context of tiered examinations, we are dealing with different groups (we expect more able candidates to enter the higher tier) and, as Klein and Kolen (1985) (cited in Cook and Petersen, 1987) demonstrated, when examinee groups are different the proportion of items common to the tests become important. Thirdly, the common items are rarely in the same order on both examinations, and this might affect the difficulty of the items. For these reasons, the linking of the tiers via candidates' marks on the common items should be treated with caution.

It should be noted that having many items with low facilities on a Foundation paper, or many items with high facility values on a Higher paper, does not necessarily mean that the papers were mistargeted: candidates might have entered for the wrong tier.

The comparison of grade C thresholds of tiered examinations is not on its own a complete method for identifying issues with difficulty targeting or standard setting. Comparing thresholds at grade D might result in a different interpretation. Moreover, issues with difficulty targeting or standard setting might not be reflected in reduced or reversed differences between the Foundation and Higher thresholds. The method of comparing C grade thresholds is recommended because it is straightforward, easy to automate and can then be done routinely as part of a wider monitoring system.

When a reduced or reversed difference between Foundation tier and Higher tier C-thresholds is detected, it is important to understand what has caused it. If items did not function as intended and an examination was harder or easier than it should have been, it is appropriate to set lower or higher thresholds respectively to compensate. Thus an unexpected difference between Foundation and Higher tier C-thresholds does not imply that either threshold was wrong or that the standards applied were not comparable; it can simply reflect the fact that the difficulty of one of the examinations was not optimal for its tier. Once this has been detected by means of the simple techniques described in this article, further investigations can take place to identify improvements for future examinations.

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An investigation on the impact of GCSE modularisation on A level uptake and performance

Carmen L. Vidal Rodeiro Research Division

Background of the study

Over the past few years modular assessment has been gaining popularity in England, particularly in large scale assessments such as the General Certificates of Secondary Education (GCSEs), which are taken by the majority of 14–16 year olds. Instead of being assessed at the end of a two-year course by following a linear syllabus, GCSE modular courses allow the assessment to take place in specified sessions in both the first and second years of the course. When multiple assessment paths exist for the same subject, it is left to individual schools to decide whether the assessment should be modular or whether candidates should enter for a linear examination.

However, it has recently been suggested that these modular assessments led to changes in learning opportunities and in the interaction between learning and assessment. In particular, modular assessment has been criticised for leading to fragmentation of learning and to a lack of coherence in the learning experience, endangering what is called synoptic understanding (Hayward and McNicholl, 2007), as students have little time for reflection, skill development and consolidation of learning. Furthermore, modular assessment might not provide opportunities for deep learning and it might, instead, encourage a climate of cramming (Priestley, 2003). In addition, the increased assessment load can lead children to spend more time revising for the next exam, rather than simply benefiting from learning (Hodgson and

Spours, 2001). Finally, there is the view that the possibility of re-sitting modules may be lowering examination standards (De Wall, 2009), and that 'teaching to the test' time is heightened at the expense of deeper learning or enrichment activities (Thomson, 1988; Poon Scott, 2010).

In the context of the English Post-14 education framework there has also been a lack of public and teacher confidence in other aspects of modularisation. In particular, teachers at schools and at colleges are concerned that modular courses are not a good foundation for advanced study (e.g. A levels, qualifications taken by students at age 18) and there is the concern that students will learn a particular part of the course and then forget it. In fact, in a research study carried out to investigate the effects of modular assessment at GCSE level, Vidal Rodeiro and Nádas (2010) found that GCSE teachers doubted whether modular GCSEs provide a good preparation for A level studies:

> *The only thing that would worry me with the modular system is … [students] don't look at it again and so I know a lot of students do that in December of Year 10. If they decide to go on to do A level and they haven't looked at material for a year and a half, I think that is a definite disadvantage.*

On the same lines, researchers, teachers and policy makers showed concerns about modularisation at GCSE leading to a significant dropout in the first year of advance studies (Institute of Education, 2010).

Another example of the concerns about modularisation, although in a higher education context, appears in Tan (1992). He found a profound negative impact on medics' level of understanding of physiology taught and assessed in a modular structure because students adopted a surface approach in order to pass their exams, rather than a high-level conceptual development of understanding the subject. As a consequence, they had difficulty in relating theory to practice later.

Some of the above issues might have led the current Secretary of State for Education to say, in November 2010, that:

> *We want to get rid of modularisation of GCSE. Instead of GCSEs being split into bite-sized elements we think it is important that at the end of the GCSE course the student should be examined on everything they have learnt at one time. We will have fewer exams but a concentration on a more rigorous approach at age 16 (BBC News, 2010).*

Furthermore, in June 2011, the Secretary of State for Education stated again that the present system prevented students gaining a deep and rounded knowledge of subjects and was forcing England down international league tables, and he added that GCSEs were losing rigour by being chopped into bite size chunks (Davis, 2011).

This study set out to investigate whether different assessment routes (linear vs. modular) equipped students equally for further study. The focus was on the impact of the GCSE assessment route on the uptake and performance in three A level subjects: English, mathematics and ICT.

Data and methods

Data

A range of GCSE and A level subjects were selected for this research. The subjects were chosen because they cover a range of curriculum areas and because their entries were reasonably high.

At GCSE level, three subjects offered by the OCR awarding body were selected: English, mathematics and ICT. At the time this research was carried out, OCR GCSEs in English and ICT were organised into modules (or units) which could either all be taken at the end of the course in a linear fashion or could be taken in different sessions throughout the two-year course (see OCR, 2003, and OCR, 2004, respectively, for a detailed description of the assessment in these subjects). However, in mathematics, OCR offered two separate specifications which were identical in content but different in structure. GCSE mathematics C (OCR, 2007) was a unitised specification and GCSE mathematics A (OCR, 2006) was a linear specification. At A level, subjects in the same knowledge area as the GCSE subjects were selected (see Table 1).

Table 1: GCSE and A level subjects included in this study

GCSE (OCR only)	*A level (all boards)*
Mathematics	Mathematics
English	English literature
ICT	ICT / Computing studies

Only candidates aged 15 at the start of the two-year GCSE course in September 2006 and who certificated in June 2008 taking the necessary units to do so in 2007 or 2008 sessions, were included in this research. This restriction was made in an attempt to mirror a typical GCSE cohort.

GCSE results in the three subjects, both at specification level and at unit level and for all examination sessions, were obtained from OCR's examinations processing system. GCSEs are graded on an eight-point scale (A*, A, B, C, D, E, F and G) and those who fail to reach the minimum standard for grade G are recorded as U (ungraded).

A level uptake and performance figures for the 2010 examination session for all English boards were obtained from the National Pupil Database, which is compiled by the Department for Education and contains individual-level information and attainment records for all students in schools within England. A levels are graded on a six-point scale (A*, A, B, C, D and E). Those who fail to reach the minimum standard for grade E are recorded as U (ungraded).

Methods

The candidates certificating in June 2008 in any of the OCR GCSE subjects listed in Table 1 were matched to the 2010 National Pupil Database, which contains all qualifications taken by candidates who were at the end of Key Stage 5 in 2010. In doing so, candidates were linked to the results of the A level subjects in which they certificated in 2010 (see Table 2).

Table 2: OCR GCSE candidates and their progression to A level

Subject	*GCSE candidates (OCR only)*	*With at least one A level (any awarding body)*		*With an A level in the subject (any awarding body)*	
		Candidates	*% (of GCSE candidates)*	*Candidates*	*% (of GCSE candidates)*
Mathematics	90732	41500	45.74	6176	6.81
English	45911	20754	45.20	2825	6.15
ICT	15262	8652	56.69	893	5.85

Descriptive statistics were used to investigate uptake and performance patterns in each A level subject for both GCSE assessment routes. However, an assessment route at GCSE might exhibit higher progression

to A level or better performance at A level simply because it had a more able candidature. To resolve this limitation, the descriptive analyses were followed by a multilevel logistic regression analysis which accounted for the ability of the students.

Logistic regression is a type of regression analysis that is used when the dependent variable or outcome is a dichotomous variable (i.e. it takes only two values, which usually represent the occurrence or non-occurrence of some event) and the independent variables are continuous, categorical, or both. It is used to predict the probability that the event of interest will occur as a function of the independent variables (see, for example, Hosmer and Lemeshow, 2000). The multilevel model was proposed due to the hierarchical or clustered structure of the data (as students were grouped within schools). If we failed to recognise this hierarchical structure, the standard errors of the regression coefficients would be underestimated, leading to an overstatement of the statistical significance.

In the following, the multilevel logistic regression model fitted to answer the question: '*What is the impact of the GCSE assessment route on A level uptake?*' is described in detail. With small variations the model can be applied to answer the question: '*What is the impact of the GCSE assessment route on A level performance?*'.

The dependent variable was the uptake of a subject at A level with the variable taking the value 1 if the candidate entered for an examination in the subject and 0 otherwise. The independent or explanatory variables were: gender, GCSE assessment route, attainment at GCSE and school type. These variables were categorical with the exception of the attainment at GCSE which was treated as a continuous variable. Interaction terms between gender and assessment route and between attainment and assessment route were also included. Schools were classified into the following groups: comprehensive, academy, grammar, independent and secondary modern.

The categorical independent variables had a baseline category with which all other categories in the variable were compared. '*Male*' was taken as the reference for gender, '*comprehensive*' for school type and '*modular*' for GCSE assessment route.

The formal representation of the model was:

$$\log\left[\frac{p_{ij}}{1-p_{ij}}\right] = \beta_0 + \beta_1 Gender_{ij} + \beta_2 Assessment\ Route_{ij} + \beta_3 (Gender \times Assessment\ Route)_{ij} + \beta_4 Attainment_{ij} + \beta_5 (Attainment \times Assessment\ Route)_{ij} + \beta_6 School\ Type_{ij} + u_j$$

where p_{ij} was the probability of student i in school j taking the subject at A level, β_0 to β_6 were the regression coefficients or fixed effects and u_j was a random variable at school level which followed a normal distribution with mean zero and therefore it was sufficient to estimate its variance.

In the first instance, main effects and interaction terms were included in all models. However, for simplicity, the interaction terms were not included in the final models if they were found not to be statistically significant.

The results of the multilevel logistic regressions, that is, the regression coefficients, are reported in the full report of this research (Vidal Rodeiro, 2011). In this article, estimates of the probabilities of taking the subject at A level by the candidates' gender and ability in the subject, the GCSE assessment route and the school attended at GCSE are reported instead. This is an alternative representation of the data which offers an easier interpretation.

In order to investigate the impact of the GCSE assessment route on A level performance, two levels of A level attainment were considered: achieving grade E or above and achieving grade A or above. In this instance, the dependent variable for the multilevel logistic regression models was the presence of a grade (e.g. grade A or above) in the A level subject under consideration with the variable taking the value 1 if the candidate obtained the grade and 0 otherwise. The independent variables were, as before, gender, GCSE assessment route, attainment at GCSE and school type.

Results

Uptake of A level subjects

Mathematics

In June 2008, 90732 candidates were awarded a GCSE in mathematics by the OCR awarding body. Among those, 6.81% carried on to study an A level in mathematics, certificating in June 2010. Table 3 shows that the modular GCSE mathematics specification was more popular than the linear one (the percentage of candidates following the modular route was 64.95%; this compares with 35.05% of the candidates following a linear route). Very similar percentages of candidates in each GCSE assessment route entered for an A level in mathematics.

Table 3: A level uptake of linear/modular mathematics GCSE students

GCSE assessment route	*GCSE*		*A level in mathematics*	
	Candidates	*%*	*Candidates*	*%*
Linear	31799	35.05	2200	6.92
Modular	58933	64.95	3976	6.75
All	**90732**		**6176**	**6.81**

The proportions of GCSE mathematics candidates who studied for an A level in mathematics, by GCSE grade, are displayed in Table 4. This table highlights that, among candidates who obtained grade A* in their mathematics GCSE, higher percentages of modular candidates than linear candidates continued to study mathematics at A level.

The probability of taking an A level in mathematics was modelled as a function of the grade and assessment route in GCSE mathematics, the candidates' gender and the type of school where the GCSE was obtained. The results of these analyses show that, once the attainment in mathematics at GCSE was taken into account, candidates following a linear assessment route at GCSE were more likely to continue to study mathematics at A level, independently of the type of school they were in.

Figure 1 shows the probability of taking mathematics at A level for students in comprehensive schools by the GCSE assessment route and the grade in GCSE mathematics. In particular, Figure 1(a) shows that a boy with a grade A* in GCSE mathematics (8 points) in a comprehensive school had a probability of 0.88 of taking mathematics at A level if he took GCSE mathematics in a linear fashion, and a probability of 0.86, if he took the GCSE in a modular fashion. These differences, although statistically significant, were small.

The differences between the GCSE assessment routes in other types of schools were fairly similar to those in comprehensive schools and are presented in Vidal Rodeiro (2011).

Table 4: A level uptake of linear/modular mathematics GCSE students by GCSE grade[1]

GCSE Grade	*GCSE candidates*			*Candidates going onto A level*			*% going onto A level*		
	Modular	*Linear*	*All*	*Modular*	*Linear*	*All*	*Modular*	*Linear*	*All*
A*	2747	1588	4335	1612	845	2457	58.68	53.21	56.68
A	6416	3692	10108	1921	1100	3021	29.94	29.79	29.89
B	9274	4804	14078	417	246	663	4.50	5.12	4.71
C	14749	8446	23195	25	9	34	0.17	0.11	0.15

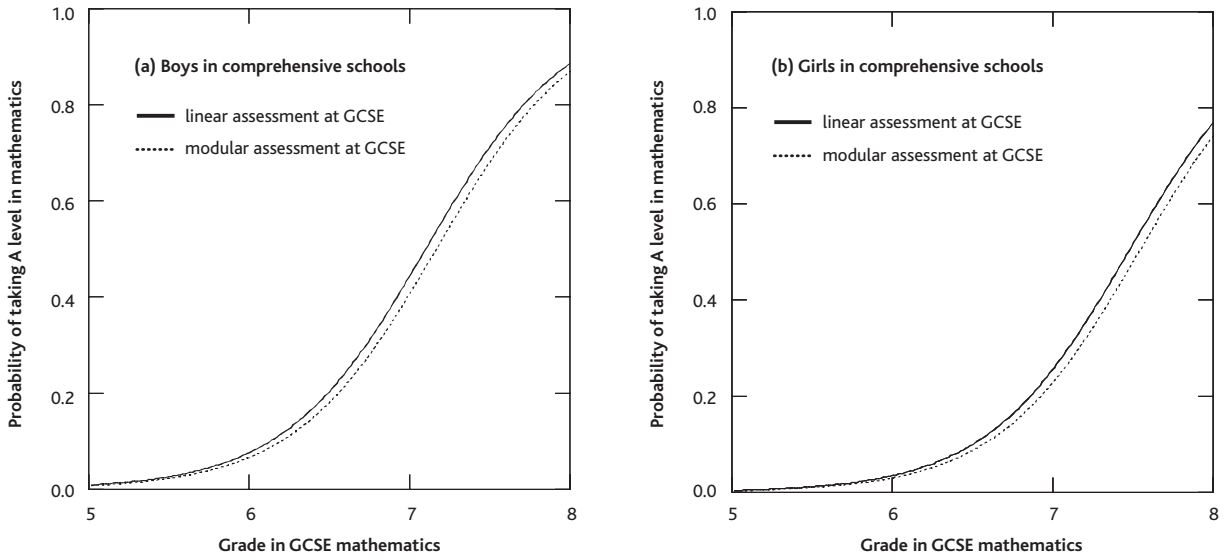

Figure 1: Probability of taking A level in mathematics by GCSE assessment route[2]

English

In June 2008, 45911 candidates obtained a GCSE in English awarded by OCR. Among those, 6.15% carried on to study English literature at A level and certificated in June 2010. Table 5 shows that GCSE English was taken mainly in a linear fashion rather than in a modular fashion (83.00% vs. 17.00%) and that higher percentages of linear candidates than modular candidates pursued an A level in English literature.

The proportions of GCSE English candidates who studied for an A level in English literature, by GCSE grade, is displayed in Table 6. Percentages of modular and linear candidates at each grade entering for an A level in English literature were fairly similar.

Table 5: A level uptake of linear/modular English GCSE students

GCSE assessment route	*GCSE*		*A level in English literature*	
	Candidates	*%*	*Candidates*	*%*
Linear	38107	83.00	2446	6.42
Modular	7804	17.00	379	4.86
All	**45911**		**2825**	**6.15**

Table 6: A level uptake of linear/modular English GCSE students by GCSE grade

GCSE Grade	*GCSE candidates*			*Candidates going onto A level*			*% going onto A level*		
	Modular	*Linear*	*All*	*Modular*	*Linear*	*All*	*Modular*	*Linear*	*All*
A*	269	2981	3250	49	560	609	18.22	18.79	18.74
A	1014	7289	8303	138	961	1099	13.61	13.18	13.24
B	1809	9551	11360	145	728	873	8.02	7.62	7.68
C	1956	8253	10209	43	193	236	2.20	2.34	2.31

1. GCSE grades below C were not considered in this analysis as only a very small proportion of candidates with such grades go on to study A levels (Bell and Emery, 2007).

2 Points were assigned to grades in each subject (A*=8, A=7, B=6, C=5).

The probability of taking an A level in English literature was modelled as a function of the grade and assessment route in GCSE English, the candidates' gender and the type of school where the GCSE was obtained. The results of these analyses show that, once the attainment in English at GCSE was taken into account, there were no statistically significant differences in the probability of taking an A level in English literature between the group of students who took English GCSE in a linear fashion and those who did so in a modular way.

ICT

In June 2008 there were 15262 candidates who obtained a GCSE in ICT awarded by OCR. Among those, 5.85% continued to study either ICT or computing studies at A level and certificated in June 2010.
Table 7 shows that GCSE ICT was taken mainly in a linear fashion rather than in a modular fashion (77.24% vs. 22.76%), and that higher percentages of modular GCSE students than linear ones pursued ICT or computing studies at A level.

The proportions of GCSE ICT candidates who studied ICT or computing studies at A level is displayed, by GCSE grade, in Table 8. At each GCSE grade, higher percentages of modular candidates than linear candidates continued to study ICT or computing studies at A level.

The results of the logistic regression analysis carried out to investigate if the probability of taking an A level in ICT or computing studies differed by GCSE attainment route show that linear students were less likely to take the A level than modular ones. This supports the percentages shown in Table 8.

Figure 2 shows the probability of taking ICT or computing studies at A level for students in a comprehensive school by GCSE assessment route and grade in GCSE ICT. The differences between both GCSE assessment routes in other types of schools were fairly similar to those in comprehensive schools and are presented in Vidal Rodeiro (2011).

Figure 2(a) shows that a boy with a grade A in GCSE ICT (7 points) in a comprehensive school had a probability of 0.23 of taking ICT or computing studies at A level if he took GCSE ICT in a linear fashion, and a probability of 0.28, if he took the GCSE in a modular fashion. As for mathematics, these differences, although statistically significant, were small.

Table 7: A level uptake of linear/modular ICT GCSE students

GCSE assessment route	*GCSE*		*A level*	
	Candidates	*%*	*Candidates*	*%*
Linear	11789	77.24	633	5.37
Modular	3473	22.76	260	7.49
All	**15262**		**893**	**5.85**

Table 8: A level uptake of linear/modular ICT GCSE students by GCSE grade

GCSE Grade	*GCSE candidates*			*Candidates going onto A level*			*% going onto A level*		
	Modular	*Linear*	*All*	*Modular*	*Linear*	*All*	*Modular*	*Linear*	*All*
A*	89	360	449	8	23	31	8.99	6.39	6.90
A	442	1305	1747	57	149	206	12.90	11.42	11.79
B	860	2625	3485	117	294	411	13.60	11.20	11.79
C	875	2787	3662	62	134	196	7.09	4.81	5.35

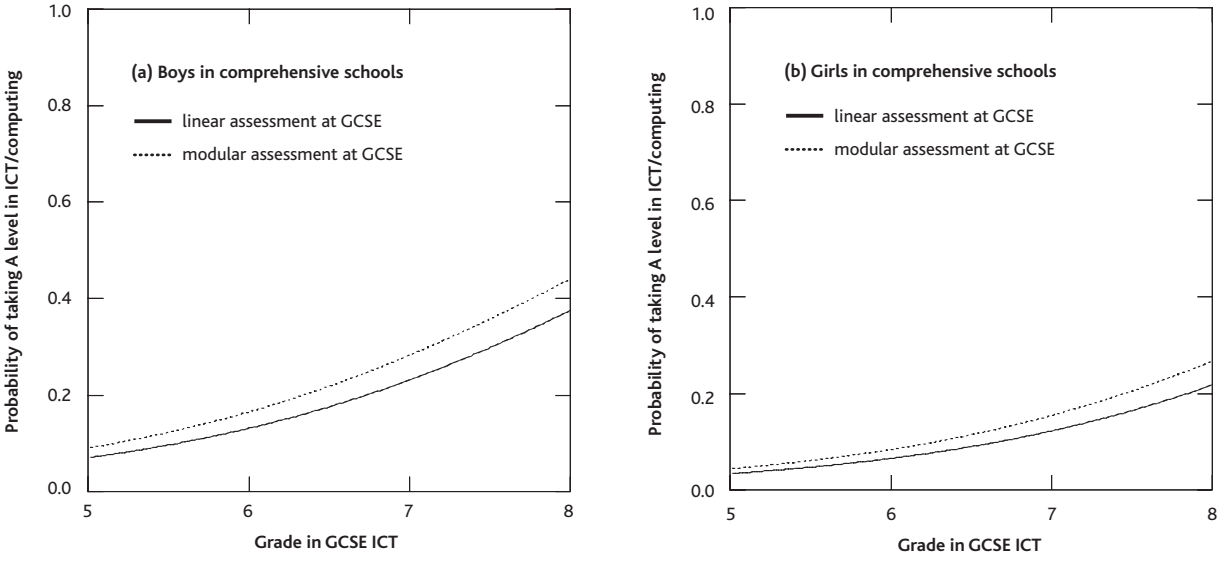

Figure 2: Probability of taking A level in ICT or computing studies by GCSE assessment route

Performance in A level subjects

Mathematics

Figure 3 presents the grade distribution for A level mathematics by GCSE mathematics assessment route. The two groups of students (linear or modular) differ significantly in the proportions obtaining each of the different A level grades. A larger percentage of linear GCSE candidates obtained grades A* and A at A level than modular GCSE candidates.

The assessment route at GCSE was found to have a statistically significant effect on the probability of obtaining at least grade A and at least grade E in mathematics at A level, after controlling for the grade obtained in GCSE mathematics. In particular, the probability of obtaining at least grades A or E in A level mathematics was higher for those candidates who followed a linear route in the subject at GCSE (Figures 4 and 5). Figure 4(a) shows, in particular, that a boy with a grade A* in GCSE mathematics (8 points) had a probability of 0.79 of obtaining grade A or above in mathematics A level if he took the GCSE in a linear fashion, and a probability of 0.66, if he took the GCSE in a modular fashion.

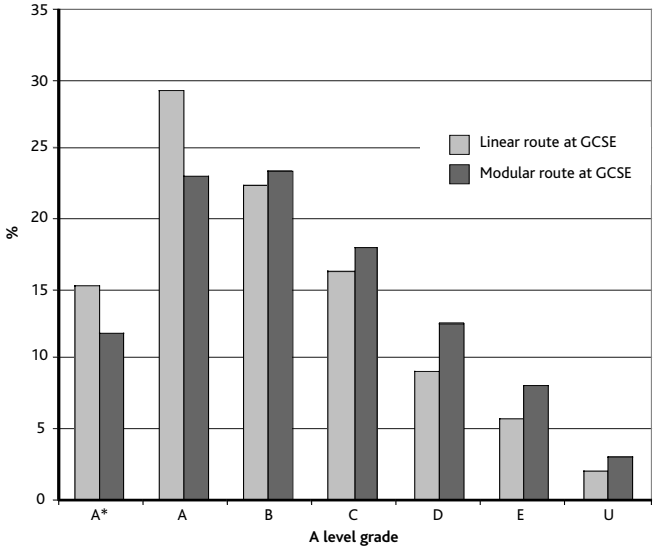

Figure 3: Grade distribution of A level mathematics by GCSE assessment route

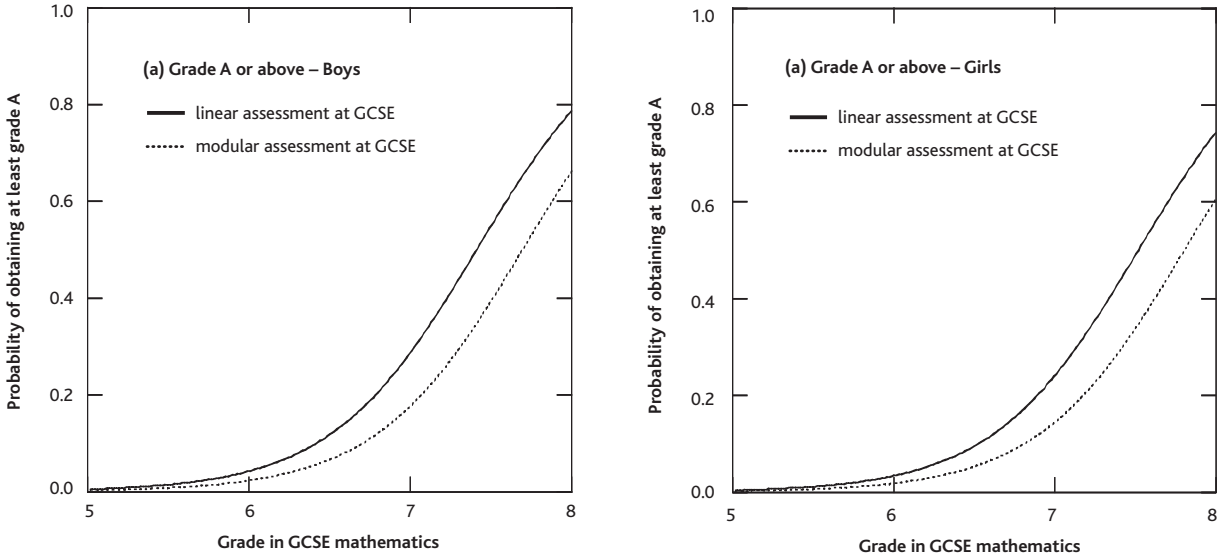

Figure 4: Probability of obtaining at least grade A in A level mathematics by GCSE assessment route

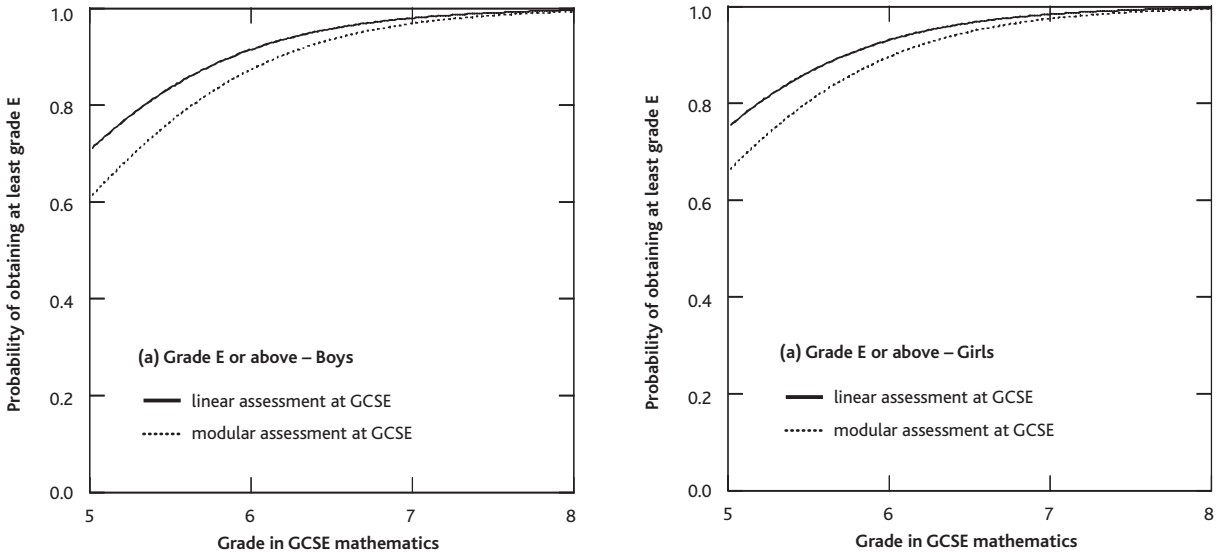

Figure 5: Probability of obtaining at least grade E in A level mathematics by GCSE assessment route

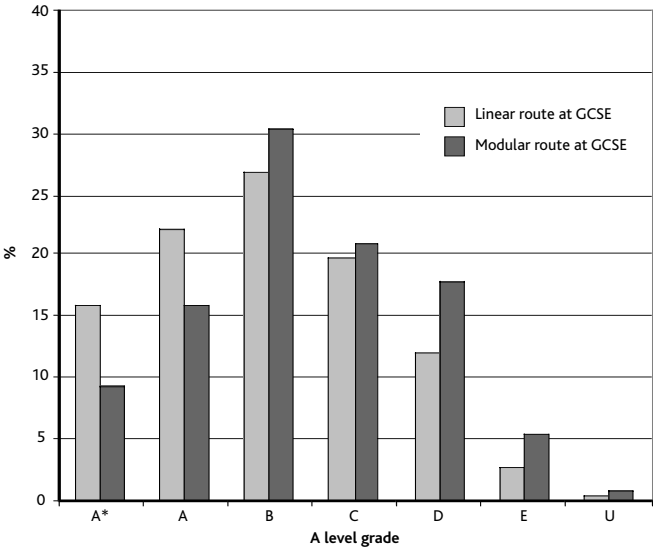

Figure 6: Grade distribution of A level English literature by GCSE assessment route

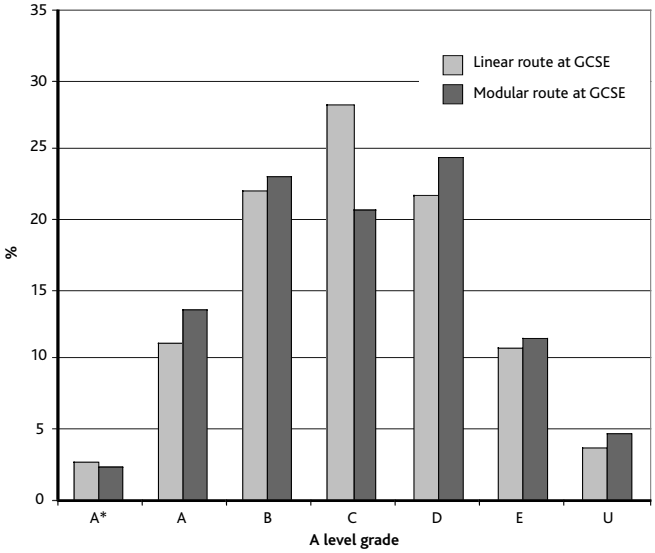

Figure 7: Grade distribution of A level ICT/computing studies by GCSE assessment route

Although these analyses show that students following a linear route had a higher probability of obtaining certain grades at A level mathematics than those following a modular one, it should be noted that this does not imply that a causal relationship exists between GCSE assessment route and A level performance. There might be other factors, such as students' motivation or students' background that could be affecting performance and have not been taken into account (Vidal Rodeiro and Bell, 2007; Vidal Rodeiro, Emery and Bell, 2011).

English

In A level English literature, the two groups of students (linear or modular) differ significantly in the proportions obtaining each of the different A level grades and, in particular, higher percentages of linear candidates than modular candidates obtained grades A* and A in the A level subject (see Figure 6).

After modelling the probability of obtaining a certain grade at A level in English literature controlling for the attainment at GCSE, it was found that there were no significant differences in performance at any given grade in English literature between the group of students who took GCSE English in a linear fashion and those who did so in a modular way.

ICT

Figure 7, which presents the grade distribution for A level ICT/computing studies by GCSE assessment route, shows that the two groups of students (linear vs. modular) did not differ significantly in the proportions across the different grades.

After modelling the probability of obtaining a certain grade in A level ICT/computing studies, it was found that there were no significant differences in performance at any given grade between the group of students who took ICT GCSE in a linear fashion and those who did so in a modular way, once attainment at GCSE was taken into account.

Conclusions and discussion

This study set out to investigate whether different assessment routes (linear vs. modular) equipped students equally for further study and presented some evidence that uptake and performance in A level subjects differed depending on the assessment route of the subject at GCSE. However, in considering the conclusions of this research, some limitations with the current study must be noted.

First, there were some limitations regarding the data used for this research. The linking between candidates with OCR GCSE qualifications in 2008 and candidates recorded in the Key Stage 5 extract of the 2010 National Pupil Database was carried out using a unique pupil number common to both datasets. However, matching in this way was not perfect and it would have been impossible to achieve a 100% matching rate. Therefore, some candidates who progressed to A level (or to A level in a specific subject) might not have been included in the analyses. In addition, the selection of subjects for analysis was limited by the OCR GCSE subjects that were available, in 2008, in a unitised version (in order to follow up linear and modular candidates to A level in 2010). In 2008, OCR offered unitised GCSE specifications only in English, ICT, mathematics and the sciences.

Secondly, the research assumed comparability among A level specifications across the different awarding bodies in England in the subjects under consideration (that is, two specifications are comparable if candidates with given characteristics who demonstrate the same level on some other measure of attainment obtain the same grade).

Finally, the statistical analysis techniques (e.g. multilevel logistic regressions) applied in this research identify associative, not causal, relationships. In particular, although these analyses showed that uptake and performance in A level subjects differed depending on the route (modular vs. linear), it should be noted that this does not imply that a causal relationship exits between GCSE assessment route and the issues studied at A level. There might be other factors, such as students' motivation or students' background that could be affecting uptake or performance and have not been taken into account (Vidal Rodeiro and Bell, 2007; Vidal Rodeiro, Emery and Bell, 2011).

Despite the above limitations, the results presented in this report have provided evidence to show that uptake and performance at A level differed depending on the assessment route (modular vs. linear) at GCSE.

Table 9 in this section shows a summary of the results from the multilevel logistic regression analyses carried out in this study. In particular, Table 9 shows that:

- Students following a linear assessment route in GCSE mathematics were more likely to continue to study mathematics at A level than those who followed a modular route. Conversely, linear students were less likely to progress to A level in ICT. There were no differences between linear and modular GCSE students in the uptake of English literature at A level.
- Once attainment at GCSE was taken into account, the assessment route at GCSE only affected performance in A level mathematics, with students following a linear route in mathematics at GCSE performing better at A level than those following a modular one.

Even when statistically significant, it should be noted that the differences at A level between GCSE modular and linear candidates in the two areas looked at in the research were very small. Furthermore, no GCSE assessment route offered consistently the best outcomes (i.e. higher uptake and better performance). Therefore, the claims about modular GCSEs not providing a good preparation for A level study do not seem to have a very strong base and should be investigated further. It should also be noted, as mentioned above, that there might be other factors that do not relate to the nature of the syllabuses (e.g. motivation, teachers' experience of the assessment route, etc.) that might be different in the different GCSE routes and could have an impact on further study.

Table 9: Summary of results

A level subject	*GCSE subject*	*Uptake at A level*	*Performance at A level*
Mathematics	Mathematics	GCSE **linear** candidates were more likely to take the A level	GCSE **linear** candidates were more likely to achieve at least grade A and at least grade E at A level
English literature	English	No difference	No difference
ICT/computing studies	ICT	GCSE **modular** candidates were more likely to take the A level	No difference

As stated above, only in one of the A level subjects investigated in this study (mathematics), were linear candidates more likely to perform better than their modular counterparts. It should be noted that among the GCSE subjects considered in this report, mathematics was the only one where there was a linear specification on offer (the other GCSE subjects were unitised and students could take all necessary units for certification in one session or in different sessions throughout the course). Therefore, this research has particularly shown that only when the GCSE specification was linear in design, was there an impact on A level performance.

The outcomes of this research provide evidence to inform key issues in an area of assessment which is currently under the spotlight as debate continues about the balance of advantages and disadvantages of these two different types of assessment.

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