



From Gatekeepers to Gateways: Courses Impeding Graduation Annual Report 2019



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Introduction

The Courses Impeding Graduation (CIG) Project is a research and development initiative of the [Centre for Higher Education Development](#) (CHED). The goal of this project is to address the problem of high failure rates in courses that are obstacles to student retention and progression. The following report lays out the background, aims, objectives, and outcomes of 2019. This is followed by the CIG specific project in the Faculty of Science in the Department of Mathematics and Applied Mathematics.

Background and rationale

There is a significant body of scholarship on student retention¹ in higher education. These models point to a number of key determinants that influence whether students successfully pass courses and ultimately graduate or not. They recognise, on one hand, the influence of students' background measured through demographic variables such as socio-economic, schooling, race, and gender and on the other hand, there are a range of variables within the institution: academic, environmental, and social. These models propose a complex interplay between students' 'commitments' (including the resources they bring with them) and institutional conditions that influence the extent to which students successfully integrate and ultimately succeed in their degrees.

The Centre for Higher Education Development (CHED) has a long-standing commitment to the quality of teaching and learning with particular responsibility for addressing the ongoing impact of educational inequality on student performance at the university. Students' access into university, placement onto and progression through appropriate curricula, as well as the quality of their overall learning experience is central to the CHED's mission.

For nearly ten years, UCT's Institutional Planning Department (IPD) has been producing data on so-called 'high-risk courses' offered by the university. These are defined as courses with a failure rate of 25 percent or higher, averaged over three years. These courses are often also service courses, meaning that they are taught by departments outside of the student's faculty of registration. They may also be requirements for entrance or continued progression in a number of different academic programmes, and thus not only contribute to high failure rates but also have a high overall impact on programme progression. Hence the title 'Courses Impeding Graduation Project'.

The analysis of these courses has become increasingly granular, but the use of the data for addressing the challenges has been slow and uneven across faculties. Over the years there have been several attempts to 'flag' these courses as an institutional priority, requiring faculty buy-in, more support and improved resourcing. During 2014 and 2015, CHED facilitated a process of faculty

¹ Tinto (1975) is the seminal work in this area but there have been many studies done in South African higher education, including most recently Case, Marshall, and McKenna (2018) Going to University.

<https://doi.org/10.24085/jsaa.v6i1.3071>

consultation that surfaced some of the contextual complexities of solving ‘high-risk course’ challenges. The high-risk course may not be the only problem or even the cause of the problem (see Allie, 2015). The wider context of the degree, the pre- and corequisites, and issues of workload need to be considered as well.

Recently, in an attempt to address some of these issues, there has been a shift at UCT to allocate these CIGs to typically younger, enthusiastic, and pedagogically skilled lecturers. This move has resulted in not only more dedicated teaching but a range of pedagogical innovations, for example learning laboratories with white-board problem solving, Saturday workshops, and innovative uses of educational technology, to name a few. **And yet, the high failure rates have remained stubbornly in place, suggesting that some of these challenges cannot be addressed only through pedagogical interventions.**

At the end of 2018, a CIG working group of the Senate Teaching and Learning Committee (STLC) was commissioned to consult each faculty with the aim to identify and prioritize its courses with the highest impact on and most risk to academic success; those they would put forward for further investigation. Conversations took place with deputy deans. Appendix A is a list of the courses provisionally identified by the faculties.

In 2019, a firm commitment to address the challenges posed by these courses was secured from both the Faculty of Science and the Faculty of Commerce. The courses selected by the Faculty of Science are from the Department of Mathematics & Applied Mathematics: MAM1000W, MAM1005H and MAM1006H. From the Faculty of Commerce, the courses are from the School of Economics: ECO1010F/S, ECO1011F/S and ECO1110F/S. In each suite there was an inclusion of the ‘mainstream’ course and the ‘extended’ versions of the course. Consultations with the remaining faculties are on-going and regarded a priority in 2020.

The terms ‘mainstream’ and ‘extended’ refer to curriculum structures that have been in place at UCT for decades in all existing faculties. These were set up in the 1990s to address the performance gap between highly academically prepared students from historically well-resourced public and private schooling, and ‘disadvantaged’ students from poorly resourced public schooling. UCT currently offers eight ministerially approved extended curriculum programmes (ECPs), located in the Faculties of Humanities, Science, Engineering and the Built Environment, Commerce and Health Sciences.

The performance gap, which is essentially the differential in performance between black and white students, takes on a variety of forms depending on the faculty. In faculties with ECPs, these essentially require an extra year of credit-bearing, hence subsidy-generating curricula. Thus, in each cluster of CIGs per faculty there is an analysis of the regular mainstream courses (e.g. MAM1000W) and of the extended courses (e.g. MAM1005H and MAM1006H).

Aims and key questions

The aim of the CIG Project is to address the challenges of high-risk courses that result in high failure rates, with a particular focus on the experience of Black² students. UCT attracts some of the top academic talent in the country³. The 2014 five-year survival cohort completion rate is 73 percent⁴. But when the data is disaggregated, it is clear that some faculties have greater challenges in retaining and progressing students⁵, for example the Faculty of Science, and the Faculty of Engineering and the Built Environment (EBE).

Of particular concern is the persistent gap between the completion rates of Black students comparing to those of White students⁶. To compound these challenges, some of the long-standing interventions to address these performance gaps need to be reviewed regularly to ensure that they are responsive to changing students' needs. There are particular concerns about the relationship between the mainstream and the extended curricula, which need to be revisited.

Despite many sources of existing institutional data, UCT has not optimally used this data to understand and address the challenges. Thus, an additional objective of the CIG Project is to bring different sources of data to bear on this key area of concern. **The second aim of the project is therefore to contribute to a data-informed institutional strategy towards the academic success of students.**

The central question driving this project is, "For whom is the curriculum working (or not) and why?" The notion of a curriculum 'working' involves a number of variables that include how the course is contributing to the development of graduate attributes necessary for the student's chosen pathway into the world of work. **This project aims to contribute to a richer conceptualization of what is meant by 'student success' and what its key indicators are at UCT.** For the purposes of the project in 2019, 'working' simply refers to who is passing (or failing) the investigated CIG course, and why.

This project is rooted in a realist approach to evaluation. In the realist approach (Pawson 2013)⁷ the standard evaluative question is stretched from "Is the programme or intervention working?" to "What is it about the programme that works for whom, in what circumstances, in what respects, over what duration and importantly, why?". For this project the question is simplified to "**For whom is the curriculum working (or not) and why?**"

² Consistent with UCT policy, the term 'Black' is used to designate African students from South Africa. This is in contrast to 'black' which is a designation inclusive of African, Coloured and Indian students.

³ In 2018, 76% of UCT first-time entering undergraduates have NSC aggregate of B or above ([UCT 2018 Teaching and Learning Report](#), p. 136).

⁴ [UCT 2018 Teaching and Learning Report](#), p. 152.

⁵ The 2013 cohort completion rates for Science, EBE and Law were 68%, 65% and 52% respectively, [UCT 2017 Teaching and Learning Report](#), Table 20a ([Appendix A](#))

⁶ The 2014 cohort completion rates for Black and White students were 61% and 85% respectively.

⁷ Pawson, R. (2013). *The science of evaluation: A realist manifesto* London: Sage.

Various sources of data are used to reflect on the appropriateness and effectiveness of the curriculum and pedagogy. In other words, the interest is in who is 'at risk', in order to gain understanding of what about the curriculum and/or the pedagogy is putting students at risk and what can we do about it?

The CIG Project sets out to address the following specific questions:

1. What are the variables that offer the strongest indicators of students who are most likely to be at risk in their performance on selected CIGs?
2. What complementary role do the National Benchmark Tests (NBT)⁸ scores have to offer:
 - 2.1 What do the NBTs reveal about the relative importance of Mathematics, Academic Literacy (AL) and Quantitative Literacy (QL) sub-domains to students' performance on selected CIGs?
 - 2.2 What is the diagnostic potential of this analysis for assisting academic staff in anticipating student engagement with course resources and aligning the curriculum and pedagogy accordingly?
3. What are the variables that offer the strongest indicators of students who are most likely to be at risk in successfully completing their undergraduate degree, and what is the impact of passing or failing the CIGs on progression towards their degree?
4. What are the students' perspectives on factors that contribute to their risk in these courses, i.e. what do the students themselves have to say about their experience of failing the CIGs?
5. In what ways does current student 'engagement' on the CIGs strengthen or weaken the predictability of the 'risk profiles' identified in 2) above? In particular, what does student engagement with resources of the course (e.g. textbooks and/or lecture recording) tell us about students' potential risk factors?
6. What are the implications of these risk profiles for curriculum review: decisions about appropriate curricula, mechanisms for placement, models of extended curriculum provision, and early assessment, i.e. what particular interventions are needed to reduce the risk students experience in these CIGs?

⁸ National Benchmarks Tests are available to any university applicant. They are measures of university preparedness. They assess in three domains: academic literacy, quantitative literacy, and Mathematics.

Methodology

To better understand the reasons for these high failures the project draws on four sources of data:

- Quantitative analysis of historical course performance
- Qualitative data of students' experience on the courses
- Data on student engagement in the course
- Formal and informal engagements with academics who convene, teach, or have taught these courses, and engagements with departmental leadership

The focus of the project in 2019 has been to develop a way of dealing with the quantitative data. This includes statistical analysis, further data analysis and data visualization.

The first step of the analysis was to produce a list of high-risk courses for the period 2015 to 2017. This was followed by a statistical analysis consisting of correlations using analysis of variance (ANOVAs) of the relationship between a range of variables and CIG course performance. The variables include race, gender, home language, school achievement scores (as measured by the National Senior Certificate (NSC) overall aggregate, as well as aggregates for Mathematics and English) and readiness for university (as measured by National Benchmark Tests (NBTs) for Mathematics, Academic Literacy, and Quantitative Literacy). For analysis purposes, NSC Symbol 7 (80% to 100%) was further disaggregated and is represented below as NSC 7 (80% to 89%) and NSC 8 (90% to 100%).

These two sets of tests provide data for tracking student performance retrospectively (how well learners achieved at school) and prospectively (how prepared are learners for university entry). For ease of reference the NSC will be referred to as 'school achievement' and the NBT as 'university preparedness'.

The quantitative analysis was completed for all the CIG courses (more detail in the course specific sections). The qualitative analysis will be discussed in each of the course specific sections.

Ethical clearance

Ethical clearance for the focus groups with students was awarded by the CHED Research Ethics Committee. The privacy of actual student performance data is confidential and follows the institution's policy guideline.

Overview of findings

In response to the question, "For whom is the curriculum working", i.e. who is not at risk, there is a consistent pattern across all the CIGs irrespective of its disciplinary content. There is a significant difference between those who fail and those who pass on all the selected variables, namely, school achievement, university preparedness, and demographic data. The only exception is gender.

Findings disclose that the CIG courses are working for White, English/Afrikaans home language students who are high performers on school-leaving and university-preparedness test scores. The CIGs are 'not working' for students who are Black, other than English/Afrikaans home language speakers, and with lower school-leaving and university-preparedness test scores. The latter students statistically are at risk of failure by registering for these courses.

From this overall pattern, the project seeks to explore this uniform pattern in more depth for each cluster of CIG courses. Further interpretations and preliminary explanations can be found in the CIG course-specific sections of this report.

General outcomes for 2019

The academic year 2019 saw a renewed project-driven approach to addressing high-risk courses at UCT. The strategy of this project to work directly with each faculty has created a strong sense of ownership of the challenges associated with these courses, as well as a high degree of commitment to finding solutions. Through this undertaking the CIG project team, including the departmental academic staff, have participated in data-informed decision making.

The experience and outcomes of the CIG Project has resulted in proposals for two different sources of additional funding to scale-up this data analytics work. On the data front the project has developed and will continue to refine prototypes for course performance data to assist curriculum review at UCT.

The emerging findings of the project have been disseminated through a number of internal presentations and also included discussions at three conferences⁹.

Way forward and strategies for 2020

The CIG Project will continue to consult with the remaining faculties. Data on the CIGs within the Faculty of EBE and the Faculty of Law has been collected. Co-working with the deputy deans and staff of these faculties will commence in 2020.

There have been discussions with the Faculty of Humanities around the challenges associated with the CIGs in Philosophy. The dialogue will continue in 2020.

The Faculty of Health Sciences does not technically have any CIGs. However, discussion has begun and will continue around courses that impede graduation for certain groups of students.

⁹ Shay, S. The inequality gap: a realist critique. Presented at Society for Research in Higher Education (SRHE) Annual Research Conference in Newport, Wales 11-13 December 2019. Abstract: <https://srhe.ac.uk/arc/19/0105.pdf>

Shay, S. Understanding the gap: A realist investigation. Presented at the Fifth Cambridge Symposium on Knowledge on Education: University of Cambridge, UK. 1-3 July 2019.

Mpofu-Mketwa, T. [From gatekeepers to gateways: the opportunities and challenges of high risk courses](#). Presented at the [USAF National Higher Education Conference](#), Pretoria. 2-4 October 2019.

The CIG Project will follow the curriculum review processes that are underway in the Department of Mathematics & Applied Mathematics, and those in the School of Economics. How these courses address the challenges that comprise a significant proportion of their students' experience will be the decisive measure of the success of the CIG Project.

Appendix A: List of provisional courses prioritized by Faculties

No.	Course Code	Course Title	Already a CIG?
1	ECO1010F	Microeconomics	No
2	ECO1010S	Microeconomics	Yes
3	ECO1011F	Macroeconomics	No
4	ECO1011S	Macroeconomics	Yes
5	ECO1110F	Microeconomics	No
6	ECO1110S	Microeconomics	Yes
7	MAM1000W	Mathematics 1	Yes
8	MAM1005H	Mathematics 1005	Yes
9	MAM1006H	Mathematics 1006	Yes
10	MAM1020F	Mathematics 1A for Engineers	No
11	MAM1021S	Mathematics 1B for Engineers	Yes
12	PBL2000W	Constitutional Law	No
13	PBL2002W	Constitutional Law (Extended Curriculum)	Yes
14	PHI1010S	Ethics	Yes
17	PSY1004F	Intro to Psychology Part 1	No
18	PSY1005S	Intro to Psychology Part 2	No

Appendix B: The CIG project in Mathematics

Introduction

The Courses Impeding Graduation (CIG) project is a research and development initiative of the Centre for Higher Education Development (CHED). The goal of this project is to address the problem of high failure rates in courses that are obstacles to student retention and progression with a particular focus on the experience of black students.

Early conversations with the Science Faculty leadership pointed to Mathematics first year courses as historically high impact/high risk courses. The selected courses are MAM1000W, MAM1005H and MAM1006H (more details provided below).

UCT's selectiveness of top academic school-leaving talent was noted above. This can be illustrated in the Mathematics data. In 2017, out of the approximately 250,000 students who wrote Mathematics, 6727 (2.6%) of those who wrote achieved NSC 7 and above (80-89%). Of the number of Mathematics writers, 1586 (0.6%) achieved NSC 8 and above (above 90%)¹⁰. In 2018, in competition with a small number of other SA universities, UCT recruited and enrolled 30 percent of this national pool of NSC 8 achievers into the Faculties of Science and Engineering and Built Environment (EBE). The key point here is that unlike other elite universities in the developed world, UCT is "fishing in a very small pond". The students enrolling for MAM1000W are the best in the country and the institutional responsibility is to ensure they succeed.

A brief explanation of the overall curriculum structure is necessary (illustrated below in Figure 1). MAM1000W enrolls 600-700 students each year. This course serves Science majors (e.g. Chemistry, Physics, Astrophysics) and a few majors in Commerce (e.g. Actuarial Science, Finance). In addition to meeting the Science faculty admission points, the course requires a minimum of 70 percent on NSC Math (NSC 6). In Week 5 of MAM1000W, all students are tested on the material covered to date.

Based on their performance on this test, plus an overall assessment of other entry scores, those who appear to be 'at risk' in MAM1000W are advised to transfer to the extended curriculum version of the course which runs over two years (MAM1005H and MAM1006H). These courses cover the same content and students write the same examinations. The difference is a slower pace thanks to a longer period available to learn the course content. The latter courses' pedagogical approaches are also different as the classes are smaller (approximately 200 students) and they are taught by Mathematic lecturers who specialize in teaching. Every year between 25 and 30 percent of the MAM1000W cohort are transferred to MAM1005H.

¹⁰ 2017 School Subject Report – Department of Basic Education, p. 8.



Figure 1 First year MAM1000W course structure

All three of these courses are CIGs with an average failure rate of 30 percent in MAM1000W, 40 percent on MAM1005H and 33 percent for MAM1006H¹¹. Thus from its elite pool of students, the MAM suite of courses is failing approximately 35 percent of its students. This raises serious questions about who is being served by this curriculum structure.

Provisional findings

As noted above, the CIG project sets out to address the following specific questions:

1. What are the variables that offer the strongest indicators of which students are most likely to be 'at risk' in their performance on the MAM CIGs?

¹¹ This data is based on the analysis of 2015-2017 cohorts of Mathematics students in MAM1000W, 1005H, 1006H.

MAM1000W

Race	Values	Percent						Grand Total
		<50	50-54	55-59	60-69	70-74	75+	
Black	No.	185	68	45	53	29	40	420
	Row%	44.0%	16.2%	10.7%	12.6%	6.9%	9.5%	100.0%
Coloured	No.	55	19	19	31	9	23	156
	Row%	35.3%	12.2%	12.2%	19.9%	5.8%	14.7%	100.0%
Indian	No.	69	32	15	38	14	31	199
	Row%	34.7%	16.1%	7.5%	19.1%	7.0%	15.6%	100.0%
White	No.	93	45	49	85	44	127	443
	Row%	21.0%	10.2%	11.1%	19.2%	9.9%	28.7%	100.0%
International	No.	52	21	10	31	14	29	157
	Row%	33.1%	13.4%	6.4%	19.7%	8.9%	18.5%	100.0%
Not Applicable / Unknown	No.	40	16	13	20	17	21	127
	Row%	31.5%	12.6%	10.2%	15.7%	13.4%	16.5%	100.0%
Total No.		494	201	151	258	127	271	1502
Total Row%		32.9%	13.4%	10.1%	17.2%	8.5%	18.0%	100.0%

Table 1 MAM1000W course performance by performance band and by race

Almost 33 percent of all students enrolled in this course over the period in question (2015-2017) achieved less than 50 percent, while a further 13,4 percent scored between 50 and 54 percent. While 21 percent of White South African students failed the course, and a further 10,2 percent scored between 50 and 54 percent, 44 percent of Black students failed and a further 16,2 percent scored between 50 and 54 percent. Thus more than 60 percent of Black students enrolled for this course either failed or scored in the low 50% percent range.

What the ANOVAs indicate, as noted above, is a significant relationship between the performance on MAM1000W and all the selected variables except gender. There is a particularly strong relationship between MAM1000W performance and NSC Mathematics and NBT Mathematics.

Group	At Risk Sub-Groups	Trend	F	p	Significant diff between sub-groups?
Demographic	Black	White perform better than all other SA groups; Unknown perform better than Black	16.04292	0.000000	Yes
Gender	None	Male mean higher	0.769199	0.380605	No
Home Language Group	Other SA	English and Other language speakers perform better than all others	13.78672	0.000000	Yes

Group	At Risk Sub-Groups	Trend	F	p	Significant diff between sub-groups?
Home Faculty	Humanities	Commerce outperform Science and Humanities; Science Outperform Humanities	20.22196	0.000000	Yes
ENHN Performance	Symbols 04, 05 and 06	Linear upward trend between symbol 05 and 08	30.78455	0.000000	Yes
ENFN Performance	Symbols 04, 05 and 06	Symbol 07 outperform all others	2.418678	0.049292	No
MTHN Performance	Symbols 05, 06 and 07	Exponential upward trend between symbols 05 and 08	140.9595	0.000000	Yes
NSC Symbol	Symbols 04, 05 and 06	Exponential upward trend between symbols 05 and 08	65.21875	0.000000	Yes
AL Performance	Basic, Intermediate Lower, Intermediate Upper	Proficient outperform all others	13.4743	0.000000	Yes
QL Performance	Basic, Intermediate Lower, Intermediate Upper	Proficient outperform all others	22.89675	0.000000	Yes
NBT MAT Performance	Basic, Intermediate Lower, Intermediate Upper	Proficient outperform all others	56.4561	0.000000	Yes
AL Quartile Performance	Q1 and Q2	Upward linear increase between Q1 and Q4	19.92011	0.000000	Yes
QL Quartile Performance	Q1 and Q2	Upward exponential increase between Q1 and Q4	32.0665	0.000000	Yes
NBT MAT Quartile Performance	Q1, Q2 and Q3	Upward exponential increase between Q1 and Q4	76.41774	0.000000	Yes
AQL Quartile Performance	Q1 and Q2	Upward exponential increase between Q1 and Q4	33.34333	0.000000	Yes
AQL MAT Performance	Q1, Q2 and Q3	Upward exponential increase between Q1 and Q4	48.75906	0.000000	Yes

Table 2 Summary of ANOVAs between course performance on MAM1000W and selected variables

The most notable finding from the ANOVA is the strong relationship between NSC Mathematics symbol (MTHN) and course performance on MAM1000W. Students with Mathematics NSC 8 performed significantly better than those with all other symbols with an average mean score of 64%. Students with Mathematics NSC 7 performed significantly better than those with NSC 5 and 6. The means scores for students with Mathematics NSC 5, 6 and 7 were all in the failure range

(34,3%, 37,3% and 47,6% respectively). There were very few students with Mathematics NSC 5 (15 students), and their performance varies widely around the mean for this sub-group.

What can be seen below in Figure 2 is the ‘cliff’ in performance on MAM1000W between those who achieved NSC 7 and those who achieved NSC 8. The very high failure rate for students with NSC 7 is of particular concern given that this is the most common minimum entry percentage and constitutes approximately one third of the enrolments (for example, the NSC Mathematics requirements for the BCom and BBusSc degrees, other than Actuarial Science and Computer Science majors, is 60%.) This suggests that there is a structural misalignment between the students’ levels of preparedness and the level of academics’ expected requirements.

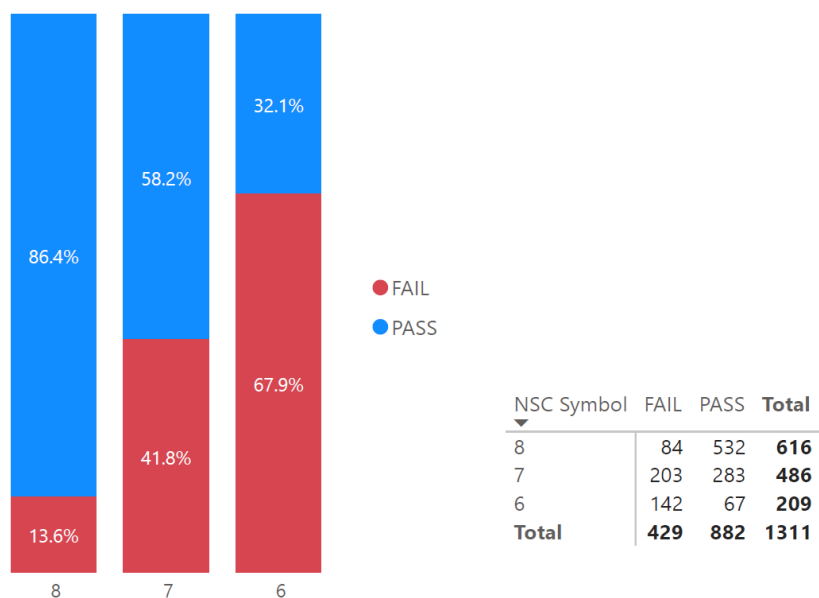


Figure 2 Performance on MAM1000W by NSC MTHN symbol 8, 7, 6

MAM1005H

Race	Values	Percent						Grand Total
		<50	50-54	55-59	60-69	70-74	75+	
Black	No.	157	59	40	47	27	36	366
	Row%	42.9%	16.1%	10.9%	12.8%	7.4%	9.8%	100.0%
Coloured	No.	49	15	9	16	2	4	95
	Row%	51.6%	15.8%	9.5%	16.8%	2.1%	4.2%	100.0%
Indian	No.	23	6	5	9	2	5	50
	Row%	46.0%	12.0%	10.0%	18.0%	4.0%	10.0%	100.0%
White	No.	24	17	12	18	10	15	96
	Row%	25.0%	17.7%	12.5%	18.8%	10.4%	15.6%	100.0%
International	No.	12	2	4	4	1	6	29
	Row%	41.4%	6.9%	13.8%	13.8%	3.4%	20.7%	100.0%
Not Applicable / Unknown	No.	13	8	4	8	4	12	49
	Row%	26.5%	16.3%	8.2%	16.3%	8.2%	24.5%	100.0%
Total	No.	278	107	74	102	46	78	685
	Row%	40.6%	15.6%	10.8%	14.9%	6.7%	11.4%	100.0%

Table 3 MAM1005H course performance by band and by race

More than 40 percent of all students enrolled in this course over the period in question achieved less than 50 percent, while a further 15,6 percent scored between 50 and 54 percent. While 25 percent of White students failed the course, and a further 17,7 percent scored between 50 and 54 percent, 42,9 percent of Black students failed and a further 16,1 percent scored between 50 and percent. Thus, 59 percent of Black students enrolled for this course either failed or scored in the low 50 percent range. 67,4 percent of Coloured students and 48 percent of Indian students either failed this course and 48 percent of Indian students either failed this course or achieved a result in the lower third band (50-54%).

Group	At Risk Sub-Groups	Trend	F	p	Significant diff between sub-groups?
Demographic	Black, coloured, Indian	Unknown perform better than all other groups	5.918835	0.000023	Yes
Gender	None	Male mean slightly higher	0.039728	0.842072	No
Home Language Group	English, Afrikaans, Other SA	Other language speakers perform better	0.172871	0.952294	No
Home Faculty	Humanities, Science	Commerce outperform Science and Humanities; Science Outperform Humanities	10.49239	0.000032	Yes
ENHN Performance	Symbols 04 and 06	Exponential upward trend between symbol 06 and 08	1.215706	0.303601	No
ENFN Performance	Symbols 04 to 07	No trend	1.180391	0.319787	No
MTHN Performance	Symbols 05 and 06	Linear upward trend between symbols 05 and 08	23.61537	0.000000	Yes

Group	At Risk Sub-Groups	Trend	F	p	Significant diff between sub-groups?
NSC Symbol	Symbols 04, 05 and 06	Exponential upward trend between symbols 05 and 08	8.356495	0.000000	Yes
AL Performance	Intermediate Lower, Intermediate Upper, Proficient	Exponential downward trend between Basic and Proficient	0.466274	0.705970	No
QL Performance	All	Linear upward trend between Intermediate Lower and Proficient	0.819253	0.482771	No
NBT MAT Performance	Basic, Intermediate Lower, Intermediate Upper	Linear upward trend between Intermediate Lower and Proficient	4.127472	0.006688	Yes
AL Quartile Performance	All	Proficient outperform all others	0.480563	0.695973	No
QL Quartile Performance	Q1, Q2 and Q3	Proficient outperform all others	1.470746	0.229194	No
NBT MAT Quartile Performance	Q1, Q2 and Q3	Upward linear increase between Q2 and Q4	5.321209	0.001320	Yes
AQL Quartile Performance	All	Slight upward linear increase between Q1 and Q4	0.27478	0.845968	No
AQL MAT Performance	All	Near linear upward increase between Q1 and Q4 but odd dip in Q2 performance	0.27478	0.845968	No

Table 4 Summary of ANOVAs between course performance on MAM1005H and selected variables

As with MAM1000W, the relationship between NSC Mathematics and performance on MAM1005H is strong. Students with Mathematics NSC 8 and 7 performed significantly better than those with all other symbols with mean scores of 59 percent and 54 percent respectively. This would suggest that students with a Mathematics NSC 7 are performing better than counterparts of the same symbol in MAM1000W, who are ‘at risk’. This would suggest that the slower pace of MAM1005H is perhaps a more enabling environment for Mathematics NSC 7 students (though the overall failure rate of the course is not good). Mathematics NSC 6 students (which constitute nearly 50 percent of the course enrolment) are not being well served by this course.

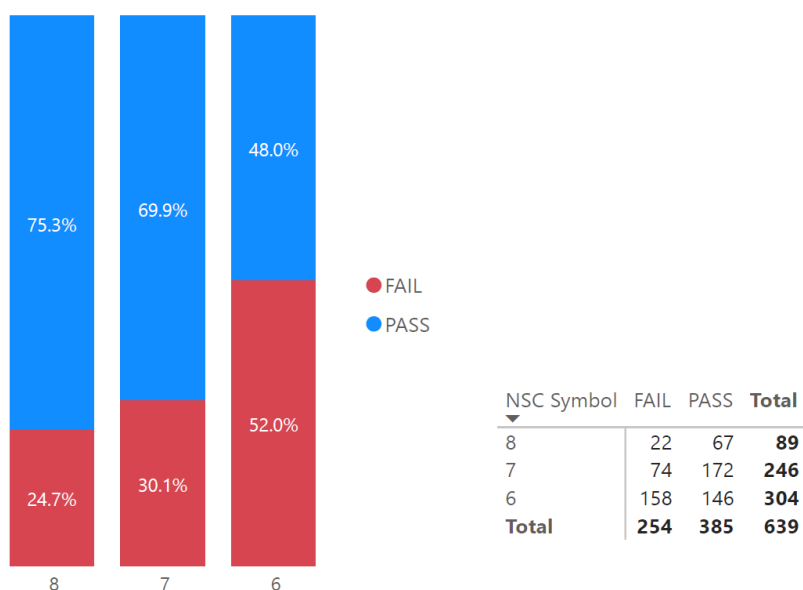


Figure 3 Performance on MAM1005H 2015-2017 by NSC aggregate 8, 7, 6

MAM1006H

Race	Values	Percent						Grand Total
		<50	50-54	55-59	60-69	70-74	75+	
Black	No.	108	45	29	44	28	48	302
	Row%	35.8%	14.9%	9.6%	14.6%	9.3%	15.9%	100.0%
Coloured	No.	20	11	7	13	4	13	68
	Row%	29.4%	16.2%	10.3%	19.1%	5.9%	19.1%	100.0%
Indian	No.	16	6	4	5	4	14	49
	Row%	32.7%	12.2%	8.2%	10.2%	8.2%	28.6%	100.0%
White	No.	31	20	10	20	6	8	95
	Row%	32.6%	21.1%	10.5%	21.1%	6.3%	8.4%	100.0%
International	No.	15	5	5	15	2	2	44
	Row%	34.1%	11.4%	11.4%	34.1%	4.5%	4.5%	100.0%
Not Applicable / Unknown	No.	3	3	3	5	4	6	24
	Row%	12.5%	12.5%	12.5%	20.8%	16.7%	25.0%	100.0%
Total	No.	193	90	58	102	48	91	582
	Row%	33.16%	15.46%	9.97%	17.53%	8.25%	15.64%	100.00%

Table 5 MAM1006H course performance by band and by race

Successful completion of MAM1005H is a prerequisite for MAM1006H. More than 33 percent of all students enrolled in this course over the period in question achieved less than 50 percent, while a further 15,5 percent scored between 50 and 54 percent. While 33 percent of White students failed the course, and a further 21 percent scored between 50 and 54 percent, 36 percent of Black students failed and a further 15 percent scored between 50 and 54 percent. Thus 51 percent of Black students enrolled for this course either failed or scored in the low 50 percent range. 45 percent of Coloured students and 45 percent of Indian students either failed this course or achieved a result in the lower third band (50-54%).

Group	At Risk Sub-Groups	Trend	F	p	Significant diff between sub-groups?
Demographic	None	Unknown perform better than all other groups	1.405614	0.220366	No
Gender	None	Female mean higher	9.132448	0.002622	Yes
Home Language Group	None	No clear trend	0.472755	0.755762	No
Home Faculty	Science	Commerce outperform Humanities and Science	> 37.72578	0.000000	Yes
ENHN Performance	Symbol 04	No clear trend	3.775268	0.005161	Yes
ENFN Performance	Symbols 04 to 07	No trend	1.083381	0.365691	No
MTHN Performance	Symbols 05 and 06	Linear upward trend between symbols 06 and 08	22.29465	0.000000	Yes
NSC Symbol	Symbols 05 and 06	Linear upward trend between symbols 05 and 08	> 24.45184	0.000000	Yes
AL Performance	Basic, Intermediate lower	No clear trend	2.098354	0.100986	No
QL Performance	Basic, Intermediate lower	No clear trend	1.71193	0.165074	No
NBT MAT Performance	Basic, Intermediate Lower	Proficient outperform all others	4.735644	0.003142	Yes
AL Quartile Performance	Q1	No clear trend	0.691242	0.558157	No
QL Quartile Performance	Q1, Q3 and Q4	No clear trend	2.143153	0.095339	No
NBT MAT Quartile Performance	Q1 and Q2	Upward exponential increase between Q1 and Q4	7.13434	0.000131	Yes
AQL Quartile Performance	Q1, Q3 and Q4	No clear trend	2.20296	0.087821	No
AQL MAT Performance	Q1, Q2 and Q3	Q4 outperform all other	1.99048	0.115914	No

Table 6 Summary of ANOVAs between course performance on MAM1006H and selected variables

Students with Mathematics NSC 8 and 07 performed significantly better than those with all other symbols with mean scores of 58 percent and 53 percent respectively. This would suggest that students with a Mathematics symbol 7 are performing better than their counterparts with the same symbol in MAM1000W who are ‘at risk’. This would suggest that the slower pace of the

MAM1006H is perhaps a more enabling environment for Mathematics symbol 7 students. Mathematics symbol 6 students (which constitute nearly 40 percent of the course enrolment are not being well served by this course). There are two other strong relationships:

- Students with overall aggregates of NSC 7 and 8 are performing better than those with lower aggregates.
- Students’ home faculty: Science students are more ‘at risk’ than Commerce students.

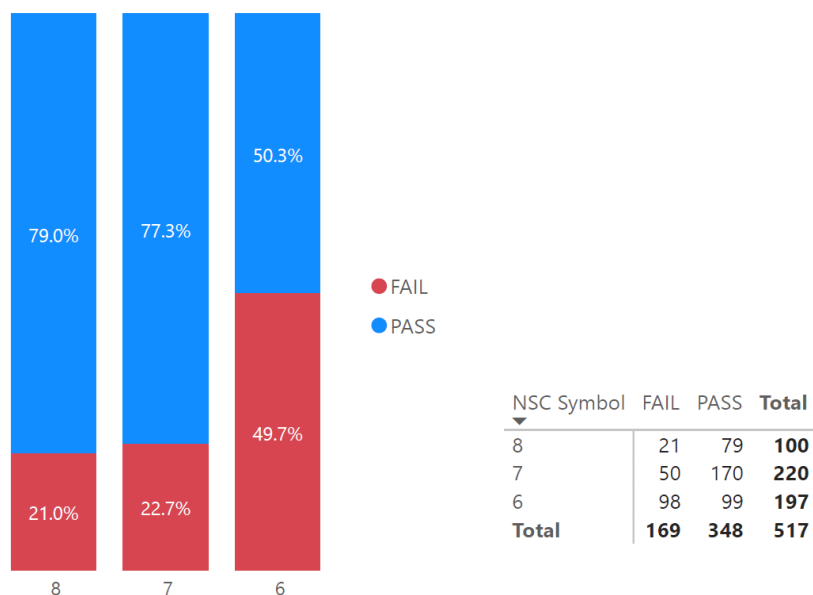


Figure 4 Performance on MAM1006H 2015-2017 by NSC aggregate

2. What complementary role do the National Benchmark Tests (NBT) scores have to offer:

- 2.1 What do the NBTs reveal about the relative importance of Mathematics, Academic Literacy (AL) and Quantitative Literacy (QL) sub-domains to students’ performance on selected CIGs?
- 2.2 What is the diagnostic potential of this analysis for assisting academic staff in anticipating student engagement with course resources and aligning the curriculum and pedagogy accordingly?

The ANOVAs show a strong relationship between the NBT scores and CIG performance for the MAM CIGs.

Two further NBT analyses are then conducted: the first is the MAM1000W cohort by NBT benchmark where 66.57 percent are Proficient in NBT Mathematics. But given the ‘cliff’ in performance the overall cohort performance is disaggregated by NSC Mathematics 7 and 8. Of those who came in with NSC Mathematics symbol 8, 92.8 percent are Proficient and the rest are Lower or Upper Intermediate.

These results stand in contrast to those who came in with NSC 7, where 55.3 percent of them are Proficient and 44 percent of them are Intermediate (lower and upper) which means they will need some form of assistance.

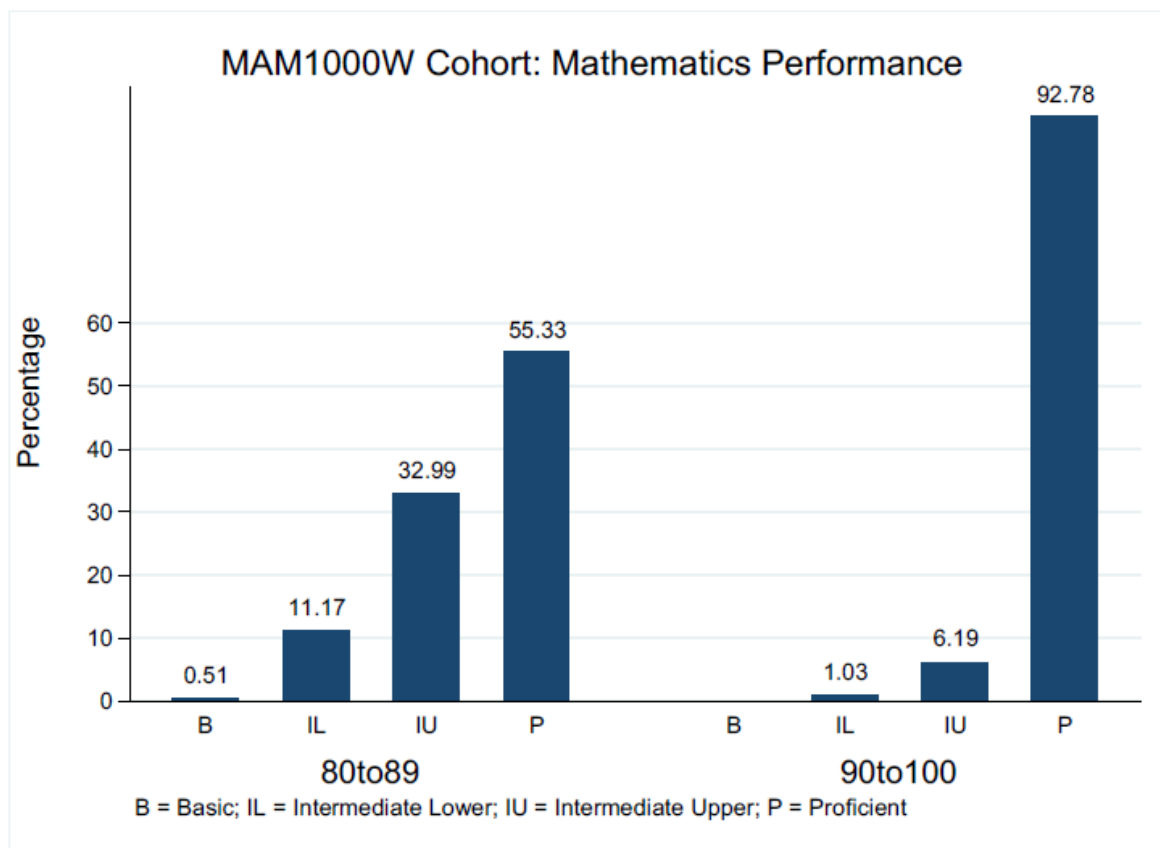


Figure 5 MAM1000W Cohort: NBT Mathematics Performance by NSC symbol

The second analysis looks at the relative importance of NBT Subdomains on predicting course performance on MAM1000W, MAM1005H, MAM1006H. This relative importance analysis was conducted for the overall cohort and then by performance band on the course. For the overall cohort, the relative importance for the different domains is Mathematics, then QL and then AL (in that order). The lower the band scores on the CIG performance, the more Academic Literacy sub-domain increases in relative importance.

Informed by existing research¹², we speculate that academic literacy skills in English (the official Language of Learning and Teaching at UCT) are the primary obstacles for students with weaker performance. The meaning of this ‘relative importance’ of these sub-domains in relation to the language demands of university mathematics will be the subject of further investigation.

¹² Prediger, S., Erath, K. & Moser Opitz, E. (2019). The language dimension of mathematical difficulties. In A.Fritz, V. Haase, P. Räsänen (Eds.), *International Handbook of math learning difficulties: From the laboratory to the classroom* (pp. 437–455). Cham: Springer. doi.org/10.1007/978-3-319-97148-3

3. What are the variables that offer the strongest indicators of which students are most likely to be ‘at risk’ in successfully completing their undergraduate degree, i.e., what if the impact of passing or failing CIG courses on progression towards their degree?

Analysis of the data (see figure 6 below) shows that for those students enrolled between the years of 2010-2014 who pass MAM1000W, 84.4 percent of them qualify, and 4.8 percent are excluded. ‘Other’ refers to students still continuing or have dropped out in good academic standing. For those who fail MAM1000W, 40.2 percent qualify and 35.2 percent are academically excluded. There are many factors that play into student exclusion; thus, this is in no way to suggest that MAM1000W alone plays a role. It points to a strong relationship between failing MAM1000W and exclusion from degree studies.

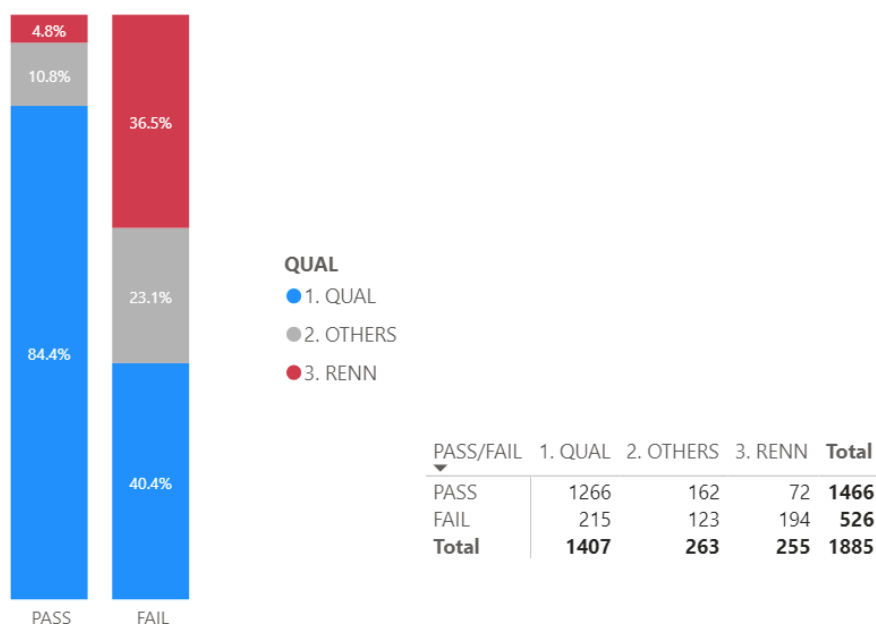


Figure 6 MAM1000W 2010 - 2014 by Degree performance

4. What are students’ perspectives on factors that contribute to their risk in this course? What do the students themselves have to say about their experience of failing the CIGs?

Focus groups were conducted with MAM1000W students as part of the CIG project. Twenty-three students participated, divided into three groups. The first group comprised students who passed MAM1000W despite the quantitative predictions of their ‘at risk’ status. These we refer to as SUCCEEDERS. The second group comprised students who failed MAM1000W in 2018 and repeated the course in 2019, referred to as REPEATERS. The third group comprised students who failed MAM1000W in 2018 and changed to other programmes or Mathematics courses, referred to as CHANGERS.

The aim of the focus groups was to elicit students' views of:

- their degree of preparedness from high school,
- experiences of Mathematics at UCT,
- MAM1000W resources,
- how student utilised their resources and made decisions about improving their grades in MAM1000W.

It was crucial to ascertain the interplay of structure (institutional opportunities and constraints) and agency in influencing student's success or failure in Mathematics at UCT. To this end, the analysis of the focus groups pays particular attention to how institutional structures like high schools, families, the Department of Mathematics and Applied Mathematics and other departments provided resources that either enabled or dis-abled students and how students themselves exercised their own agency in making decisions around their learning and the utilisation of resources. These themes are explored in Appendix C below.

5. In what ways does current student 'engagement' on the CIGs strengthen or weaken the predictability of the 'risk profiles' identified in 2) above? In particular, what does student engagement with resources of the course (e.g., textbook, lecture recording) tell us about students' potential risk?

It is too early to answer this question. The CIG project commissioned a predictive model analysis from the Statistical Consulting Service of UCT's Department of Statistical Sciences. This modelling included various variables measuring in-course 'student engagement' such as tests, and views of lecture recording. The view of the CIG project is that there is still too much 'noise' in the system for using student engagement data meaningfully as a risk predictor. The inclusion of student engagement will be a focus of 2020.

6. What are the implications of these 'risk profiles' (including for curriculum review: decisions about appropriate curriculum, mechanisms for placement, models of extended curriculum provision, and early assessment?)

Two key questions are relevant to consider of future curriculum review:

- What (starting and ending) level of Mathematics is appropriate?
- What purpose does the Mathematics serve?

Firstly, "What level of Mathematics is appropriate?"

For some time, the convener of the extended courses has been arguing that the threshold in the transfer test for remaining in MAM1000W rather than transferring to MAM1005H is set too low. In other words, more students need more support than those who are currently being transferred.

He also acknowledged problems in the actual course. Even though the extended model gives students double the time, the content covered is precisely the same as that of MAM1000W. The data would suggest that those who enter with NSC Mathematics 8 (about half) are relatively well prepared but those with NSC Mathematics 7 are not prepared (this indication is supported by the students' accounts). The first challenge is to address is the articulation gap between the course and the preparedness of a significant proportion of the class.

The second question is “What purpose does the Mathematics serve?”

Several years prior to the CIG project, the Department of Computer Science approached the Department of Mathematics and Applied Mathematics with a proposal to run a separate MAM course for Computer Science majors. The reason for this was a sense that there was not a good alignment between the mathematics that Computer Science students need and what MAM1000W currently offers.

Following this request, a new course MAM1008S was created (to follow a first semester MAM course – MAM1004F – largely for non-Mathematics major). This course appears to have been successful from the point of view of the pass rate (90%), the experience of the lecturer and the student course evaluations which were overwhelmingly positive. This has however raised concerns from some in Computer Science. While they are supportive of the new course, they are concerned that MAM1008S (which does not lead to MAM2000W) will not provide a solid enough mathematical foundation for students who want to specialize, for example, in Artificial Intelligence.

Outcomes for 2019

The outcomes of the MAM CIG project are positive largely as a result of the commitment of the first year Mathematics team, on the one hand, and the support of the Head of Department. A small team of Mathematics staff are committed in 2020 to reviewing the curriculum of the three CIGs to respond to issues of level and purpose, among other questions. Drawing on other innovative practices in the teaching of Mathematics will form part of the review. There has also been the formation of a research and development project to investigate the role of language in Mathematics concept development, using the CIG courses as a research base.

Science Faculty participants

Prof Peter Dunsby (Head of Department)

Dr Jonathan Shock (course convener)

Dr Claire Blackman (Lecturer in Mathematics)

A/Prof Bob Osano (head of Extended Degree Programme in Science)

Dr Ruan Moolman (Lecturer in Mathematics)

Dr Patrick Adams (Lecturer in Mathematics)

Appendix C: MAM1000W Focus Groups

We have included a full report on students' views as their perspectives are vital to the way forward.

Background

The focus groups were a part of a larger project on courses identified as impeding progression to graduation at UCT. Twenty-three students participated in focus groups comprising of students who passed MAM1000W despite identified risk factors (succeeders), students who failed MAM1000W in 2018 and repeated the course in 2019 (repeaters) and students who failed MAM1000W in 2018 and changed to other programmes or Mathematics courses (changers). The aim of the focus groups was to elicit students' views of (1) their degree of preparedness for Mathematics from high school (2) experiences of Mathematics at UCT (3) MAM1000W resources and (4) how they utilised their resources and made decisions about improving their grades in MAM1000W.

The discussion below elucidates each of the themes in greater detail. It was crucial to ascertain the interplay of structure (institutional opportunities and constraints) and agency in influencing students' success or failure in Mathematics at UCT. To this end, the discussion pays particular attention to how institutional structures like high schools, families, the Department of Mathematics and Applied Mathematics and other departments provided resources that either enabled or disabled students and how students themselves exercised their own agency in making decisions around their learning and utilising resources.

Degree of preparedness from high school

Schooling support

Students from all focus groups described their high schools as mostly supportive and having provided them with sufficient preparedness for passing their Matric Mathematics but not necessarily for coping with MAM1000W. Institutional support structures offered by schools, teachers and peers went a long way in preparing students well in their foundational stages of learning Mathematics. Teachers played a crucial role in fostering students' understanding of core mathematical concepts, exam preparation, good learning strategies and high standards that helped them to prepare for university Mathematics. For example, when narrating how teachers' teaching methods prepared them well, one student elaborated:

Yah, well, my teacher was general in teaching content. He wasn't actually concentrating on the paper. The knowledge that he gave you was that, "you would know what's going on" in all the areas you were taught. Because with the help of past papers as well, you know that, "Ah man, Maths was fine" ... He was actually going around in general, in depth of Maths... It was a good approach because even when we came to Varsity, you would recognise all the things that we were doing in MAM1000. (Participant 4, Repeaters focus group 1).

From the citation above, one can deduce the student's appreciation of a pedagogical approach that taught in-depth understanding of content material that went beyond answering exam question

papers. From the student's perspective, although past exam papers were crucial to learning and exam preparation, it was by no means the only important part. By alluding to the ability to recognise things that they were doing in high school and link them to MAM1000W, the student demonstrates the importance of understanding key concepts rather than simply calculating answers, as in-depth knowledge led to longer-term understanding and application. This teaching approach can be distinguished from one that focuses superficially and relies too heavily on past exam papers as reflected in the following students' comments:

I think also with that point, is that in high school, they taught us how to write exams and tests and university they don't do that. It's that they're teaching us these concepts and you have to be able to apply a concept and that's why a lot of us kind of were, like shook a bit because we were like, "oh we've never seen this before" ... You must just know the work so well that we must be able to apply it. And I was doing the same amount of past papers.... Because if you don't fully understand the concept then you won't know how to answer the question. That learning the steps isn't learning the Maths of it all (Participant 1 Repeaters Focus Group 1).

Thus, teachers' pedagogical approaches influenced the degree of students' preparedness for better or worse. Some students reported that their teachers taught them Mathematics that were for a grade above their grade pushing them to do more challenging Mathematics thus setting higher standards for their students (Participant 2 Repeaters Focus Group; Participant 1 Repeaters Focus Group).

In addition to practising past exam papers and teaching methods, some students stated that their teachers prepared them through competitive empowerment initiatives such as the Olympiads and other supportive programmes that sought to bolster their mathematical aptitudes. The citation below demonstrates the extent to which some schools went in preparing their students.

Like our teacher really did well by preparing us for our Matric exams. And of course it also showed on our like, Matric results that we went into the final exams being like well prepared. So, the four of us in here we all got like distinctions in Maths and not just like any distinctions, but those top marks. And you know we even went to the point of some of us participated in Maths Olympiads and even went to final half and all of that. So, I feel that my teacher specifically did what she was supposed to do and prepared me for life. And even Varsity Maths.... (Participant 1 Repeaters focus group1)

Although there were variations in the degree to which different schools and teachers prepared their students, by and large common narratives related some degree of preparation. Another distinctive way in which some schools prepared their students was in the form of the curriculum. Students whose schools offered Cambridge As level, A level and AP Mathematics reported that they were better prepared for varsity Mathematics and MAM1000W in particular as indicated in the students comments below:

Yes, it [doing AP Maths] did [help] because...I started doing AP Maths in grade 10.... So, when I was in grade 10, I was doing grade 11 Matric Maths. And going into grade 11, it was, rather we were doing grade 12 and possibly even University Maths and while in Matric I was already touching base on some University Maths. So, when I did get to University, I had a solid foundation because a lot of the things that they were teaching in MAM1000 I was familiar with starting out, so that was why I felt I did do okay in the first semester, because I had at that phase, I had that support (Participant 1 Repeaters focus group 1)

Evidently, doing AP Mathematics laid a solid foundation in helping student to transition from high school Mathematics to Varsity Mathematics as echoed in the student's sentiments who echoed the sentiments of other students who also did a curriculum other than the mainstream South African CAPS curriculum.

However, it was evident from the focus group discussions that students who did AP Mathematics or the Cambridge Curriculum, only had limited advantages such as doing familiar Mathematics concepts only in the first semester. When students moved into the second semester, they struggled as much as those students who did not do AP Mathematics or A level Mathematics. For example, the student cited above reported how his sense of support and familiarity with work wavered in the second semester by stating that:

But it was when the second semester came around I didn't have that support anymore and I couldn't just get by on not studying or the same sort of high school methods that I had where I ... in as much as I did have my notes and my past papers, that was all I did, notes and past papers... There was more and also MAM1000 at some point did go beyond what I knew, and it was at that point that it was all done (Participant 1 Repeaters focus group 1).

Clearly, despite having been prepared well for first semester, in second semester there was now a need to shift study methods and studying beyond what the student knew. This also suggests the inadequacies of some study methods employed by students in high school in relation to those required for university mathematics. In addition, some students who did Cambridge Mathematics reported that while the curriculum prepared them to work on some of the Mathematical problems, there were differences in concept application which worked against them. For example, a student who did his A level in Tanzania reported that in the beginning most of the MAM1000W was repetitive to what he did in A level. However, he reported the need to shift learning strategies by reporting:

Then the difference is that, while I could do most of the questions, because I've done it already. The concepts, the way they went about the concepts was different. So, and the thing is, I already studied this stuff. So, I had this mind set of how I was taught, so to shift that and you can just begin and start from scratch and have those ways of thinking and that came to bite me back in the arse. Because some questions I could do because I knew how, but the way of thinking, the concepts was different (Participant 6 Repeaters Focus group 1).

This finding suggests the limitations inherent in the high school curriculum in relation to preparation for MAM1000W. A student who passed MAM1000W without having done AP Mathematics put the limited benefits of doing AP Mathematics in perspective when he commented:

I remember how I used to carry on about first year students who had done AP Maths. I was like, "Oh, you did advanced programme Maths?" it's going to be tough. I realised that, when we started doing MAM1000W it gets to the best of us all, all of us (Participant 3 Succeeders).

Needless to say, AP Mathematics and A level Mathematics provided relative support and preparedness. It appears that while the high school Mathematics curriculum has substantial influence on student preparedness for varsity Mathematics, the curriculum needs to be supplemented with continuous effort and developing new study habits and learning strategies that suit the MAM1000W academic demands better.

Not to be underestimated in student preparation for university Mathematics is the role of peer support and student mentorship. Peers helped students by providing mutual support and encouragement to work hard and clarifying difficult Mathematics problems. The sentiments below reflect the crucial role played by peer support in helping students academically.

.. One of my best friends and I, we did the exact same subjects in high school, so we would always study together. And Maths was also something that we would like, "okay I don't understand this question, please explain how you think about", and then I'll explain how I think about it, and then... like that peer support as well. Because sometimes it's like, you know when you're in high school there was always that kid that got 100% in everything. So sometimes a teacher can't explain to you properly, so you go to them and then you say, okay what's happening, and they explain (Participant 1 Changers Focus Group 1).

In addition to peers, there were teachers who served as role models and mentors. They helped nurture the love for Mathematics, motivated students to set high Mathematics related career goals or provided relevant information and advice regarding subject and career choices.

With me, there's this girl from Venda, her mum and my mom are actually friends. She's also in her final year in Act Sci, and she was performing well. She was the inspiration because she never did the AP Maths in high school. So I was like, 'umm, if she is studying it, maybe I can'. I guess she was the role model, and she still is, even though I'm no longer doing MAM1000 or doing Act Sci. So I think that's the only role model I have (Participant 3 Changers Focus Group).

Role models thus go a long way in influencing and preparing students for their academic careers.

In addition, some students cited their families as also playing a significant role in helping them shape their Mathematics career goals. Prior to entering university, families played a crucial role in facilitating and influencing students' decision-making processes around choice of curriculum, schools, and support in academic endeavours. Although focus group participants were fairly

homogenous in terms of class as there were mostly black participants, some students conformed to middle class status and had better privileges compared to their counterparts. The former students enjoyed privileges of attending well-resourced schools, schools with a better curriculum and schools that oriented them to university through open days, access to information or other support mechanisms (Participant 3 Repeaters Focus Group; Participant 1 Repeaters Focus Group; Participant 2 Changers Group). One participant for example explained how her mother who was a teacher helped her to access resources by stating:

So I can say that, like most of the things I was self-taught. I was kind of on the privileged side because my mom is a teacher and I could afford like checking up things online. I could afford having study guides. I mean I used... I forgot this other thing with study guides like its red and it has black dots and white and red dots (Participant 3 Changers Group).

Evidently the student's mother and status as a teacher played an influential role in her high school preparedness. In some instances, familial influence on decision making pertaining to school choices was also evident. For example, one student narrated how she had to move from an international school to a Catholic school because her marks were deteriorating in the former school which was also more liberal than the latter.

So I had recently gone to Umtata International High School and then I went to Holy Cross. It was a totally different schools. In the Eastern Cape. So the other one is really Catholic, the one that I ended up going to eventually...it was like strict and yes... And the other was like freedom and, yah, so it was chilled and that.... And I had to like really focus and my mom was really paying a lot of money for me to be here because, yes, the school was really expensive and stuff, so, yah. And anyway, okay, so I went to the school and I met the teachers there. Like they were really nice and especially my Maths teacher (Participant 2 Changers Group).

The family thus played a crucial role in facilitating the decision to change schools, a decision that was critical in this instance as it influenced the successful completion of Matric. The nuclear family was not the only influential role player for learners' preparedness. In some African familial and cultural contexts, the concept of a family is defined in very broad terms such that extended family members including neighbours and family friends are considered family and they sometimes play a supportive role (see Ramphela, 1989; Wilson & Mafeje, 1963; Spiegel et al., 1996). One student related how a neighbour who was also a family friend that he perceived as a brother influenced his Mathematics trajectory significantly:

Fortunately, now there was a guy, from my township he was like in my neighbourhood, so our families were close in that we were more like sibling and stuff. So I looked up to him as my older brother. He was doing grade 11 when I was doing grade 8.... After school, I would go to him for extra classes I would even skip cooking at home and go to sit with him doing everything with him. So I think that guy really impacted most of my learning because it's like I had someone to always ask something.... And then my results picked up and I started doing well in Maths (Participant 1, Succeeders Group).

The brotherly support rendered to the above student went beyond just academic support but rather to other important life skills like developing the ability to be an independent learner, crucial in university and also access to internet as a resource as reflected in the student 's further comments:

He introduced me to the internet so that with internet there were more answers. It clearly expanded my knowledge When I got to grade 10 he left the town. So I like started to be independent again. And then like he also introduced me to how to find answers and solutions because I also know at that time how to use google on the internet so it was easier for me (Participant 1, Succeeders Group).

This evidence shows that the learning process is embedded within familial and cultural contexts which when channelled in positive ways can play a crucial role in transforming circumstances. Thus structures in which students operate are pivotal in influencing success.

Access to better resources was however did not always translate into achievements in MAM1000W as some of the students with better resources had to repeat the course and others changed. Participants in the Succeeders groups demonstrated this evidence as all participants in succeeders group 2 went to public township schools that prepared them well for their Matric through supportive interventions like Mathematics and Physics workshops and they also applied themselves diligently and passed both Matric Mathematics and MAM1000W from a CAPS curriculum (Participant 1, Participant 2, Participant 3 Succeeders Group 2; Participant 2 Succeeders group 2). This evidence points to the important role of individual agency in rising above constraints. Succeeders Group 1 also had similar experiences of attending under resourced schools but still managed to beat the odds and succeeded in both Matric and MAM1000W (Participant 1, Participant 3 Succeeders Group 2). Thus students drew support from people in their social milieu who provided the needed preparation for varsity and laid the necessary foundation for their careers in Mathematics. This confirms the notion of systems perspective in understanding students' opportunities and constraints that is crucial for intervention targets.

High school deficiencies

The section above reported on how most students narrated the support derived from their schools, teachers, and other support systems. Nonetheless, there were also a few students who reported that their schools were dysfunctional with respect to teachers' teaching methods, school leadership, inadequate teaching staff and other factors that limited their degree of preparedness. For example, one student reported that he did not have a Mathematics teacher at his high school and he had to rely on a teacher from a nearby school for support. The student reported how he studied Mathematics in high school in the following way:

So, we were assisted by another teacher. So we used to revise a lot according to WhatsApp calls since he was not from our school. He would just come in the morning and all. So when we didn't have time to print and all so we just send him the problems and our solutions via WhatsApp... It wasn't our teacher, it was a teacher from another school. Because we didn't have a Maths teacher. Our Maths teacher left at the beginning of the year... We never wrote Maths tests and in Matric we never wrote exams because there was no teacher (Participant 5 Repeaters Focus group 1).

Clearly, the above student's high school preparation was fraught with deficiencies as he stated that in his school they learnt via WhatsApp and never wrote tests or exams. Learning this way is likely to have a negative impact on students' success in transitioning to university Mathematics. Some students reported that they would have loved their schools to prepare them for university through open days so that they got a glimpse of what university was like before coming to university. Others needed preparation and warnings about the degree of academic demands and the required adaptations to the new learning environments. Evidence from the student below echoed other students' sentiments about lack of preparedness:

It [the high school] didn't. It prepared us for exams. I feel like my school prepared us for exams and not beyond the exam. Because it was just we came here to pass exams. And we never got to go to any open days, or anything, we never had Varsity talks. It was just exam, exam, and exam. Even when they were teaching, they never gave us a hint of what University would be like. Cape Town Universities and stuff (Participant 3 Changers Focus Group 1).

In addition, students complained about not being prepared for the broader university life in relation to adapting to different cultures, new learning approaches and how to negotiate their freedom and independence in a balanced way. One student narrated:

... like just being told or like being introduced that when you go to Varsity, you gonna be independent like a bit of," everything there goes differently. You going to be exposed to like into other cultures and differences and all the different things. I think it would have been better preparation for me to know. So I didn't even know what to expect. I'm like," okay I'm just going to varsity, I'm going to do my courses, I'm going to pass, and everything has to just go my way" (Participant 2 Changers Focus Group 1).

No doubt, a certain degree of preparing students about the broader university context is necessary to help students transition from high school to university. Similarly, some students needed relevant information regarding choosing subjects relevant to their careers in Mathematics and such information was not always available or when rendered it was not timely. A student explained how her teacher advised her accordingly to take AP Mathematics in preparation for her Actuarial Science degree, however when the teacher gave that information, it was rather late as indicated:

... When he [the Maths teacher] suggested it he said, take AP Maths if you want to be an actuary. But by the time we had had that conversation I was already halfway through Grade 11. So then it was going to be catching up a year and a bit of AP Maths. So it was already too late and then I said no, it's too late now. So rather just carry on with Maths (Participant 1 Changers Focus Group 1).

More timely advice would have helped the student to make informed decisions that could have helped her in preparing for her career in Actuarial Science. Linked to advice about choice of subjects relevant for degree programmes, some students especially in the Changers focus group reported how the wrong advice they got from registration and curriculum advisers at UCT impacted negatively on their academic career. According to the students, they were led to register for MAM1000W under mistaken assumptions of students' majors. Advisers assumed that all students should take more than one major and imposed additional majors that students did not initially intend to take thereby forcing them to register for MAM1000W when they were under prepared. The students related this experience by stating:

They don't tell you all your options that you have when you come to university. And I think that is so important because I've seen people break down. I've seen people drop out because... So they [advisers] also made me do Mathematical Stats because they have an idea that people who are doing Analytics want to do Act Sci but that's not what it is. And so they made me do Mathematical Stats first and I wasn't doing well in that and then I changed to Applied Stats. But first I had to go through Mathematical Stats to then... Like they wasted my time, basically. And I wish they would be more informative as to what you're getting yourself into (Participant 1 Changers).

For first year students coming to university and being overwhelmed with the number of courses, it is indeed important to inform students well rather than assuming that all students need more than one major or other programmes or courses as such misinformation has long-term implications for students' academic success. In some cases, students reported that they were not informed about the alternative Mathematics courses as reflected below:

That what they told me. So I did not know that there was another option of doing 1004. So like you have to do MAM1000. Oh, I am like "Okay these are my majors that I have chosen", she just writes down the course that you're going to do. She doesn't even ask you what, what, which one would you like. You're like, "what?" And then you get to your room you're like, oh, I'm doing MAM1000 (Participant 2 Changers Focus Group)

Another student lamented

It was last year after first semester but that was too late to register for 1010 because 1010 is a first-semester course.... Because now we were in our Mathematical Statistics class and then Tim who was our lecturer is also an adviser and then he started speaking about it. So the previous advisers hadn't mentioned it but now he said that option. And then most of the Analytics kids were like, "yah, I'm going there..." Because if you look at it like a lot of Analytics kids failed Maths. A lot. Because the combination of Stats, Maths, Comp Sci and Commerce courses is hell. I can't. It's a lot (Participant 1 Changers Focus Group).

From the above comments it is clear that some of the failures in MAM1000W can be attributed to lack of preparedness caused by being ill informed about course options relevant to degree programmes or inadequate registration advice. Preparedness therefore needs to take place both at high school level and at UCT orientation and registration.

Students' perceptions of resources and support in MAM1000W

As part of understanding impediments to graduation, it was crucial to explore students' appraisals of the resources and support mechanisms in MAM1000W. Because resources and support systems in the Department of Mathematics and Applied Mathematics are essential components of structures that influence student achievements, it is important to ascertain the degree to which they enable or disable achievements for intervention purposes. From the data, students appraised their resources along a spectrum ranging from positive appraisals to negative appraisal in some areas that they deem as necessary to improve. The middle range of the spectrum pertained to resources that students perceived as useful but needed students to utilise more effectively if they were to get optimum results from them. In this section attention is drawn to positive appraisals of resources and support systems, resources that need improvement and how students can use some resources more effectively.

Positive appraisal of resources and support systems

Among the resources that were unanimously cited by all the groups as most useful for MAM1000W were [WebAssign](#) exercises (referred to by students as web assignments), Kenny's workshops, the Mathematics Learning Centre (MLC) and some lecturers. Regarding web assignments, a student from the succeeders group stated:

They [web assignments] were relevant to what we were doing in class and the tutorials. And also some questions that we did in web assignments you also find them in the tests and stuff. So if you understand you web assignments your test will be fine (Participant 1 Succeeders Focus Group 1)

Notwithstanding comments from some students who complained that web assignments were too long because of too many questions (Participant 1 Changers Focus Group 1) students who practiced web assignments regularly appraised them very positively. Some students specified the usefulness of web assignments not only in relation to tests, but also in terms of the repetitive nature

of questions that reinforced understanding and in depth understanding as stated by the following Repeaters group participant:

Voluntary web assignments. They just ask you the same questions, multiple times, so that you be like quick to understand what's going on. The depths, then they'll be like, "if you don't get it. You watch a video.... Or you could talk to a tutor (Participant 4 Repeaters Focus Group 1).

In addition, to web assignments, students also appraised the MLC positively as reflected in the following comments:

The classes [MLC] were very helpful; I attribute some of my success to them (Participant 3 Succeeders Focus group 1.

It also appeared that while the Department of Mathematics and Applied Mathematics provided a wealth of resources, only students who made use of them gained from them. Some students stated that the MLC was good, but they stopped attending because of other academic demands as stated below:

I went like three or four times because I liked the tutor Justin he was a really good tutor that was there at the MLC. But then, life just happened and other courses were also now taking time. Maths took a lot of time. So when I could go to the MLC I would go, but if I couldn't then I wouldn't go (Participant 1 Changers Focus Group 1).

Lecturers are the most instrumental agents in facilitating learning. Students reported that some of their lecturers were good. Students were however limited in gaining the most from their lecturers because of limited lecture attendance as indicated below.

... There was new lecturer, his name was Mashood. And Mashood is amazing. So I used to wake up and go to Mashood's lectures and I did that for a period of time. But then waking up at 8am became harder because we were writing tests... (Participant 1 Changers Focus Group 1).

Lecture times and competing academic demands thus limited optimum use of lecturers. For some students, the HOD of Mathematics was a good role model for them as reflected in the comments of a participant from the succeeders group:

I think for me it's this guy, he was the HOD I think he still is, he is the coolest... Down to earth and he is like open to every kind of a person. It's like he knows that there are different people, there are people who are smart, there are people who are not smart, there are people who think they are smart but then they are not smart... He understands like he understands everything... He connects, even when he is lectures like. For me that's when I picked when he started lecturing, because he only started lecturing to us in second semester. From there I started like, even though he was fast, exceedingly fast, I was just like, "I love this guy" (Participant 1 Succeeders Focus Group 1).

From the above reflections, it is evident that some students valued lecturers that they connected with and who relate well to students. Similarly, students appraised support systems in the department positively as commented by a changer group student:

There was the whiteboard workshops. There was...so yah, it was your TUTs, it was the whiteboard workshops, it was consultations, there was a textbook, the online textbook, there were extra notes that Jonathan had written out that you could go through. Yah, he had an open-door policy as well, he was like, if you guys need anything please email me (Participant 1 Changers Focus Group 1).

Clearly as the data indicates, the Department supports its students through both material and human resources. The open-door policy allowed students to approach lecturers when they needed support as also reflected below:

After test 1... almost all of my lecturers knew me by that time because I kept on knocking on their doors. Because it was like, for the first term I was afraid to asking questions I just kept it in.... After failing test 1, the confidence was pushed it was like, "if I don't ask questions I am gonna fail again" (Participant 1 Succeeders Focus Group 1).

The section thus far has shown how students positively appraised some resources in the Department of Mathematics and Applied Mathematics. The next section discusses some areas that students appraised negatively and suggested improvement areas.

What needs to improve?

Students made suggestions about how lectures and tutorials should be administered to enhance their learning experiences. Students admitted that while tutorial classes were helpful, they should be made smaller in order to give students the attention that they need. A participant in the repeaters group summarised the sentiments for improving tutorials by stating:

Tutorials if you do them they are very helpful I won't lie... They [lecturers] actual copy tutorials. I'm not even talking about the actual tutorials because I mean ... I don't get a lot from them. I think our tutorials are so big, they are so big. The interaction is like not good. I mean at least I can count lively TUTS some of the teachers like answer. I feel like if they were like smaller like this [referring to focus group]. They just need to reduce the size... So, if you have a tutor and a tutor has about 10, 15 to 20 students that they're assigned to. It's easier for us, not only as a group, but also for the tutor to like come also. If you go to a tutor the tutor will pick up on our flaws it would help us improve in that area (Participant 3 Repeaters Focus Group 1).

In addition, students reported that the way the tutorials were organised hindered their ability to get the best from them. The tutorials appear to not have been structured but rather students get support from tutor according to the questions that they and sometimes tutors take longer on some students excluding others. For example, a student from the changers group stated that:

.... and these tutors and you get to them, I mean they do help you get rid of that one question that you have in mind. And at the same time it's not like a continuous flow of assistance. You know what I mean. Sometimes I just stand by and just watch him help someone else with another question. Because I am like, "Oh, I don't get noticed" (Participant 3 Changers Focus Group 1).

Students also complained that the tutorial questions were also very long as reflected in the following comments:

And they were long, they were really long. And apparently they said that in our year they weren't as long as they used to be. Like they used to be really long and annoying because the thing was that people would always say, "Agh man, we don't really finish our Maths tutorials, we don't really finish our Maths tutorials". But then they said that they had shortened them so that we were supposed to finish them in a week, but yah... It would be like on average three pages, so that's about 15 questions...15 to 20 questions. But it was like, sub-question of a question of a question, and sometimes it was like, derive the derivative of like six things and those things each take a page of working, as one question by itself. So, time. (Participant 1 Changers Focus Group 1).

From the above sentiments one can deduce that too many tutorial questions demanded a lot of the students' time and also discouraged them from doing them hence some students suggested shortening them. Regarding lectures, some students suggested improvements in the way the lecturers paced their lectures, taught mathematical concepts especially considering their first-year status and engaged students. Most students in the focus group lamented that when lecturers were too fast, they struggled to follow the lectures. As student who repeated the course made comparison of lecturers from the previous year:

But then I feel like this year, it's not that heated like last year. Because last year we had like an eight am lecturer who was like super-fast. And then this year, the eight am lecturer is just like taking bit by bit for people to understand the concepts. ...I mean you were like running like speed, just lightning, not even getting what was going on in the lecture you were just going in and going out without understanding even a single thing he said (Participant 4 Repeaters Focus Group 1).

Fast-paced lectures thus limit students' learning experience. Similarly, when lecturers failed to explain concepts in ways that students understood, it also hindered their learning. Reflecting on a lecturer's teaching style one student from the changers group stated:

I think also the teaching styles were completely different. In MAM1000, it's very quick, very fast, like this, this, that's that, okay we're done, next topic. In two days you can be done with two chapters and you're like, "what is going on, I don't even know anything" ... And I think the biggest difference between UCT and high school is that, UCT at the beginning assumes you know a lot more. And you understand a lot more concepts than what you actually do. Because I remember, one thing for example, absolute values, I've never heard of an absolute value in my entire life. And I think the lecturer just said, okay guys, absolute values, that's what it looks like, that's that, and moved on without, you know, just moved on (Participant 1 Changers Focus Group 1).

From the above student's perspective, as an area of improvement, lecturers should do better to explain concepts and not assume that students know them. A common narrative among the students was that lecturers sometimes approached teaching difficult concepts by neglecting a bigger group which lacked understanding of a concept, preferring to focus on a smaller group that knew the concepts. To illustrate this dilemma faced by many students in MAM1000W, the student in the changers mentioned:

And there would be times when she [lecturer] would ask like, "how many of you guys have done this?" And not even that many people would raise their hand and say, "we've done it". And then she would still carry on as if we had done it, as a whole. But the teaching styles, I think for me, was the biggest difference that I had to adjust to. And the pace as well that I had to adjust (Participant 1 Changers Focus Group 1).

The difficulty of not having concepts explained clearly and in-depth was further exacerbated by the interconnected nature of chapters in MAM1000W such that failure to understand concepts in one chapter led to failure to understand subsequent chapters as indicated below:

I just wish we had started with a different lecturer at the beginning. That's it. Like not even, just to understand better. Because like she [another participant] said, the beginning was, if you didn't understand the beginning, you didn't understand for the rest of the way. And it's very difficult to have a lecturer who has an accent, you can't really hear them, you can't, they're very, it was confusing. There was a lot, I mean, your first year, first time at university, your first Maths lecture, like everything is like a lot and it's overwhelming. And it would have been nice to have, if Jonathan taught, that first.... (Participant 1 Changers Focus Group 1).

To deal with the problem of assuming that students understood certain concepts, one student suggested differentiated classes whereby students who did AP Mathematics had their own class and those who did not do AP Mathematics have separate classes, so that lectures can explain concepts more in-depth to classes that did not do AP Mathematics (Participant 3 Changers Focus Group 1).

Furthermore, students made recommendations on incorporating learning tool such as calculators and formulae sheets to facilitate calculations, an idea captured in the following sentiments:

The Formulae, a sheet would work. They just want you to prove theories on most of the things in section C. If they can only just give you a sheet of like for special angles it will be fine (Participant 4 Repeaters Focus group 1).

Students also recommended using vernacular language in lectures and tutorials to help them understand concepts and content better. To emphasise the benefit of multiculturalism in pedagogical approaches, a succeeder participant stated the following:

I really think that there should be something whereby if I have a burning question, let's say you have a burning question you can't say it in English, you will be you like, "ok this is my burning question, I have it in my vernac and I am just going to post it there if someone who also understand my vernac can translate it in English for me to the lecturers". And sometimes also like it comes a point whereby you say, "Ok I want to pass this course but I can't put it in English" (Participant 2 Succeeders Focus Group 1).

Evidently using English as a medium of instruction tends to disadvantage some students whose first language was not English. Because most students learnt Mathematics in vernacular in high school, the transition to using English in university hindered their learning (Participant 3 Succeeders Focus Group 1). In fact, a student in the succeeders group cited above reported on how his marks improved because of meeting fellow students in tutorial classes who also spoke his home language.

For MAM1000W in tutorials you get people who speak vernacular but I only knew them during the second semester and then I also like my results improved because I was speaking in vernacular (Participant 2 Succeeders Focus Group 1).

In relation to assessments, students voiced their discontent with multiple choice questions in section B because they did not account for how students worked out the mathematical problems. Multiple choice questions also carried heavy penalties when students missed the correct answers. A student in the repeater group voiced:

And also the fact that the whole thing of MAM1000 to penalise us on multiple choice questions sucks a lot. Because in section B the whole thing that you have to provide the answers only. I mean, you can actually like work through and work through and you just make a slight mistake somewhere and you lose all the marks. It's really not fair. I think this is probably why most of us did well in high school because they afforded us a chance to show them your work throughout the whole paper, not only on section C as they say. I mean I'm pretty sure that we relatively do well in section C compared to section B at some point. And like they should just change like the whole setting of the question paper to say. Even when you should take out a multiple-choice thing, just like a question paper where like you just show them you are working. Then it's easier that way, I feel like that (Participant 2 Repeaters Focus Group 1).

Clearly the way question papers were set had a bearing on students' passing the papers. Another important aspect recommended by students in the focus groups was the ordering of content material in the curriculum and lecturers who should teach the respective sections. Students argued

that the beginning part of the lectures was difficult and crucial and needed a lecturer who was more attentive and engaging. In addition, some felt that because in the second semester there was a lot of work, it would help to have some of the work covered in second semester in the first semester as the work was denser and more needed more time. The proposed changes, are presented as follows:

I just wish we had started with a different lecturer at the beginning. That's it. Like not even, just to understand better. Because like she [another participant] said, the beginning was, if you didn't understand the beginning, you didn't understand for the rest of the way. And it's very difficult to have a lecturer who has an accent, you can't really hear them, you can't, they're very, it was confusing. There was a lot, I mean, your first year, first time at university, your first Maths lecture, like everything is like a lot and it's overwhelming. And it would have been nice to have, if Jonathan taught, that first.... (Participant 1 Changers Focus Group 1).

Lastly students proposed their preference for making tutorials workshop-like and creating more workshops than lectures as the former were perceived to be more interactive and hands-on by actually working through the problems, preparing for tests, having students bring their own questions as well as making students accountable for tutorials (Participant 1 Repeaters Focus Group 1). A student in the repeaters group stated preference for workshop as follows:

Well I think, if they could reduce some of the lectures and replace some of the days with like workshops. More workshop, less lectures. Because it's a lot of lectures and then only have short tutorials and the one workshop on Saturday to actually work through the stuff (Participant 6 Repeaters Focus Group 1).

Presumably because Mathematics is a practical subject, spending more time working through questions made more sense to students than attending lectures.

The section that follows discusses how student used resources and thus how they demonstrated their agency.

Students' own use of resources

Notwithstanding identified areas of improvement in lecture delivery, tutorials, and other learning tools that students pointed out above, students appraised resources as mostly useful.

Resources that students identified as useful included web- assignments, Kenny's workshops, MLC (Mathematics Learning Centre) and some lecturers. To capture an idea of some factors that lead to student failure, it was important to inquire how students used resources made available to them. The narratives from the repeaters' group largely indicated that they neglected to use some resources such as web assignments, lectures, tutorials, and the textbook. They expressed a preference for workshops to lectures when they are embedded in tutorials as was practiced at Kenny's workshops. Students' preferred attending workshops because of the whiteboard sessions as explained by the following student:

And what I have seen about Kenny's problems they're so much tougher than the problems that we get on the tests. His problems are really tough, you know. But he explains thoroughly... He just explains things very well. And then you have like a whiteboard session afterwards... He will give you a worksheet and then with people you work together and you work through this worksheet on the whiteboards (Participant 1, Participant 2 Repeaters Group 1).

Explaining how the whiteboard sessions helped her, a student in another repeater group stated:

They are very useful those classes. Like I said Kenny provides with tough questions than those that we get tested on, on tests. So I find them very useful. Whiteboards are also interesting because now you write your own things and you mark, you feel like you tutoring your own self. So you're motivated to work even on all the problems that you're given. Just push them because you work on the board. It's like explaining to your own self. It gives you that motivation to just do all the problems (Participant 2 Repeaters Group 2).

From the above sentiments, it is clear that students in the repeaters group used Kenny's workshops in place of lectures. More students in the repeaters groups reported not attending lectures for reasons highlighted above (Participant 1; Participant 2; Participant 3; Participant 4; Participant 6 Repeaters Group & Participant 1 Repeaters Group 3). In addition, students in the repeaters group also tended to rely on past exam papers as a learning method, while neglecting lectures and tutorials as reported by the following student:

I think the only thing that was tricky with me was, even though I didn't attend lectures and tutorials, I would like literally just like maybe two days or three days before the test, start doing past papers and all of that. Go to the test and then pass the test. But that wasn't the case when I went to write the final exams. And I didn't really see it as something that was like more harmful to myself. Because I was still able to pass all the tests for MAM1000 but at the end, yoh, I don't know what happened. And the final exam just kicked me (Participant 1 Focus Group 1).

Considering that some students did not attend lectures regularly, it was important to explore if they used lecture videos, and if they did how they used them. Student's responses varied from those who did not use lecture videos to those who used them selectively. Those who did not use them learnt the hard way that binge watching of lecture videos was not an effective way of learning as stated below:

... and me sitting there watching a lecture video, I thought it was just going to drop into my brain and it didn't. They are helpful but you have to engage with the content actually (Participant 1 Focus Group 1).

Some students expressed that they used lecture videos but only as a back-up plan for missing a lecture on the day that they miss the lecture rather than let missed lectures pile up and try to binge watch (Participant 3 Repeaters Group 3). Others used lecture videos to refer and seek clarity on certain topics and they also liked the flexibility of pausing to write notes and engage with the material gradually (Participant 1 Focus Group 3). For students who struggled with language and

understanding lecturer's accents, lecture videos helped them to pause and play the videos slowly so that they understood the topics (Participant 2, Focus Group 2).

Because students in the repeaters group failed MAM1000W, they learnt retrospectively about the importance of using other resources beyond Kenny's workshops, partial completion of tutorials and relying on past exam papers. Responding to a question on what resource he could have used the previous year to pass Mathematics, a student echoed the responses of most participants in the repeaters group:

For me I think if I did voluntary web assignments, last year. Because most of the people survived through them (Participant 4 Repeaters Group 1).

One student mentioned that she used to copy her friend's web assignments, as a result she did not benefit much from them. She stated:

Because my neighbour was also doing MAM1000, I would just copy from her. I'd copy answers from her and then on Web assigns and then submit. And then as a result I ended up knowing not really...Although I did Web assignments. It was sort of useless because that wasn't my answers. I copied (Participant 2 Repeaters Group 2).

By copying another student's work and presented it as her own, the student demonstrates that availability of useful resources alone does not benefit students if they do not use them. In addition, most students in the repeaters group neglected to use the textbook. For those who used it, they had mixed responses about how they used it and how useful they found it. One student in the repeaters group used the textbook fully and expressed its benefits as follows:

I use the textbook because most of the things that we do in lectures, they come from the textbook. And most of the exam questions, they are from the textbook. So, I use the textbook for that (Participant 7 Focus Group 1).

From the above student's comments, it is clear that the student identified many benefits from using the textbook. Conversely some students used it to check examples (Participant 2 Focus Group 2), some used it as a reference book than for studying (Participant 1 Participant 4 & Participant 6 Focus Group 1). In some instances, students tried to use the textbook but stopped doing so because they didn't find it useful (Participant 3, Focus Group 1). Explaining how he used the textbook as a reference book, a student stated:

I just study the digital copy of it because it's easy to navigate. So, I do use the textbook even though like I said you can't use it to teach you. You can use it if you want to go and check something up. So, I use it when I want to learn proofs or if I want to go and check something up. And you can literally search the thing that you want and then open a whole of different places in textbook where you can find like differential, or root and you can go to those places and look at those different things (Participant 1 Focus Group 1).

Another important resource at students' disposal was how they managed their time as well as completing assigned tasks. A student who learnt retrospectively explained what she was doing better in the current year compared to the previous year by stating:

Now I make sure that no matter how swamped I get with work during the week I do my tutorials. I don't miss my tutorials because there that's when I actually get to know that... Because at times you could study something and do and do and feel like, "oh I did it". But when you get to the tutorial, the tutor is like, "no, no, no that is not how it was supposed to be done". And then you get graded. So now I don't not only do my tutorial, I also go to the task to actually get graded. I do... Okay sometime like I'll do my Web assignment and not finish it. I've that time tended not finish things, but now I do it to the fullest (Participant 2, Focus Group 2).

From the above statements, one can deduce the importance of applying oneself and managing time effectively to get work done.

Students in the changers group were similar to the repeaters group in the way that they mostly utilised resources that included the Mathematics Learning Centre, Kenny's workshops, lecture notes and YouTube videos. Compared to repeaters, changers did not report a high lecture absenteeism hence their utilisation of lecture videos was more for reference purposes than supplementing lecture attendance. Participant three explained how she used lecture videos:

Maybe if I was in a lecture and I was writing an example and they may be moved on quickly. Like sometimes they go back and I'm like, "what, what was that?" I go to the recorded lectures. Even when like I don't understand a certain topic and what not then I go back. But rarely do I do that because You Tube's always there (Participant 3 Changers Group 1).

Students also practiced web assignments for bonus marks as expressed by the student below:

I loved web assignments, honestly. Number one because it gave me bonus marks. Number two because I feel like it was like the simple stuff. I mean, you could really understand the basic stuff through web assigns. That's what I felt (Participant 1 Changers Group 1).

It was evident from the focus groups than changers. While repeaters criticised lectures for being boring and time wasting on the most part, changers directed their criticism to the content of MAM1000W and its decanted version, MAM1005 as too deep, intense, and overwhelming. For example, a student expressed that they thought when MAM1000W was decanted to MAM1005 that would mean reduced workload as they would be learning Mathematics at a slower pace as stated:

I thought decanting meant... what it really meant I think we would do better. Like if they actually really took MAM1000 content and put it... And slowed it down. Because now decanting just meant you were learning extra There was so much extra like you go talk to the MAM1000 kids and they're like, 'we didn't do that'. Like we did, finch, that weird stuff...., like deep, deep, deep Maths. (Participant 1 Changers Focus Group 1).

Students in the changers group also stated that passing MAM1005 did not guarantee progression as some students who passed MAM1005 ended up failing MAM1006 and not get to MAM2000 (Participant 3 Changers Focus Group). Some succeeders also shared the same sentiments that MAM1000W is better than its decanted version (PA3 Succeeders Group). The lack of continuous assessment in MAM1000W was also an object of criticism for changers. For example, regarding tutorials, some changers felt that tutorials in MAM1000W would have been more beneficial if there was some form of accountability expected of students. Voicing this concern, a participant stated:

I don't like how the tutoring system is structured in MAM1000. Because it's what essentially they're telling us... I know we are adults and everything but we're still children. Because when we come from high school you are used to being forced to do your work... Now with MAM1000, I feel like their total system is just way off because you just go there. No one knows if you've returned your tut or not. No one knows if you understand your tut or not (Participant 3 Changers Focus Group 1).

Students made comparisons with other course on how they felt tutorials should benefit them.

MAM1000 should follow MAM1010. You must tell them that they must go look at MAM1010. We have tut tests at the end of the thing and the tutorials are not too long. Like you say I actually do my whole tutorial before I go to the test, so by the time I'm there I've got questions. And, yes, MAM1000 just needs to... Something that allows you to do homework because they don't have hand-ins or tests. They need to have either or (Participant 1 Changers Focus Group1).

Students thus felt that if they are not continuously assessed they lose focus and fail to apply themselves more extensively to their work. Changers also neglected to use some resources such as the textbook, past papers and none had used the [MathemAfrica](#) blog. Reflecting on what she could have done to improve her marks, a student stated:

I wish I had done more question papers because, yah, that's one thing that I neglected. Practising more, not just like looking at the lecture notes and understanding the examples and then what not but then putting in more practice. I feel like with more practice in Maths you get a more pure perspective on like the tricks and things than the work itself (Participant 3 Changers Focus Group 1).

Like their counterparts in the repeaters group, participants in the changers group found using the textbook very daunting and unnecessary. A student who attempted to use the textbook responded to a question on whether she found the textbook useful:

To some extent it [textbook] was. Because like the examples that they were using in class also were from the textbook. But like the whole textbook is when you open it it's daunting. Not that it's bad. It's just a lot happening (Participant 2 Changers Group1).

Other students added:

Like, for me, I felt like at any point in my Maths journey I did not see the use of the textbook because everything that we needed to know or needed to learn were in the lecture notes (Participant 3).

Clearly students in both the changers and repeaters groups did not like using the prescribed textbook. Among the challenges that changers faced were time management impacting on their ability to utilise some resources more optimally and meeting competing academic demands (Participant 2; Participant 3 Changers Focus Group 1).

Thus far the discussion focused on how repeaters and changers used their resources. Attention is now directed to the succeeders. The succeeders differed from their counterparts in the repeaters and changers groups in the way they used resources in that of the three groups, they tended to use all the resources provided to them. A participant's comment captured this synopsis by echoing the narratives of most succeeders participants when he said:

Yah I like tried everything like I asked, so I went to my lecturers and asked them to get to this course and they give me advice. Time management and then they also like talked about extra classes. I tried extra classes, MLCs, Kenny's workshops, Instant Science and then met up with other people and whenever I had assignments just texted each and ask, "How did you do this one?" YouTube like... (Participant 2 Succeeders Group 1

Succeeders did not only use additional resources popular with the other two groups, but rather, they used those resources that other participants shunned such as the core textbook (except for 2 participants in Succeeders group 2 who preferred lecture notes and workshops). Succeeders participants attended lectures more regularly. This is not to say succeeders did not fall into similar pitfalls of avoiding lecture attendance like the other two groups; the difference lay in their reflecting on failing test one and implemented strategies that benefitted them.

For example, reflecting on changes that he put in place after checking his deteriorating progress, one participant stated:

Yah, at some point we had to, like because seeing that you are lacking in the studies and like if you are lacking that means you are failing ... So I was like, "no I should stop this and this should stop". I started attending lectures more often and doing a lot of tuts ... And as I was on test two I was like, "no I had to stop doing that and attend lectures". That's what my mentor said to me. He was like, "if you want to pass then you need to attend the lectures and also do the tutorials". So that's when I started doing like the tutorials every day and going to lectures almost every day as well (Participant 2 Succeeders Group 2).

From the above statement it is noteworthy that the student took stock of his learning deficiencies, namely lecture attendance and doing tutorials and acted to improve. Students in the repeaters and changers groups also had to reflect on their learning journeys, however for some students, the timing of the reflections might have been a bit too late for corrective measures. This draws attention to the crucial role of continuous and early assessments and individual evaluation for both students and lectures as this has implications for students' academic growth. What also distinguished the succeeders from the repeaters and changers was that for some of the succeeders, lecture attendance alone was not enough, they made an effort to consult with lecturers, asking questions to gain more insight on Mathematics topics as reflected below:

After test 1, I like, almost all of my lecturers knew me by that time because I kept on knocking on their doors. Because it was like, for the first term I was afraid to asking questions I just kept it in. "I will work afterward I am gonna understand blah, blah". But then after test 1 I already saw that I failed. After failing test 1, the confidence was pushed it was like, "if I don't ask questions I am gonna fail again" (Participant 1 Succeeders Group1).

Engaging with lectures by asking question in and outside lectures is evidently an important part of learning, yet most students refrain from doing so due to shyness (Participant 1; Participant 2 Repeaters Group 2). Because they attended lecturers more regularly, participants in this group used lecture videos less. A student who expressed his philosophy of learning stated:

Well for me I made a pact with myself since grade 12 that I won't miss a lectures. It's like it has just been like that for me (Participant 2 Succeeders Group 1).

Thus when students have ownership of their own learning, they go a long way in achieving their goals. Succeeders group participants did use lecture videos on occasions when they missed lectures, but their preference was to attend the actual lectures:

Yes, like when I missed the lecture. But for me I prefer to go to the lectures because like watching a lecture video is like most of the time they upload it around four or five somewhere there.... So I was always like watching it after dinner. And, you know, after dinner you get tired and when you are tired you can't like focus on what you want to do. So I prefer to go on the lectures every day than watch the lecture videos every day (Participant 1 Succeeders Group 2).

Another crucial resource that the succeeders group participants used differently from the other group participants was the textbook. All participants in the succeeders group 2 reported that they

used the core textbook and found it to be useful. Explaining how useful he found the textbook, the participant stated:

On the second semester, I did a lot of proofs, so I needed to use the textbook to understand those proofs because like the textbook explains better than the way the lecturer does. So I used the textbook to understand the proofs better. I think that's what worked out (Participant 1 Succeeders Group 2).

One student explained the contrast between relying on lecture notes and using the textbook.

That textbook is really useful. It is the most important one in terms of MAM1000. And also like on the second year Maths, Advanced Calculus, I found it very helpful actually. It is the one that makes me pass like Maths because I started using it and then like my knowledge in terms of Maths it changed drastically.... Like I wasn't understanding that much when I was reading like the notes and summary notes that were covered in lectures. But reading stuff briefly it was kind of like most important thing because like you see why some things are done. Like why the integral was involved. Like they explain why it is like the signs and everything. (Participant 2 Succeeders Group 2).

In the succeeders group 1, one out of the three participants used the textbook much later in the course and appreciated it retrospectively by saying:

In a textbook which I didn't use and I regretted later when I realised that most of the questions are similar to the problems I was getting.... Calculus, Steward Calculus. It gets interesting towards the end of the year and you realise, "the textbook is actually useful, why I didn't get a copy?" Like I don't understand why I lost track of the usage of the textbooks because they were very helpful when consulting with them (Participant 3, Succeeders Group 1).

The other participants in the succeeders group 1 did not use the textbook as they found it not to be useful:

It's [textbook] not really important. It's important for broader understanding but MLC, Instant Science, YouTube, Kenny's workshops. (Participant 1 Succeeders Group 1)

Instead of the textbook, the other two students in the succeeders focus group preferred to use lecture notes, YouTube videos, workshops, and other resources.

It was also important to assess how students in the succeeders group used tutorials and workshops. Students in this group valued attending tutorials as reflected in the comments below:

I'm just going to be honest, I didn't use James Stewart that much but I was using like (MLC). Those extra learning services I was using all of them like almost every day. And tutorials I used to go to almost every day like even the tutorials that I wasn't signed up for I used to go every day. But I also signed even there. But like doing that it also helped me like boost my marks in MAM1000 although it was kind of confusing but like if I didn't use those materials like the tutorial sessions and extra learning sessions I wouldn't have gained like a lot of experience with MAM1000 (Participant 3 Succeeders group 2).

These sentiments portray the degree to which all the participants in the succeeders groups used workshops such as the MLC, Kenny's workshops, and tutorials. Succeeders group participants had similar opinions to changers regarding improving tutorials by creating accountability. For example, a student stated:

So I think if MAM1000 like it can make like those tuts questions... Like to make it compulsory for a student to submit those tuts. Because like some of the students like, "if they see like, yah, there are a lot of questions then I'm not going to do it" or "I'll do it when we get to the tut section". And then when they get there they don't get enough information because like they don't know what's going on. And then you have to start to ask questions from the like basics of what they are learning about (Participant 1 Succeeders Group 2).

In addition to using the tutorials and workshops, students also used additional resources like web assignments, YouTube videos and [MathemAfrica](#) blog to expand their knowledge and deepen understanding (Participant 1 Succeeders Group 1; Participant 2 Succeeders Group 1). One student explained the benefits of doing web assignment by emphasising their flexibility through online contact with lecturers and offering opportunities to identify areas needing further studying:

So in Web Assign, like it was a compulsory that you had to do it otherwise you're going to get less marks. So like having that it means like you have to read the concept first and then try to do the questions. So it was encouraging me to study. Like even if like I didn't go to lectures it would encourage me to study and make sure that I understand the work before trying to attempt the question. Because like it also had access to the textbook and you could also send the lecturer a question from that specific question. Like I have this problem then they would answer through the Web Assign. You didn't have to like meet face-to-face (Participant 3 Succeeders Group 2).

To sum up, students in the repeaters, changers and succeeders groups used resources differently with varying degrees of success. The variation in the approach of study methods and utilising resources speak to students' own agency as dictating their learning trajectories. While the institution provided adequate resources which were nonetheless not perfect, students had to make personal choices and decisions about how to use the resources. Notwithstanding other structural constraints such as home language, class, race, and gender as well as previous high school experiences, it appeared from the students' narratives that a certain degree of agency influenced student success.

Experiences of MAM1000W

The report thus far explored themes relating to students' (1) degree of preparedness for Mathematics from high school (2) experiences of Mathematics at UCT (3) MAM1000W resources and (4) utilisation of resources. It was also crucial to explore student's views on their experience of failing the CIGs. Three things stood out regarding student views of factors that exposed them to risk in MAM1000W. These were the lecturing styles of some lectures as indicated above, learning strategies that needed improvement and difficult content material especially in the second semester.

Students expressed their discontent about how some lecturers pace their lectures very fast such that they could not follow. In some instances, they try to cover as much material as they can in one lecture which affects students understanding of key concepts. In addition, students reported that some lecturers assume that students already knew material, a situation which favoured those students who did AP Mathematics or other superior curriculums. From the students' narratives, they attribute these deficiencies in lecturing to exacerbating their risk of failing MAM1000W.

Students also reported their lack of preparedness for university Mathematics such that they had to revise their high school learning strategies. What used to work for them in high school had become obsolete at university. One student who had done AP Mathematics in high school managed well especially in the first semester because of his curriculum advantage. However, when second semester came, he struggled as he needed new study methods. The new study methods were worsened by highly demanding content material which some students struggled to understand. One student in the changers group expressed that she struggled to link her high school knowledge to MAM1000W and that grasping the key concepts was difficult:

I think for me it was just not grasping the concept. It would be there, and it would say, this is this is this, and I'm like, okay fine. But I don't understand, I just don't get it, I don't get it, like what? What are you...? I would always be like, what does this mean? What does it mean? ... And I think I just kept asking what does it mean, and it was too late, and then it was too much, and then you couldn't what does it mean for everything.... Because it felt like, even the Maths that I knew in high school was null and void now. (Participant 1 Changers Focus Group).

The difficult content material seemed to get worse in the second semester as most students expressed. Commenting on the content material in second semester a student lamented:

The material covered in second semester even the solutions hey? Some of the second semester work maybe should be covered in first semester because it's more work (Participant 5 Repeaters Group).

Examples of such material are expressed as follows:

The Formulae, especially in second semester, it's so frustrating.... It's so much you go already from three dimensional this and you have to know, oh, this is how you find the difference between a point and a plane, and a plane and a plane, and a line and a plane. And you're like, "I have so much to learn already", and then you get there and you cannot even tackle the problem because you don't have some sort of basis and I'll be like, "it's the point of university. We all look at university as some evil thing that's, like, "ha, ha you don't know this, then bye" (Participant 1 Repeaters Group).

Thus the content and topics covered in MAM1000W was so difficult that some students when they changed to other versions of Mathematics like MAM1010 they felt so relieved, as they could link their high school learning to university learning. It also important to mention that while the three key factors were identified as contributing to higher student risk, student learning occurred in the context of high academic demands of competing courses, time management constraints, lack of preparedness for university and uninformed decision-making around choosing Mathematics courses relevant to a career path.

Conclusion

The report summarised the key themes relating to (1) students' degree of preparedness for Mathematics from high school (2) experiences of Mathematics at UCT (3) MAM1000W resources and (4) utilisation of resources. The discussion showed that while some schools prepared their students to pass Matric and meet entrance requirements for university, the students were not prepared to deal with the demands of MAM1000W.

Students experiences of MAM1000W were linked to frustrations and anxieties of passing MA1000W particularly for changers and repeaters. All students had to revise their high school learning methods and approaches and how they used resources to meet the demands of a challenging Mathematics curriculum. The three groups differed in the way they utilised resources: the succeeders used multiple resources, whereas the changers and repeaters tended to be reluctant to use some core resources such as lectures and the textbook.

The focus groups illuminated students views of MAM1000W and factors they thought contributed to their risks.