Project Title: Using Student Analytics with tutors to increase retention

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Executive Summary

Our project investigated the potential of tutors using two strategies designed to highlight potentially "at risk" students. The first strategy built on a project undertaken by the Student Support Team at the Open University in Scotland (Gilmour et al, 2016), in which Scottish students with a marginal probability of passing were contacted.

The second strategy built on a project carried out in the East Midlands region involving a number of MU123 tutors. In this case, tutors contacted students based on OU analyse data. While the results could not demonstrate that the OU analyse data would result in a successful intervention; preventing a student withdrawing, it did highlight the potential of VLE usage data (Calvert, 2016). In our project, 27 (from a pool of 92) MU123 2017J tutors took part, volunteering to use the "at risk data" when deciding whether or not to intervene and contact students.

The "predicted probabilities of success" generated by the University's analytical models were not only used as an "at risk measure". These probabilities, take into account all the known proxy measures associated with success, and by generating these before module start, we were effectively creating a measure of prior ability. The availability of a "prior ability" measure enabled us to generate a control group for those students contacted by tutors. Pass rates of the students receiving additional tutor contact were compared to those of students that did not receive additional tutor contact whilst controlling for prior ability.

Our project was included in a cross-Faculty evaluation of module use of analytics (Walker et al, 2018), and as such some qualitative data regarding tutors' views of our project is available. The results of these qualitative and quantitative assessments suggest that there is potential for expanding and rolling out this project across all of our level one Mathematics and Statistics modules.

Aims and scope of your project

The aim of our project was to develop a strategy that would eventually lead to increased student retention on MU123. To do this, we planned to use student analytics, available in the student support tool, in an innovative way, in that, we made the student analytics available to the tutors, asking them to make contact with students when the analytics, combined with their experience, informed the need for contact.

At the start of the project tutors were given guidance on a number of themes that their initial contact might address particularly when discussing the students past study experience or general mathematical life history, for example, how the student felt about studying maths or studying in general, what was their source of motivation when studying MU123.

A key focus of these initial conversations was to investigate approaches that might be used to develop mathematical resilience and good study practice. The project also sought to assess the impact of these resilience building conversations using a set of attitude scales in the form of a questionaire administered before and after the project.

Figure 1 shows how our project is linked to other similar OU projects with a potential roadmap for future projects based on our findings and the findings of others.

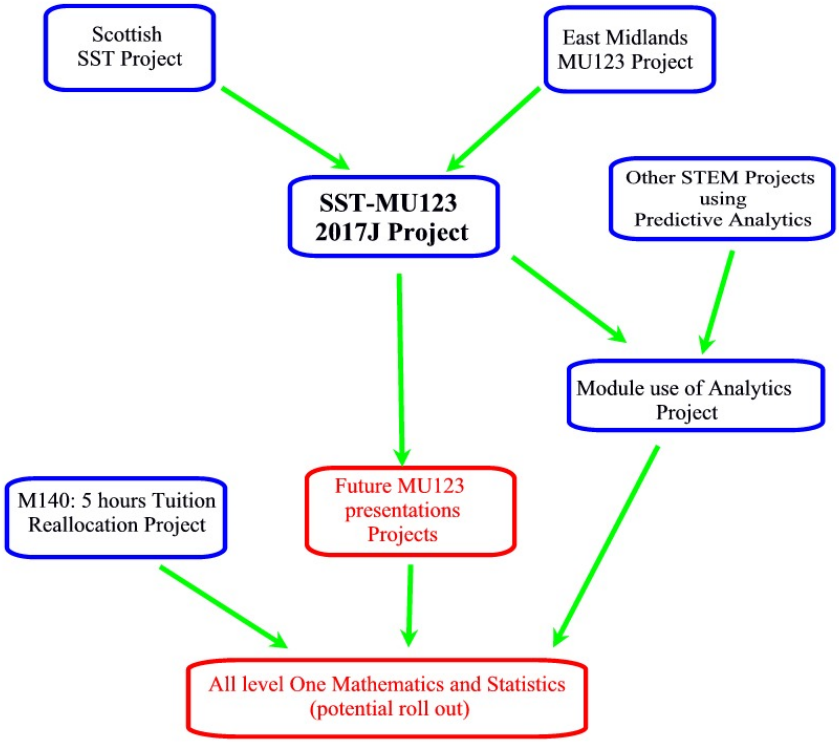

Figure 1: Linked projects
(Note: Projects in blue already completed/ongoing. Projects in red under consideration)

Activities and Findings

There were 92 tutors teaching on the 2017J presentation of MU123 and of those tutors, 27 volunteered to take part in at least one part of the MU123 project. From a total of 2012 students registered at module start, predicted probabilities of success were available for 2028 students.

Although the tutors involved in the project were volunteers, part way through the module presentation, we acquired some funding that allowed us to offer them a small payment to cover additional time spent recording student contact for the project.

Phase One Activities: Initial Contact Based on 'at risk' information

Initially, we had planned to ask participating tutors to focus their attention on students who had a 40%-60% chance of completing the module. However, having performed our initial analysis, we refined our focus to a slightly smaller set, those with a 40%-60% chance of passing the module; the "middle" band.

Our aim was to investigate:

- If the retention and pass record of "middle band" students differed between those contacted and those not contacted at module start?

- Whether there was any statistical difference in pass rates between the two groups once prior ability was controlled for?

At the start of the presentation, there were 227 students with a predicted probability of passing in the “middle “band and for the 22 tutors who took part in phase 1 of the project, 58 of these students were distributed across their student groups. These 22 tutors successfully contacted 36 of their middle band students and returned a log of who they had contacted.

Findings of Phase One

Table 1: Numbers of MU123 “middle band” students at key module points during the presentation

	Number of students		
Key module points	**Initial contact made for this project**	**No contact made for this project**	**Total number of “middle band” students**
At module start	36	191	227
At 25% fee point	35	175	210
Submitted iCMA41	35	159	194
Submitted TMA01	34	159	193
At 50% fee point	31	159	190
Submitted iCMA42	29	135	164
Submitted TMA02	29	133	162
Submitted iCMA43	28	123	151
Submitted TMA03	25	114	139
At 100% fee point	27	146	173
Submitted iCMA44	23	102	125
Submitted TMA04	23	100	123
Passed MU123	21	102	123

Table1 above and Figure 2 below show the same information -. Table 1 shows actual numbers and Figure 2, the percentages, in terms of the numbers at module start, still present at the key module points.

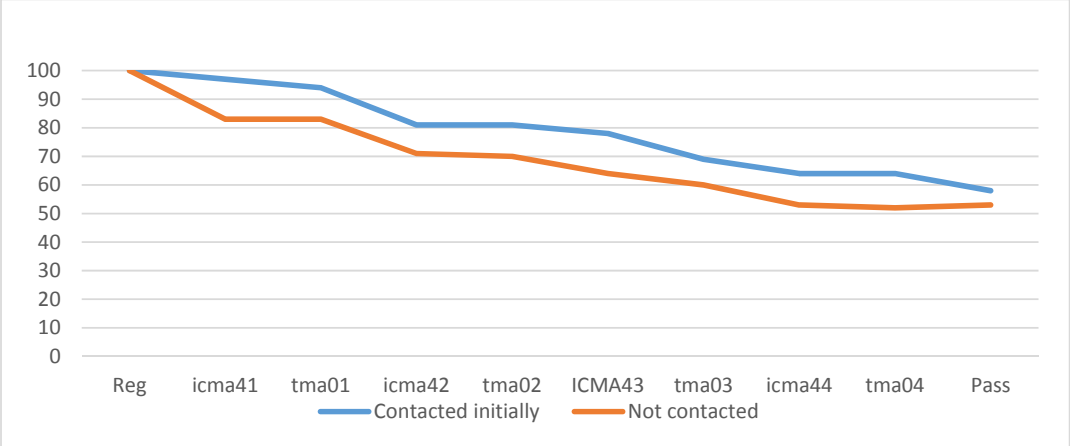

Figure 2: Progress of "middle band" students by initial contact as a percentage of those registered at module start

Although numbers are small, if we compare the performance of those contacted with those not contacted as part of the project, we would have expected 19.2 students to pass. As 21 of those who were contacted passed, it would appear that around two extra students passed out of the initial 36 contacted.

A chi-squared test on the difference in pass rates of the two groups is not significant - $\chi^2(1)$ is 0.279. It might be considered that any impact would be on submission of the first TMA but that difference is also not significant - $\chi^2(1)$ is 2.983.

Finally there was no strong prior reasons to believe that the students contacted by the volunteer tutors differed in prior ability from other students in the "middle band" of success. A logistic regression model, with success defined as "passing the module", and with explanatory variables being "predicted probability of success" (continuous) and "contacted or not" (categorical), confirmed that contact was not significant in predicting whether a student passed. Neither was there any effect of exactly where within the 40-60% band the student's predicted probability lay. Thus the use of the control group as "within the same band" sufficed to control for prior ability.

Comparison of results to Scottish Early Indicators study

The Scottish Study targeted students with predicted probabilities of success in the 30-40% and the students were contacted by the SST before module start. In this study students in the 40-60% range were targeted and contacted by their tutors after module start. The table below is taken from the Scottish study internal report (Gilmour et al, 2016) and indicates that the students contacted by the SST- the intervention group- had a higher pass rate than the control group. Applying the control group pass rate to the intervention group would generate 128.5 passes compared to the actual number of 153 passes meaning there were 24 additional passes. The initial intervention cohort was 312 students at module start and hence there was a 7.8% (24.46/312) increase in relation to the numbers at registration.

Students who reached module pass by pilot group						
	Control		Intervention		Total	
Status at module end	**N**	**%**	**N**	**%**	**N**	**%**
Reached module pass	131	41.20%	153	49.00%	284	45.10%
Did not reach module pass	187	58.80%	159	51.00%	346	54.90%
Grand Total	**318**	**100.00%**	**312**	**100.00%**	**630**	**100.00%**

Figure 3: Table from the SST early alert indicators project showing pass rates for students in the project and a control group.

In this study we had 36 students at module start who were contacted. An increase of 7.8% would equate to 2.8 students which is consistent with the observed results of 1.8 additional passes.

Phase Two Activities: Students whose VLE usage decreases

In this phase of the project there were 26 volunteer tutors who received, in the period October 2017 to March 2018, a monthly data set which flagged students whose VLE usage had dropped in the previous 14 days.

The SST tool records a student's overall VLE usage for the duration of the module, giving it a score of High, Medium, Low or None. It also records a student's VLE usage in the last 14 days. When there was a drop in the last 14 days of a student's VLE usage tutors on the project were alerted.

Tutors were asked to consider if this drop surprised them and, if so, consider contacting the student to check whether there were issues the tutor could help with. Tutors then returned a log of who they had contacted.

An important difference to phase 1 was that all students in the tutor group were included in the study regardless of their prior ability. Students in the tutor groups of the volunteer tutors were found to be marginally weaker than those generally (see following section on potential tutor bias). Figures 4 also shows this general pattern of slightly weaker students with the average predicted probability of success within the volunteer tutor's groups being 0.67 compared with 0.70 across all students on MU123.

All students on MU123 Students within tutor groups in VLE study

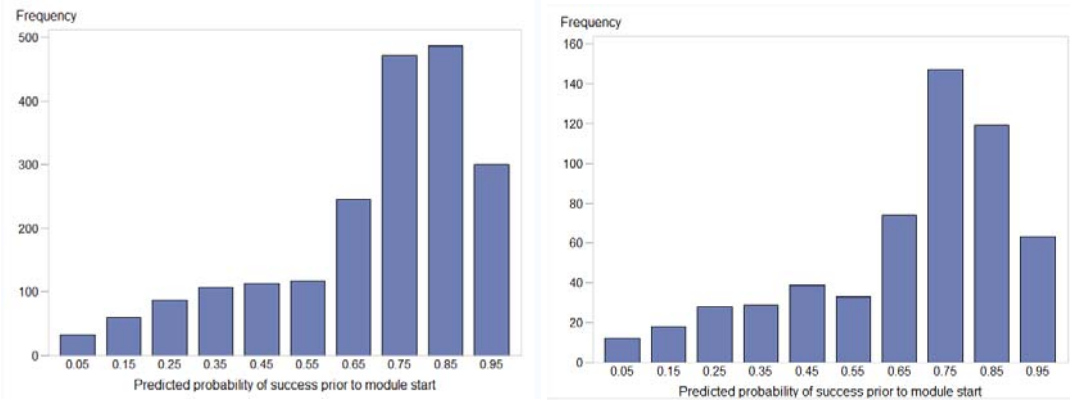

Figure 4. Distribution of predicted probabilities

A logistic regression indicates, as expected, that passing is highly linked to the predicted probability of success ($\chi^2(1) = 118$, $p < 0.001$) and as the predicted probabilities of success vary across the two groups so it is important to control for this variation. As stated earlier, the predicted probabilities of success, are effectively a measure of prior ability. Students are allocated to one of four bands with the same number of students in each band (quartiles groups) and comparisons of pass rates etc. are made within these groups.

In this phase the project was focussed around the following questions:

- Did the change in VLE indicate students were indeed less likely to pass?
- Did the choices made by the tutor about whether to contact the student or not act as a refinement to the raw change indicator?
- Did the intervention appear to impact i.e. what we would have expected of a similar prior ability students?

Findings of Phase Two

Change in use of VLE indicator as an indicator a student is less likely to pass

The 26 volunteer tutors had 591 students (two tutors had more than one tutor group) in their tutor groups which was 28% of the MU123 2017J population registered at module start.

There were six, approximately monthly, VLE usage alerts to tutors and hence it was possible that an individual student might be flagged up to six times. The tutor, based on their existing knowledge of

the student circumstances, decided whether to contact the student. Table 2 shows the number of actual contacts. In column (3) we expect less contacts than the number of flags, column (1). Table 2 also shows that the tutors are less likely to make as high a number of contacts as there are flags when there are many flags.

Table 2: Number of times students were flagged with a change in VLE usage and the numbers of times students were contacted

Number of times a student was flagged because of a drop in VLE usage	Number of students	Number of times the tutor contacted student
1	159	144
2	108	90
3	64	41
4	40	13
5	23	3
6	6	0

The change in VLE usage is hypothesised to identifying students who are more likely to drop out. Table 3 shows information summarised simply based on whether "a student passed or not" versus whether the student was "flagged at least once or not".

If there were no association between "passing" and being "flagged" the expected number of passes would be as presented in Table 3. In reality, only 264 passed compared to that expected 273, a difference of 9 students. This indicates that flagged students did indeed do less well but the result is not statistically significant; ($\chi^2(1)$ =1.15, p=0.29).

Tables 3 Observed and Expected numbers to pass /fail for flagged and non-flagged students

		No changes flagged	At least one change flagged	Total
Fail	Observed	529	135	664
	expected	*537.96*	*126.04*	
Pass	Observed	1174	264	1438
	expected	*1165*	*272.96*	
total		1703	399	2102

Tutor refinement of which students to contact

Table 2 showed that tutors were increasingly less likely to contact students flagged repeatedly. This accords with the request to tutors to consider if the change surprised them and to contact the student if it did. It may well be the case that after a couple of contacts a tutor might sometimes decide that there is no benefit in repeatedly contacting a student further. Table 4 shows comparable data to Table 3 for the students who were contacted by a tutor as a result of a VLE flag. Once again, contacted students have fewer passes than expected but the size of the difference is reduced to 4 students (that is 193 passed compared to 197) and the significance of the difference is reduced ($\chi^2(1)$ =0.30, p=0.58)

Table 4: Observed and expected numbers to pass /fail for students who were contacted by a tutor as a result of a VLE flag

		No contact	At least one contact	Total
Fail	Observed	569	95	664
	expected	*537.02*	*90.976*	
Pass	Observed	1245	193	1438
	expected	*1241*	*197.02*	
Total		1814	288	2102

Impact of intervention by tutors

The impact of tutor interventions is difficult to assess. Students are flagged because they had a drop in their VLE usage. Students were contacted because their tutor was surprised/concerned by the drop in their VLE usage.

The meta-analysis project[3] held interviews with tutors involved in our project and following a qualitative analysis, it was recommended that the "MU123 SIO Probabilities tool" having been well-received by tutors should be continued and/or expanded."

"I used it [the MU123 system] because it made me think a couple of times and I actually got in touch with students a lot earlier than I would and I think I saved a couple, if I'm honest with you, that I maybe would have... They would have slipped because they'd have got too far behind." (MU123)

The excess number of nine fails in the flagged group is reduced to an excess of four in the contacted group. These are small numbers but we have five additional students within the contacted group of 288 students (2%) passed. There are some indications that the effect is more pronounced in the set of students who also had a less than 60% chance of passing the module and we will explore this idea further in future projects.

Resilience Building Activity

At the start of the project tutors were given guidance on the sort of themes their intial contact might address with a focus on building resilience and good study practice. The project sought to assess the impact of these resilience building conversations.

Students in the target cohort of Phase One (the middle band) were sent a pre and post questionnaire to assess a potential change in their attitude towards mathematics during their MU123 experience. The attitude scale initially constucted by Fennema and Sherman (1976) to study students' attitudes towards mathematics and later modified by Doepken, Lawsky and Padwa (1993) includes four subscales: a confidence scale, a usefulness scale, a scale that measures mathematics as a male domain, and a teacher perception scale. Each of these scales consists of 12 items. Six questions measure a positive attitude and six measure a negative attitude. In our project, the modified Fenema-Sherman (Doepken et al, 1993) scales were used to measure a change in attitude during the project. It was felt that a positive change in attitude would indicate a similar positive effect on their maths mindset/resiliance. Unfortunately, of the 36 target students, just 4 returned both surveys. This restricts our scope for meaningful statistical analysis but we can however present the scores generated by these 4 students and comment on how we might interpret these results.

Table 5: The before and after scores of the Modified Fenema-Sherman scales

		Mathematical Confidence	Usefulness of Mathematics	Mathematics as a Male Domain	Perception of the Tutor
Student A	Before	38	49	55	39
	After	41	45	52	49
Student B	Before	35	46	55	31
	After	39	42	49	38
Student C	Before	47	53	50	43
	After	49	53	48	53
Student D	Before	35	59	47	36
	After	35	55	44	46

The before and after scores for each subscale are presented in Table 5. The maximum score that a student could achieve for each subscale was 60. Each student was asked the same set of questions before and after the learning experience. This involved choosing the answer that best represented their attitude having read a sentence (without spending too much time muling over the decision). The answers provided were A (strongly agree), B (Agree), C (Not sure or can't answer the question), D (Disagree) and E (Strongly Disagree).

Positive questions were scored: A = 5, B = 4, C = 3, D = 2, E = 1.

Negative questions were scored: A = 1, B = 2, C = 3, D = 4, E = 5.

Mathematical Confidence

Of the 4 students who completed the before and after questionaires, 3 had an increase in "mathematical confidence" scores with the remaining student showing no change. Taking all 4 students as a group, their average "before" score was 38.75 and their average "after" score was 41. This equates to an average increase in "mathematical confidence" score across the group of 2.25 or approx 6%.

Usefulness of Mathematics

Of the 4 students who completed the before and after questionaires, 3 had a decrease in their "Usefulness of mathematics" score with the remaining student showing no change. As a group, their average "before" score was 51.75 and their average "after" score was 48.75. This equates to an average decrease in "Usefulness of mathematics" score across the group of 3 or approx 6%.

Mathematics as a Male Domain

All 4 students had a decrease in their "Mathematics as a male domain" score. As a group, their average "before" score was 51.75 and their average "after" score was 48.25. This equates to an average decrease in "Mathematics as a Male domain" score across the group of 3.5 or approx 7%.

Perception of the Tutor

All 4 students had an increase in their "Perception of the tutor" score. As a group, their average "before" score was 37.25 and their average "after" score was 46.5. This equates to an average increase in "Perception of the tutor" score across the group of 9.25 or approx 40%.

Interpretation

It is clear from the results generated that the most positive impact for this particular small group was on their "perception of the tutor" score. To try to explain why this has occurred, we draw on some literature and in particular, work on mathematical life histories. Coben et al (1995) were concerned with the significance of mathematics in an individual's life and the possible effects on individuals' lives in terms of occupation, life chances and self-esteem. They were concerned that mathematics seemed to operate as a 'gatekeeper' effectively excluding people from work and learning opportunities. They identified a number of themes during their research, also widely associated with mathematics anxiet. Two of these themes may help explain our results:

1. *"The significant other – someone perceived as having a major influence on their mathematics life history. The influence might be positive or negative, past or present, persisting sometimes for many years after the event. Significant others include, for example, a parent who tried to help with mathematics homework; a teacher who abused their authority and the power of the subject; and a partner who undermined their confidence in their mathematical abilities."*
2. "*Invisible mathematics – the mathematics one can do, which one does not think of as mathematics – also known as common sense." Coben et al (1997)*

The first of these themes may help to explain the positive change in their perception of the tutor. A student coming from a background where a "significant other" may have had a negative influence in their past mathematical studies would not have expected their MU123 tutor to be any different. The positive change in their attitue may be directly attritributed to the experience of feeling valued as a result of the interventions and extra support offered by their MU123 tutors.

The second theme may explain why there was little substantial change, either positive or negative in the other subscales. Coben et al (1997) found that for many students, mathematics ceased to be mathematics and became common sense once the student had mastered a technique. Instead of the student feeling that they had achieved some mathematical ability, what actually happens is that mathematics becomes more unattainable. What the student considers being mathematics is only recognised as that which cannot be mastered. Everything else is common sense. The increased negative perception of "mathematics being a male domain" supports this theory as all 4 students who responded were female so increasing that negative attitude, could be percieved as suggesting that mathematics was still unattainable for them.

While these results are not statistically significant because of the small group size, they do however highlight a number of themes that we may need to consider in future projects. We need to consider how we might convince more students to return their questionaires or maybe replace the way we measure the impact of these interventions with some kind of qualitative survey that would inform what we do to better tailor these interventions, to maximise our retention efforts.

Factors which have been accounted for in the analysis and project findings

Potential bias of a Tutor effect

There were 92 tutors teaching on MU123 2017J and 27 of these volunteered to be involved in at least one strand of this project. The tutors involved in any strand of the project are potentially a biased group but the choice of suitable control and adjustment mechanisms means that some of these potential sources of bias can be controlled for. The key element in this control and adjustment process is the use of the predictive probabilities, generated by a University modelling system that indicates the likelihood that a student will succeed on a specific module. This predictive probability can be

generated prior to module start and is a summary measure of the levels of all the factors known to impact on success for a student. This measure is derived from proxy measures for factors such as resilience, motivation, self–efficacy etc. and of course at the individual level carries a much higher level of inaccuracy than when averaged over an entire tutor group. None the less, we effectively have a measure for prior ability at student level that can meaningfully also be aggregated up to tutor group level.

Tutors involved may have had atypical groups on MU123 2017J

The average of prior ability, on a scale of zero to one, of the tutor groups involved with our project is actually lower than that across the tutor groups with tutors who did not volunteer to be a part of the project. So the volunteer tutors tended to have weaker tutor groups – an average prior ability level of 0.66 compared to that of 0.70 for the non-volunteer tutors. Figure 5 shows this same effect with the average prior ability of the tutors involved in the project marked as orange squares and those not involved as blue circles.

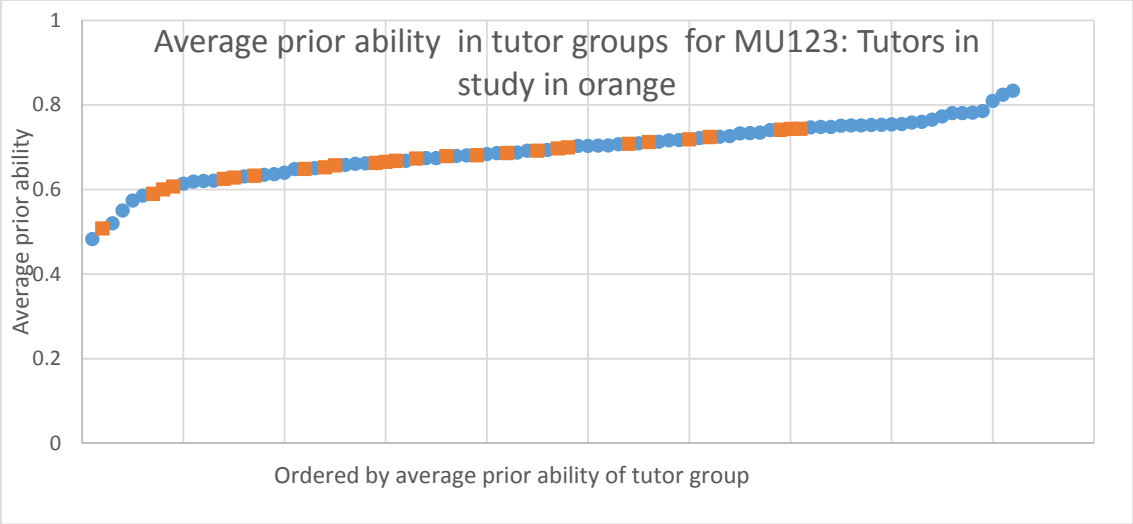

Figure 5: Prior ability by tutor group

The first stand of the project involves trying to improve the chances for students who have a borderline prior ability 0.4 to 0.6. It would therefore be a benefit to the study if our volunteer tutors had disproportionately more students in this category. Overall eleven percent of students had a prior ability in the 0.4 to 0.6 range (235 out of 2066) and, in the volunteer group, this was 13%.

Tutors involved in pilot may consistently have a higher impact on student performance

The tutor population on MU123 is very stable and most tutors who tutored on the October 2017 presentation also tutored on previous presentations. Hence using prior ability and results from 2016 enable

a) Any **differential** tutor impact to be determined when prior ability of students has been taken into account.

b) Any **differential** tutor impact of the volunteer tutors compared to the non-volunteers to be determined when prior ability of students has been taken into account.

Using a logistic regression model with success defined as passing MU123 and potential explanatory variables being prior ability measure (continuous) and tutor identifier (categorical) there is no differential tutor effect. A technical description of the process is that we replaced the tutor identifier by a simple 0/1 variable to denote if the tutor was a volunteer in the project in 2017 or not. We found that there is no volunteer effect. Table 6 summarises the output with the prior ability measure clearly being highly significant in predicting success in both analyses.

Table 6: Tutor effect controlling for prior ability

Effect	DF	Wald Chi square	Pr>ChiSq
Table 1a			
Prior ability measure	1	137.89	<0.001
Tutor identifier	97	96.32	0.5004
Table 1b			
Prior ability measure	1	145.43	<0.001
Tutor in volunteer group or not	1	2.22	0.1358

Tutors involved in the pilot might be more willing to try and contact their students

The volunteer tutors were involved on one or both of two strands of work. The first strand involved contacting students at the start of the module who appeared to have a borderline chance of success and discussing coping/resilience measures with them. The second strand involved considering contacting the student if the student's VLE usage had declined. The information on change in VLE usage was supplied in a spreadsheet monthly to the volunteers.

It is very likely to be broadly true that the volunteers were more willing to contact their students based either on strand 1 or strand 2 information. In the future tutorial hours could be allocated specifically for this purpose for at level 1, and so this pilot project is scalable to larger cohorts of tutors.

Impact

a) Student experience

- Number are very small but are consistent with the "Early alerts" project in that, a 5% increase in pass rate, out of those at module start, might be achievable by contacting students with a predicted probability of success in the 40-60% range.

- The project suggests that a change in the VLE data is indicating students at greater risk of not passing.

- The effectiveness, in terms of retention, of tutor contact on the basis of the VLE usage data is difficult to assess but tutors believe in its effectiveness.

- Whilst participating tutors were volunteers, their 2017 tutor groups were very typical. If anything the volunteer's tutor groups were slightly weaker than those of the non-volunteers.

- There was no evidence that the 2016 results of the volunteer tutors systematically differed from the 2016 results of the non-volunteers when prior ability of the tutor groups was taken into account.

b) Teaching

The cross-Faculty evaluation of module use of analytics was an independent piece of work, which gave some participating tutors the chance to say what they thought of the project. We have received useful feedback on improvements we can make to how we share the data with tutors and other aspects of the delivery of the project. In particular tutors would like the data they receive to include the student's name. We have had a positive response to the project from the tutors involved with comments about the project overall including:

'I feel that it's made me a better tutor and I think it's made me a more successful tutor in terms of retention and it's made the students, in most cases, benefit'

'The tutor become more engaged I think and the student becomes engaged then.'

'I have been more effective this year because having been nudged to, if you like having opted-in, I felt more dutifully bound to do the follow-ups.'

This feedback gives some evidence that the MU123 SIO Probabilities Tool has been well received by tutors and found to be effective. 'All MU123 tutors who were interviewed reported positive views on using the SIO Probabilities tool. They like the trigger that is the regular email but would appreciate student names being on the spreadsheet to make their work easier.'[3]

Moreover, the project team on the cross-Faculty evaluation project noted differences between our project and other modules using OU Analyse. Tutors seem to find it easier and more efficient to use than OU Analyse. Tutors did report taking all the data they were given with a pinch of salt. This is interesting given how strongly we know the predictive analytics are tied to the student's actual chances of passing. This finding warrants particular attention in any future roll out of the project.

c) Overall Impact and Next Steps

Given the (not statistically significant but nevertheless existent) increase in student retention we want to continue this work further. The project has support amongst the volunteer tutors it is recommended that the project should be rolled out across MU123. For MU123 18J we would like to formalise Phase 1 of the project (initial contact based on predictive probabilities) into a Mills intervention. Tutors will be sent information about the predicted probabilities of their students within their groups and asked to be proactive about establishing contacting with students in the 0 – 60% range and to attempt phone contact with this group.

In 19B we would like to roll out both phase 1 and 2 to the modules M140 B and MU123 B. That is we want to send out the initial probabilities and the VLE change data.

If the two activities above are successful then we will expand the roll out in 2019J to include all Mathematics & Statistics level 1 modules.

Figures

Figure 1: Links to other projects

Figure 2: Progress of "middle band" of students by inital contact as a percentage of those registered at module start

Figure 3: Table from the SST early alert indicators project showing pass rates for students in the project and a control group.

Figure 4. Distribution of predicted probabilities

Figure 5: Prior ability by tutor group

Tables

Table 1: Numbers of “middle band” students at key module points by whether initially contacted by their tutor or not as a part of this project.

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Tables 3 Observed and expected numbers to pass /fail for flagged and non-flagged students

Table 4: Observed and expected numbers to pass /fail for students who were contacted by a tutor as a result of a VLE flag

Table 5: The before and after scores of the Modified Fenema-Sherman scales

Table 6: Tutor effect controlling for prior ability

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