum covers:

1. Sets (basic notions, relations, maps and principle of induction)
2. Groups, Rings and Fields (groups, rings and fields and integers mod n and the field of prime numbers)
3. Linear equations
4. Multiplication and addition of matrices
5. Vectors spaces (definition of a vector space and examples, subspaces, spanning, linear independence, bases)
6. Linear transformations (definitions, examples and elementary properties, kernels and images, linear transformations defined on basis elements)
7. Matrices and linear transformations (matrix of a linear transformation, invertible matrices, Gauss-Jacobi method, change of basis, rank of a matrix)
8. The determinant

5.2 Links to questionnaires

The pre-activity questionnaire can be found at:

https://forms.office.com/Pages/ResponsePage.aspx?id=rRkrjJxf1EmQdz7Dz8UrP-jz8LfXu3JLgXr8w7vGpf1UNlRQNE1XVFRCN0pQVTYyTVJKRUJJMVQ2WC4u

The post-activity questionnaire can be found at:

https://forms.office.com/Pages/ResponsePage.aspx?id=rRkrjJxf1EmQdz7Dz8UrP-jz8LfXu3JLgXr8w7vGpf1UNFJXSlhBWEkzUk5BWTNQRzdONUZYOTVVTi4u

The interview questions can be found at:

https://forms.office.com/Pages/ResponsePage.aspx?id=rRkrjJxf1EmQdz7Dz8UrP-jz8LfXu3JLgXr8w7vGpf1UNTRFRlM3M0dPNzZYN1dTMEJUU1lUSE9OTi4u

5.3 Reflexivity on IPA method

IPA is an interpretative method of analysis of interview conversation, well suited for the analysis of interviews of single participants. However, because it is an interpretative method, the personality, history, and experience of the researcher necessarily influences the coding of themes.

As a woman who has studied and worked as a researcher in STEM disciplines, I (Morgiane Richard, Academic Skills Adviser in Maths and lead researcher in this project) am probably particularly sensitive to the gender imbalance in STEM subjects, and to the difficulty for girls and women to feel as capable as boys and men to do well in those subjects. I feel quite strongly about this, and it would be fair to say that another researcher might not have picked up this thematic in the same way in the interview transcript.

To help decide whether the themes I coded were reasonable, my colleague on this project, Dr Mirjam Brady-Van den Bos, who is a lecturer in the School of Psychology, also read the transcript and generated some themes. As the themes were consistent between our two codings, and particularly since Mirjam does not have a background in either mathematics or mathematics education, this comforted me with the idea that the themes were compatible with both our backgrounds, and not solely linked to my background as maths support adviser and physical scientist.

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CASE STUDY

Making the Move from “Med Math” to Medication Administration and Safety

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Abstract

The World Health Organization (WHO) recognized medication errors as a global health problem in 2017 highlighting them as a top patient safety challenge (World Health Organization, 2023). The American Association of Colleges of Nursing (AACN) highlights quality and safety as one of the essentials of nursing (2021). In response to declining medication math scores and the emphasis on patient safety, one Midwest United States nursing program updated their curriculum to address medication administration and safety on exams instead of just “med math” as dosage calculation. Addressing the varying skills and knowledge of foundational mathematical concepts for nursing students entering and progressing throughout the program remains an area of further study.

Keywords: Medication Administration, Medication Safety, Nursing, Medication Errors, United States.

1. Introduction

It is widely accepted that safe medication administration is an essential nursing school competency and is supported by a variety of assessment strategies utilized throughout the nursing curriculum. There is variability among requirements of exams, definitions, teachings and even what is considered competency among nursing programs, but most undergraduate programs require some sort of “med math” exam that is successfully completed by their students prior to graduation There is also great variability in the definition of “Med Math”. Some definitions consider only dosage calculation, others consider safe dosage calculation and quality in administration of medications. Preparation of graduates for competent medication administration is the goal of nursing programs, related to the overwhelming evidence of the safety and quality issues regarding medication errors. Medication errors are a global health issue. The World Health Organization (WHO) has recognized and identified medication errors occurring in all stages of the medication use process, including prescribing, transcribing, dispensing, administering, and monitoring (2023). Medication safety is a concern for both patients seen in acute settings and in outpatient settings, and the WHO has named medication errors as one of the top patient safety challenges since 2017 (WHO, 2023).

In the United States healthcare system medication errors, among others, were brought to light with the Institute of Medicine’s (IOM) report, *To Error is Human: Building a Safer Health System* (Kohn, Corrigan and Donaldson, 2000). As a result, regulatory agencies like The Joint Commission, https://www.jointcommission.org, have continued to make medication safety a priority, focusing on areas such as National Patient Safety Goals. As a result, nurses and nurse educators have a responsibility to work for the achievement of these goals, and to share this information with students and other colleagues (Joint Commission, 2023). The American Association of Colleges of Nursing (AACN) has also prioritized patient safety through their updated document “*The Essentials*” (American Association of Colleges of Nurses, 2021).

That document updated the framework outlining expectations for competency in nursing practice and describes 10 Domains which are the “essence” of nursing practice and from which the expected competencies follow. Domain 5 is centred on Quality and Safety. This domain focuses on enhancing quality and minimizing “risk of harm to patients and providers through both system effectiveness and individual performance. In alignment with *The Essentials*, the decision was made at the University of Detroit Mercy, to move from “Med Math” to “Medication Administration and Safety” and highlight the importance of integrating the competency into the nursing curriculum, prioritizing patient safety and quality care.

2. Intervention to improve competence

The undergraduate nursing program at the University of Detroit Mercy was analysing program assessment data to consider curriculum redesign. Anecdotal data presented to faculty by students regarding medication assessment competencies in the classroom, advising sessions and in clinical setting was concerning. In alignment with the new AACN essentials, this nursing program’s current “med math” (dosage calculation) assessment strategy underwent a philosophical change to a more integrated approach that became known as medication administration and safety.

The shift from “med math” to “Medication Administration and Safety” was a policy redesign for this, Midwest United States nursing program within a Catholic University. A year was spent on the redesign to map competencies of three different Bachelor of Science in Nursing (BSN) educational tracks. In the United States the BSN leads the graduate to a licensing exam in the state where the graduate resides. The nurse, upon passing the exam (which includes math incorporated into multistep scenario questions), becomes a Registered Nurse (RN). The graduate may not work in the hospital as a graduate nurse until the licensing exam is successfully completed. The three educational tracks were as follows: The student who comes to the university directly from high school, the student who comes to the university who has a degree in another discipline and can move more quickly through the nursing program, and lastly, the student who comes with a degree from a community college with a degree known as an associate degree that can transfer 90 credits towards the required 126 credits of the BSN degree. This challenge to change began for two reasons. First, was the obvious need to connect and better align with *The Essentials.* The second and more concerning challenge was the increase in the number of students failing the previous Med Math exam. These failures had significant impact on progression through the program for students, as they could not meet clinical/curriculum objectives. Students who were unable to pass Med Math exams were not able to pass medications at clinical/practicum sites. Students who failed were held back a semester to repeat the clinical course. The faculty of the department had concerns about this from a financial, psychosocial, and spiritual perspective of the student. As a Catholic institution with a commitment to academic excellence and social justice, this policy was not mission driven.

A small ad hoc group was formed to work on the policy in the Spring 2022 semester, with plans for implementation in the Fall 2022 semester. Transition from the old policy to the new occurred during the summer 2022 semester. Emphasis was focused on preparing faculty for the transition as there was a shift to” more teaching” and” less testing.” Teaching of medication administration and safety concepts was specifically stated as an expectation in specific courses, as it related to course content. This was a large shift in how content throughout the curriculum was taught. Content related to medication administration and safety was previously primarily taught by one or two faculty members, in only two didactic courses (one in the beginning and one in the middle) of the nursing program, with the expectation that competencies were reinforced in the clinical setting. Medication

administration and patient safety competencies were outlined in eight additional didactic courses within the new program design. Each of these courses also had a clinical component.

Additional learning experiences were also written into the policy Medication Administration and Safety. For example, students now had medication administration and safety simulations and skills sessions as well as medication administration and safety-focused instructional sessions. Students were assigned self-study modules to assist in their preparation as well. Exam testing was decreased to a total of two exams throughout the course of the curriculum, from the previous five exams. In the Fall 2022 semester a new faculty member was assigned to help facilitate the policy rollout. This faculty member was also responsible for assisting faculty with testing and working with faculty and the simulation centre coordinator to ensure medication administration and safety competencies were achieved.

3. Results

A summary of differences in exams before and after the policy change is shown in the Appendix. At the time of article submission, data had been collected for one full year since the new policy was implemented. Exam scores were assessed per nursing education track for exam 2 taken at about midpoint in the curriculum for all educational tracks. Test taker exam scores, of those who would be graduating under the new policy and had received education under the new policy, were compared against those of students in education tracks graduating under the old policy. The combined mean score on exam 2 of educational tracks for those who will be graduating under the new policy was 85.5%. This score was higher than the mean score of 83.2% for those in educational tracks graduating under the old policy. The mean percent of students who passed on the first attempt increased from an aggregate of 55% among educational tracks post policy implementation compared to 51.1% pre-implementation (Table 1)

Nursing Ed. Track test takers for Exam 2 by Graduation Date	Number of Students in Ed. Track (n)	Passed on first attempt [n (% of Ed. track)]	Combined first attempt pass rate (%)	Mean exam score for Ed. Track (%)	Combined Mean Score based on competency Policy (%)
May 2022	34	17 (44.7)	51.10	82.2	83.2
Dec 2022	33	19 (57.5)		84.2	
Transition to new policy					
May 2023	24	12 (50)	55.5	84.3	85.5
Dec 2023	30	13 (43.3)		83.1	
May 2024	15	11 (73.3)		89	

Table 1: Nursing student exam 2 aggregate scores and pass rates per graduation date by education track

4. Discussion

This change in philosophical approach to viewing “med math” as more than just dosage calculation but an encompassing policy of the administration of medication and improving patient quality and safety was considered a bold change for this nursing program. The program will continue to need to

evaluate progress and outcomes as data is collected. Test scores improved with less testing and more interactive learning. As expected, anecdotal responses from student reported decreased stress from fewer exams. Faculty reported enhanced engagement with students in the classroom. Students continued to struggle with story problems. Clinical nursing practice requires critical thinking, estimation, logic and reading. Students must be able to read provider orders, look at pictures of medication labels and understand abbreviations used on these labels. For example, the "Do Not Use" list has many abbreviations often found on medication labels. Students properly educated and trained and able to understand what is being asked in a story problem will be less likely to make medication errors. These competencies were assessed in simulation and could not have been assessed as accurately though a written exam.

Dosage calculation as "med math" will continue to be a part of nursing curriculum. Nursing programs can and should expand "med math" to include the principles of critical thinking and decision making that are foundational to medication administration and safety. Teaching improved quality and safety in classrooms can help to reduce medication errors and ultimately decrease patient harm. Students should be able to self-assess medication administration competencies throughout the continuum of the program. The program is working to offer a variety of learning opportunities for assisting students who score low. Moving forward we will also continue to work on effective ways to objectively meet competencies with testing. The program continues to search for ways to engage students with the competencies of patient quality and safety related to medication administration.

5. Appendix

Summary of differences in exams before and after the policy change

	Exam Before Policy Change	Exam After Policy Change
Number of Tests During Curriculum	Five exams – exams taken in theory courses associated with accompanying clinical courses: First: skills/fundamentals Second: med surg Third: Pediatrics Fourth: OB Fifth: Leadership/Immersion	Two exams First: prior to start of didactic learning Second: midway through nursing curriculum
Student Exam Preparation	Primarily student responsibility to study suggested material	Content and student learning objective added to specific courses in curriculum Medication Safety and Administration specific content added to simulation scenarios Medication Safety and Administration faculty and peer review sessions available for student sign up
Exam Format	10 questions 25 minutes If the class is online, the exam was recorded video on lockdown web browser; otherwise, the exam was in person All questions multiple choice	20 questions 45 minutes All exams taken in person regardless of class format Questions may be multiple choice or fill in
Example Questions from Exam 1	1. If a patient weights 220 lbs, how many kilograms does the patient weight? a. 2.2 kg	1. A nurse caring for a child who weights 22lbs has a fever of 102.7. There is a prn order for ibuprofen 10mg/kg prn fever >102.5. Available

Example Questions from Exam 1 continued…	b. 52 kg c. 100 kg d. 220 kg 2. A child is ordered: Amoxicillin 200mg po x 1 now. Pharmacy has sent: 80mg/3ml suspension in a multiuse container. How many ml should be administered to the child? A. 1.2 ml B. 3 ml C. 7.5 ml D. 80 ml 3. The order is to administer Pepcid 15mg IVP x 1 now. Pharmacy sends Pepcid 10mg/ml. How much will you give? A. 0.5ml B. 1ml C. 1.5 ml D. 2ml	from pharmacy is ibuprofen 40mg/ml. How many ml should the nurse administer to the child? (round answer to the nearest tenth) a. 1.5ml b. 5.5ml c. 2.5ml d. 3.25ml 2. Mr Shaham is ordered furosemide 60mg PO x 1 now. The supply from pharmacy is pictured below. How many tablets will you instruct the patient to take?  Picture from https://dailymed.nlm.nih.gov/dailymed/fda/fdaDrugXsl.cfm?setid=79d9aef8-cfb9-4f6e-ac15-f830d7ea2324&type=display 3. The IV order reads 300ml of NS to infuse over 6 hours, what is the hourly rate?
Example questions from Exam 2	1. The order for your patients continuous IV fluids reads “0.9NS IV @ 30ml/hr”. Pharmacy has sent you a 0.5L bag of IV fluid. How long before you expect your IV fluid to run out and you will have to change the bag again? A. 16 hours and 5 minutes B. 16 hours and 25 minutes C. 16 hours and 40 minutes D. 16 hours and 67 minutes 2. You are the nurse caring for a patient who is ordered sucralfate 500mg PO q 6 hours for a duodenal ulcer. Available from pharmacy is 1g/10ml. What will you prepare for administration to your patient? a. Administer 2 tablets orally b. Administer ½ tablet sublingually c. Administer 20ml sublingually d. Administer 5ml orally	1. A nurse is reviewing the prescriptions for four clients. The nurse should contact the provider to clarify which of the following prescriptions? a. Haldol 0.5 mg at bedtime b. Clonidine 0.1 mg PO once daily in the morning c. Chlorpromazine 25 mg IM q 12 hrs prn psychosis d. Fluoxetine 20mg PO daily q am 2. You have an order to administer ondansetron8mg IV piggyback 200ml in 0.9NS to infuse over 30minutes. What rate should you set the infusion pump (in ml/hr)? 3. You are caring for a patient with constipation, docusate 2 tabs PO BID prn constipation is ordered. What is the max number of tablets the patient can have in a 24 hour period? a. 1 tablet b. 2 tablets c. 3 tablets d. 4 tablets

6. References

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