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Modelling the preferences of students for alternative assignment designs using the Discrete Choice Experiment methodology

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This paper outlines how a discrete choice experiment (DCE) can be used to learn more about how students are willing to trade off various features of assignments such as the nature and timing of feedback and the method used to submit assignments. A DCE identifies plausible levels of the key attributes of a good or service and then presents the respondent with alternative bundles of these attributes and their levels and asks the respondent to choose between particular bundles. We report results from a DCE we conducted with undergraduate business students regarding their preferences for assignment systems. We find that the most important features of assignments are how relevant the assignments are for exam preparation and the nature of the feedback that students receive. We also find that students generally prefer online to paper assignments. We argue that the DCE approach has a lot of potential in education research.

Educators and students tend to have different viewpoints regarding assessment. Arguments for a constructive alignment of teaching and assessment practices are generally based on reducing these differences. For many educators, assessment seems to be an afterthought whereas, for students, assessment defines the actual curriculum (Biggs 2003). Misalignment and inconsistencies between teaching and assessment tend to frustrate students and educators alike. Student evaluation surveys consistently find high levels of dissatisfaction with assessment (Price et al. 2011). One of the root causes of this dissatisfaction is tension between what is desirable from an educational point of view on one hand, and what is feasible on the other, given increases in student numbers, greater diversity amongst the learner population, and a consumer service approach to education (Birenbaum 2007). Another source of tension is the difference between what students want and what educators think is best from a learning perspective for students (Struyven et al 2005). The gap in perception between instructors and students in relation to assessment led Carless (2006) to conclude that more "assessment dialogue" between the two groups would be beneficial. One feature of assessment in many disciplines such as mathematics, physics and economics are problem-oriented assignments that are often completed by students on a regular basis throughout a term. There have been significant changes in the environment within which many instructors make decisions regarding the nature and type of assignments that students have to complete. Technological change has meant that online assignment systems have become a feasible alternative in many basic and intermediate level courses. Some of the online systems allow students to get automatic and immediate feedback on the attempts that they make. Another significant change is a reduction in resources that are available to instructors to help them grade assignments and to give timely and relevant feedback

to students. Unfortunately, many universities have chosen to reduce budgets for part-time teaching assistants in recent years and this has led to difficult decisions regarding what can and cannot be provided to students as regards regular assessment. Given these developments it is important for instructors to learn more about what students think about the kind of assignments that they might be required to do in a course at university

The goal of this article is twofold. First, we hope to persuade the reader that an experimental approach called a Discrete Choice Experiment has considerable potential to reveal interesting and valuable information about what students think about important aspects of the learning process. Secondly, we report the results from a particular experiment about assignments that we conducted with undergraduate business students in three universities in Ireland and argue that the results provide interesting insights for educators about what students think. While our paper is mainly concerned with the results of a particular experiment, we suggest that the technique that we use has the potential to address other interesting questions in education. We outline some of these possibilities in the concluding section.

Rationale for discrete choice experiments

Standard consumer choice theory in microeconomics is based on the premise that individual utility is a function of the quantities of a good that an individual consumes. Under strict assumptions about preferences we can state that the utility that a person gets from buying the last unit of a good is worth at least as much as the price of the good; if it were less, why would the person buy it? Utility cannot be measured or observed directly so all we can deduce is that, by buying a good, a person is revealing that her or his valuation of the good is at least as high as the price of the good.

Many goods and services, however, are not traded in markets which means that we cannot infer what peoples' preferences are for such goods or services by observing whether they buy them or not. Over the past fifty years economists have developed a series of methods for estimating the value of non-market goods and services. Discrete Choice Experiments (DCEs) are one of these methods

DCEs are based on two important extensions to the standard theory of consumer choice. In the first extension, Lancaster (1966) argued that it is the attributes of a good that determine the utility that a person receives from a good and, as a result, utility can be expressed as a function of a good's attributes. One basic idea underlying a DCE is that the satisfaction that an individual receives from something can be broken down into the satisfaction that the individual receives from the key attributes of the good or service in question. An advantage of DCEs is that they encourage people to think systematically about the attributes of a good or service by asking them to reveal how they would be willing to trade off different bundles of these attributes.

The second extension to standard consumer choice theory is the Random Utility Model, developed in McFadden (1974). This model argues that, when presented with a choice set containing two or more options, there is a latent construct called "utility" in a person's brain that cannot be observed by researchers. This construct consists of a systematic and a random component. The systematic component is based on the levels of the attributes of the options in the choice set. The random component comprises all unidentified factors that affect choices (Louviere et al, 2010: 62-63). We can summarise this model mathematically by the following equation: $U_{ni} = V_{ni} + \varepsilon_{ni}$. This states that the total utility U_{ni} associated with individual n's chosen alternative i is represented by an observable component V_{ni} and a random component ε_{ni}. The observable component can in turn be captured by the following expression $V_{ni} = \beta' x_{ni}$ where β' represents a vector of parameter coefficients used to describe the person's preferences for the x attributes.

The use of DCEs in areas such as transport, health and the environment has increased significantly in recent years. For example, within health economics, De-Beeker-Grub (2009) designed a discrete choice experiment to elicit the relative weight that patients place on various aspects of a preventive drug treatment for osteoporosis. The experiment was designed so that individuals had to choose between drug profiles/options that differed in five treatment attributes: effectiveness, side effects (nausea), total treatment duration, route of drug administration, and out-of-pocket costs. The results showed that people considered the reduction of the relative 10-year risk of

hip fracture by 40% or more by the drug compensated for nausea as a side effect.

As the example above shows, for non-market goods such as health care[1] the satisfaction an individual gets from a certain treatment can be broken down into the satisfaction that he or she gets from characteristics such as the treatment effectiveness, duration, side effects etc. DCEs allow a researcher to obtain considerable insight into the trade-offs that a respondent is willing to make between different levels of the characteristics of a particular good or service.

Several aspects of the education process lend themselves readily to being analysed with DCEs. Consider the choice that universities face in designing education programmes. A programme could have large or small classes, the material could be taught and learned didactically or through active learning techniques, learning could be done by people working alone or by people working in groups, etc. These were among the issues analysed by Cunningham et al. (2006). They used conjoint analysis to elicit students' preferences regarding the design of a medical education programme in Canada (conjoint analysis is similar to DCEs). Cunningham et al. found that a large majority of students preferred a problem-based approach with small group tutorials led by expert tutors while a much smaller group of students preferred large group lectures, explicit learning objectives and streaming options based on learning preferences.

The particular aspect of the education process that we were interested in is the assignments that instructors in disciplines such as economics or statistics assign to their students. We use the term, assignment system, to refer to a set of assignments that an instructor requires students to complete for a particular course. Although the term assignment system is not commonly used, many course outlines or introductory lectures include details about the kind of assignments that are required in a course. These details cover issues such as whether the assignments are completed on paper or online, whether feedback will be given to students when their assignments are given back to them, whether practice assignments are available, and so on. These issues can all be interpreted as attributes of an assignment system and thus a DCE is a natural method for eliciting information about students' preferences over these attributes.

The DCE approach differs from the end-of-course questionnaire which is the standard instrument for eliciting the views of students about any aspect of their learning experience. These questionnaires are useful for asking students to rate particular issues such as feedback on assignments. Various rating scales of differing complexity can be used. These instruments do not allow us to gain any understanding of how students may be willing to trade off assignment characteristics against one another and this information might be of particular interest to instructors who are working under strict time and/or financial constraints.

Conducting a DCE to analyse the preferences for alternative assignment attributes

The first step in any DCE is for the researchers to define the good or service that they wish to analyse. We began by specifying that the term 'assignment system' referred to the set of assignments that students might have to complete for such a course. An assignment system is an example of a non-market service as they are generally not traded in the open market. On some occasions the assignment system chosen may have a price attached to it (for example, in courses which use online tools such as Aplia) but in these cases, purchasing is typically made compulsory and so the price will not reflect student preferences (see www.aplia.com for details of the Aplia online assignment system.)

The next step is to agree on the set of attributes of assignment systems that will be presented to respondents in the experiment. We consulted the literature on assessment and assembled a focus group of second year business students at NUI Galway to ascertain the relevant attributes of assignment systems that the students considered to be important. These students had experience with three different assignment systems in various courses they had taken in the university - Aplia (where the students were able to manipulate graphs and answer questions), Blackboard (where students answer multiple choice questions but were not able to manipulate graphs), and traditional pen and paper assignments. We also had to

[1] This can be viewed as a non-market good where the consumer does not pay the full economic cost of the health care intervention.

decide on the different levels that would capture the relevant variation in these attributes. The attributes and their associated levels are outlined in Table 1.

Table 1: Description of attributes and their levels

Attributes	Levels	Description
Nature of Feedback	High	Complete answers to all of the questions are provided and an explanation of each student's mistakes is also provided
	Moderate	Brief answers to all of the questions are provided
	Low	There is no feedback
Exam Relevance	High	Most of the questions on the assignments help in exam preparation
	Moderate	About half of the questions on the assignment help in exam preparation
	Low	Few of the questions on the assignment help in exam preparation
Assignment Type/Form	online with graphic interface	The assignment is done online using a system with an interface that requires the manipulation of graphs in answering the questions
	online without graphic interface	The assignment is done online but without an interface that allows the manipulation of graphs in answering the questions
	paper assignments	The assignment is done on paper by hand or on a computer and is handed to the lecturer/tutor or handed in to a department office
Practice Assignments Provided	Yes	before each assignment the student has access to a fully worked out practice assignment that has questions that are very similar to those on the graded assignment
	No	There are no practice assignments
Speed of Getting One's Result on an Assignment	Fast	The student can find out her/his mark within 24 hours of the deadline for the assignment
	Moderate	The student gets her/his mark within one week of the deadline
	Slow	The student gets her/his mark more than one week after the deadline has passed
Money cost	0, 5, 10, 20, 35, 45, to 60 Euro	This money is over and above any regular college fees that the students have to pay.

The first attribute is the nature of feedback. This refers to the extent to which students received detailed explanations from their instructor about any errors they made on their assignments. This attribute was presented at three levels - high, moderate and low. The second attribute is the relevance of the assignments for end-of-term exam preparation and referred to the proportion of questions on assignments that helped students prepare for exams. This attribute was also presented at three levels - high, moderate and low. Our third attribute was assignment form. This was included because we wanted to understand how students rated traditional paper-based assignment systems against the newer online methods of delivering assignments. Additionally, we wanted to explore student preferences between online systems that enabled graphical manipulation and online systems that did not. This attribute consisted of three levels, as described in Table 1.

The fourth attribute was the availability of practice assignments which students could complete prior to answering similar questions on their graded assignment. This attribute was presented at two levels; practice assignments were either available or not. The fifth attribute was the speed of getting assignment results. This ranged from fast to moderate to slow. The inclusion of these attributes is consistent with recent research about the effectiveness of assignments. For example, the issue of the level of feedback is related to the issue of whether assessment without feedback has any educational value (Price et al, 2011). The issue of whether students are only interested in surface learning and passing exams has been extensively discussed (Gijbels and Dochy, 2006). Recent work on the relative effectiveness of online and paper assignments has found that the answer depends critically on the type of exams that the instructor gives to students (Flannery et al, 2013a, Kennelly et al, 2011).

The final attribute in the DCE was a cost attribute. This attribute is necessary to determine the implicit prices that the students are willing to pay for the different levels of the other attributes. This was described as an additional once-off payment that students would be required to make for the assignment system in a particular course, over and above any other

university charges that they are required to pay. This attribute was presented at six levels to reflect realistic payment amounts. We found that six levels was sufficient to enable students to make meaningful trade-offs while providing enough variation in the levels to establish the range in students' willingness-to-pay amounts.

The use of a cost attribute in many DCEs is controversial because it implies that all questions of value can be reduced to estimates of how much a person is willing to pay for a particular attribute level. There are several interpretations of the concept of value and the DCE methodology is not able to determine whether every student thinks about value in a similar way or not. What we are able to do is infer the extent to which the students are willing to trade-off one attribute level for another and to calculate the monetary equivalent that students are willing to pay for a particular attribute level. But a student might conclude that, while she is willing to pay more for an attribute level such as high exam relevance than say a moderate level of feedback, she regards feedback as more valuable as regards her long term educational and intellectual development. For an interesting and wide-ranging discussion of the complicated relationship between choice, preference and value see Hausman (2012).

There are no guidelines as to how many attributes should be used in an experiment. If the number of attributes is too large there is a danger that respondents will only focus on a subset of the attributes. We considered a number of other attributes such as the length of time it took students to complete assignments but following some discussion with the focus group we decided not to include this. The actual experiment included a question that asked students whether they thought important attributes had been omitted and very few students thought so.

The next step in the design of the experiment was to design the choice cards for the main experiment. A choice card is a page or card on which is printed two or more versions of the good in question where the versions differ from one another with regard to the levels of the attributes of the particular good. An example of a choice card used in the experiment is presented in Table 2.

Table 2: Sample choice card

	Assignment System A	Assignment System B	Assignment System C
Nature of Feedback	High (complete answers to all of the questions are provided and an explanation of each student's mistakes is also provided where mistakes have been made)	Moderate (brief answers to all of the questions are provided)	Moderate (brief answers to all of the questions are provided)
Exam Relevance	Moderate (about half of the questions on the assignment help in exam preparation)	Low (few of the questions on the assignment help in exam preparation)	Low (few of the questions on the assignment help in exam preparation)
Assignment Form/Type	Paper Assignments	Online without Graphic Interface	Paper Assignments
Practice Assignments Provided	No	Yes	No
Speed of Getting Back Result of Assignment	Fast (the student gets mark within 24 hours of the deadline for the assignment)	Slow (the student gets mark more than one week after the deadline has passed)	Slow (the student gets mark more than one week after the deadline has passed)
Additional cost of Assignment System.	€60.00	€5.00	€0
Please tick the one option you prefer most.	□	□	□

As the number of attributes and levels expands, the number of possible choice cards grows to a very large number. In our case there were a total of 972 different assignment systems that could be generated from the six attributes and their respective levels. Fortunately, researchers in this field have developed techniques for reducing such large numbers down to a much smaller number of options. These techniques are now encoded in software packages such as Ngene (which we used). The basic idea is that the computer programme is able to generate a small number of choice cards that will capture the key trade-offs that the researcher is interested in (for a technical discussion on the principles behind such techniques and the types of designs that are available, see Scarpa and Rose, 2008).

Each student was asked to complete 12 choice cards. There were two blocks of 12 choice cards and half the students were given one block and half the other. On each choice card, respondents were asked to choose between two experimentally designed alternatives (these were labelled A and B) and a status quo option (C). The status quo option did not vary over the choice cards and had a zero cost while options A and B on each of the choice cards varied in terms of the different levels of the attributes. The inclusion of this status quo option is motivated by a desire not to 'force' respondents in to choosing an experimentally designed alternative. As noted by Lancsar and Louviere (2008) and Rose and Hess (2010) this is especially relevant where individuals do not have to consume the good. Designing the experiment in a 'forced choice' framework may lead to respondents having to choose between two potentially unappealing alternatives, neither of which may be chosen in practice. Therefore, recognising that individuals can postpone choice or decide not to choose at all and in the interests of increasing the external validity welfare estimates, the inclusion of the status quo option is recommended within a DCE.

The next step in an experiment is to use the choice cards that the computer programme has generated in a pilot experiment. In our case, we conducted a pilot experiment with a small group of students at NUI Galway. The main goals of the pilot experiment were to test whether participants could understand what the experiment was about and whether their responses were consistent with theoretical predictions. None of the students in the pilot experiment seemed to have any difficulty in completing the choice cards. We analysed the responses of the pilot experiment and were happy to proceed to the actual experiment.

For the actual experiment we recruited students at three universities in Ireland, namely the NUI Galway (NUIG), University College Cork (UCC) and the University of Limerick (UL). The experiment took place in lectures so students who did not attend the lecture could not participate in the experiment. Students were asked to reveal their gender and their results from previous examinations in economics. We also asked them whether they thought that going to university was a significant financial burden for them or their families. Gijbels and Dochy (2006) found that assessment preferences may vary with student experience; therefore it seemed reasonable to allow for some differences in preferences for assignment systems across the three universities as the student assignment experience varied between UCC, UL and NUIG. All of the students had been exposed to online assignments as well as paper assignments.

At the start of the experiment students received a note that explained in considerable detail what each attribute and the different levels were referring to. The note also stated that we wanted students to think about assignment systems in the context of a course such as economics or mathematics where assignments could be given on a regular basis and where the assignments in total would be worth approximately 25% of the course grade. The note asked students to consider the assignment systems on each choice card and to indicate which assignment system they preferred. We stated that there was no right or wrong answers and the students were not asked to identify themselves in the experiment.

Analysing the results of the Discrete Choice Experiment

The central statistical question in any DCE is to examine whether the choices people make are related in a systematic way to the attribute levels of the various options on the choice cards. Beyond that, there are a number of related issues such as whether it is possible to identify sub groups within the sample that have particular preferences. The specific models that are reported in a particular paper will depend on what questions the researchers are most interested in. To illustrate the kind of insight that can be gained from a

DCE we present results from a Conditional Logit model and a Latent Class Model. Both models have been used extensively within the wider DCE literature. For an extensive technical discussion of the various model specifications available for discrete choice data, see Train (2003). In our experiment we observed the choices that each person made on 12 choice cards. A total of 329 students took part in the experiment so therefore we have 3,948 observations. Our final sample consisted of 122 NUIG students, 66 UL students and 141 UCC students. Table 3 presents summary statistics on the characteristics of the students in our sample.

In general, approximately 40 percent of the students in NUIG and UL were male, while in UCC there was almost an even proportion of males and females. There were a much smaller proportion of mature students in the UCC cohort compared to NUIG and UL. Approximately half of the students in each of the universities thought that the cost of higher education was a substantial economic burden. A much smaller proportion of students in UL had received a B+ grade or higher in a previous economics course compared to NUIG and UCC. The age and gender profile of the different samples fit the programme profiles in the respective universities.

Table 3: Summary statistics

Proportion of Students in Sample (%)	NUIG		UL		UCC	
	Mean	sd	Mean	sd	Mean	sd
Male	0.38	0.48	0.36	0.48	0.49	0.50
Non-Mature (i.e. aged less than 23 years)	0.77	0.52	0.65	0.48	0.90	0.30
Students that feel the cost of higher education is a great burden	0.51	0.49	0.52	0.50	0.46	0.50
Students that received a grade equivalent to a B+ or higher in a previous economics course	0.17	0.37	0.05	0.21	0.18	0.39
Sample Size (n)	122		66		141	

In order to analyse the responses to the experiment each of the attribute levels used on the cards (apart from the cost attribute) is coded as a (1,0) dummy variable. For example, in the sample choice card shown in Table 2 the variable called 'practice assignment is available' is coded 1 in Assignment System B and coded 0 in Assignment Systems A and C. For the cost variable the actual money amount is entered for each option on every choice card.

The next two coefficients in Table 4 indicate the impact of a change in assignment form from paper in the status quo case to either of the online forms has on choices. These coefficients are not statistically significant which suggests that, for the group as a whole, the method by which an assignment is completed has no effect on the choice of assignment system. The coefficient on assignment price is negative and significant which means that students are more likely to choose cheaper assignment systems

The results from the Conditional Logit (CL) model are reported in Table 4. The first seven coefficients in the Table represent the effect that a change in each of the attribute levels from the base level to a moderate or high level has on the choices made by individuals in our experiment. The relative size of the coefficients indicates which attribute levels are considered by our sample to be most important in affecting their choices. Thus the most important attribute level is exam relevance is high, followed by exam relevance is moderate, nature of feedback is high, etc.

The last five coefficients in the table test whether certain characteristics of the students had an impact on their choices. The results indicate that students who stated that they found financing study a burden were more likely to choose the status quo option (which, recall, had a zero cost) whereas male students were more likely to choose an option other than the status quo option.

A useful way of using the attribute level parameter estimates is to derive the willingness to pay associated with each attribute level. This is done by dividing the coefficient on a particular attribute level by the

Table 4: Conditional logit model estimates of preferences for assignment attributes

Variable	Coefficient
Exam relevance is high	1.629** (0.076)
Exam relevance is moderate	1.125** (0.064)
Nature of feedback is high	0.876** (0.064)
Nature of feedback is moderate	0.552** (0.064)
Speed of getting back assignment result is fast	0.373** (0.060)
Practice assignment is available	0.324** (0.044)
Speed of getting back assignment result is moderate	0.189** (0.059)
Assignment form - online with graphical aids	-0.003 (0.058)
Assignment form - online with no graphical aids	0.023 (0.059)
Assignment Price	-0.029** (0.002)
Male	-0.296** (0.074)
Mature Student	-0.275** (0.095)
Financing study a burden	0.203** (0.073)
University Limerick	0.653** (0.102)
University College Cork	0.698** (0.084)
Alternative specific constant	0.362** (0.173)
Log likelihood	-3713
AIC	7459
BIC	7559
Obs	3948

Standard Error in parentheses. ** indicates significant at 95% level.

coefficient on assignment price for the CL. The results are reported in Table 5. The willingness to pay for an assignment system that has high exam relevance is a little over €56. This seems intuitively plausible to us given that many students would have paid more than this for private lessons in secondary school and university.

Table 5: Conditional logit model Willingness to Pay (WTP) Estimates for Attributes of Assignments

Variable	WTP (€)
Exam relevance is high	56.17 (2.8)**
Exam relevance is moderate	38.58 (2.4)**
Nature of feedback is high	30.03 (2.3)**
Nature of feedback is moderate	18.9 (2.2)**
Speed of getting back assignment result is fast	12.7 (2.06)**
Practice assignment is available	11.1 (1.55)**
Speed of getting back assignment result is moderate	6.5 (1.99)**
Assignment form - online with graphical aids	-.09 (1.98)
Assignment form - online with no graphical aids	.79 (2.0)
Alternative specific constant	12.4 (6.0)**

Standard Error in parentheses. ** indicates significant at 95% level.

The CL model is associated with some important limitations (Train, 2003)—as a result we also present estimates from a latent class (LC) model. This is a popular alternative to the CL model within the wider DCE literature and it potentially provides greater information with respect to respondents' preferences. For instance this model enables us to examine whether there are sub groups within our sample who have different preferences for the attributes. Much attention has been paid in education research to the idea that there are different types of learners who might share different preferences for assessment (see Gijbels and Dochy, 2006). We were interested in exploring whether there were important differences between groups of students regarding their preferences for assignment systems.

In the LC model specification the vector of coefficients on the explanatory variables take on a finite set of distinct values in which each student has a probability of belonging to a particular class based on their preferences for the attributes. The assumption underlying the model is that students who have a probability of belonging to the same class are assumed to have the same preferences as each other but differ in their preferences compared to students assigned to different classes. We can also investigate the possibility that certain factors such as gender, aptitude for economics, etc. help to explain variations in student preferences for different assignment systems by using

these as covariates explaining membership in a particular class.

To illustrate the LC method we present the results of a four-class LC model specification[2] in Table 6. This model probabilistically assigns 27% of students to class 1, 26% to class 2, 20% to class 3 and 27% to class 4. The coefficients representing the attributes are quite different across the four classes indicating a substantial degree of heterogeneity across our sample with regard to assignment system preferences. All classes have negative and significant cost coefficients and positive and significant coefficients on the feedback and exam relevance dummies, except for the moderate feedback level which is not significant in class 1. As expected, the magnitude of these coefficients varies across the four classes.

We also observed variation in preferences with regard to the form that assignments are delivered. Students probabilistically assigned to classes 1 and 2 are shown to prefer paper-based assignment systems while those assigned to classes 3 and 4 tend to favour online assignment systems. We also observe heterogeneity across the student sample in relation to preferences for the speed of getting assignment results back. Students probabilistically assigned to class 1 and 2 show no significant preferences for the speed of result attribute while those in classes 3 and 4 exhibit a significant positive preference for receiving results quickly.

Table 6: Latent Class model estimates of the coefficients for assignment attributes

Coefficient	Class 1	Class 2	Class 3	Class 4
Assignment Price	-0.035 (0.01) **	-0.033 (0.01) **	-0.006 (.003) **	-0.085 (0.006) **
High feedback	0.514 (0.22) **	2.106 (0.26) **	0.592 (0.15) **	1.311 (0.19) **
Moderate feedback	0.116 (0.26)	1.429 (0.21) **	0.437 (0.18) **	0.851 (0.18) **
High exam relevance	0.650 (0.24) **	3.663 (0.27) **	1.230 (0.21) **	2.461 (0.25) **
Moderate exam relevance	0.635 (0.21) **	2.235 (0.21) **	0.998 (0.18) **	1.796 (0.19) **
Assignment form online with graphical aids	-0.443 (0.24)	-0.701 (0.16) **	0.829 (0.25) **	0.317 (0.15) **
Assignment form online with no graphical aids	-0.590 (0.24) **	-0.387 (0.19) **	0.776 (0.21) **	0.149 (0.15)
Practice assignments available	0.145 (0.15)	0.678 (0.10) **	0.343 (0.09) **	0.492 (0.12) **
Speed of getting back assignment result is fast	0.397 (0.28)	0.052 (0.16)	0.897 (0.24) **	0.342 (0.15) **
Speed of getting back assignment result is moderate	-0.337 (0.27)	-0.031 (0.17)	0.651 (0.17) **	0.229 (0.17)
Alternative-specific constant	4.093 (0.52) **	0.483 (0.44)	-1.22 (0.71)	-0.085 (0.47)
Male	-0.743 (0.16) **	-1.023 (0.22) **	0.781 (0.31) **	0.367 (0.22)
Mature Student	-2.197 (0.40) **	0.486 (0.29)	-0.138 (0.32) **	-1.498 (0.25) **
Financing study a burden	0.381 (0.13) **	0.123 (0.20)	0.253 (0.26) **	-0.530 ** (0.21)
Class Probability				
Constant	-0.534 (0.35)	-0.487 (0.37)	-0.039 (0.31)	-
University of Limerick	0.492 (0.53)	0.461 (0.56)	-0.661 (0.59)	-
University College Cork	1.004 (0.47)**	0.865 (0.48)**	-0.554 (0.57)	-
Estimated class probabilities	0.257	0.25	0.187	0.258
Log likelihood	-2774			
Pseudo R2	0.344			
AIC	5677			
BIC	6084			

Standard Error in parentheses, ** indicates significant at 95% level.

To investigate whether the preferences varied across the three universities we estimated the model with the university dummies as covariates explaining class membership in the LC model. As the covariate terms in Table 6 highlight, students from UCC are more likely than NUIG students to belong to classes 1 or 2 compared to class 4 (the base class). However, we find no such evidence with regard to UL students. The results suggest that UCC students have a preference for paper-based assignments and are indifferent to the speed of receiving their assignment result relative to students probabilistically assigned to class 4. This

[2] In order to decide the number of classes with different preferences, we use the information criteria statistics developed by Hurvich and Tsai (1989) and based on guidance from Scarpa and Thiene (2005).

might be explained by the greater use of in-class exams rather than take-home assignments in UCC coupled with the lower usage of online technology in assessment submission there compared to students in UL and NUIG. It also suggests that the preferences of the UCC students may change as they are exposed to more use of online assignments.

In Table 7 we present the willingness-to-pay (WTP) estimates for the LC model. We present the class specific estimates and also the weighted average of WTP from all classes combined. This is calculated by multiplying the class specific WTP estimates by the probability of class membership and adding the resulting estimates. There was a substantial degree of heterogeneity in WTP estimates between the classes. High exam relevance was consistently associated with the highest WTP estimate of all the attributes across the classes. There were differences between the classes in terms of the preferences for online versus paper-based assignments. In particular, students probabilistically assigned to class 1 and class 2 were willing to pay some money not to be given online assignments, while students assigned to classes 3 and 4 had a positive WTP for online assignment students compared to paper-based assignments. This suggests that variation in assignment form would be required to satisfy the range of student preferences. Apart from class 3, students do not show a strong preference for the highest level of the attribute that captures the speed with which they receive their assignment results. We also note that for class 3 in particular very large WTP estimates are retrieved (this may be a function of the large number of parameters that are estimated in the LC specification, which can result in extreme values being obtained.)

There are other interesting statistical models that can be used with DCE. The Random Parameters Model also allows for heterogeneity in preferences but assumes a continuous distribution in the preferences of respondents for attribute levels. We estimated this model and found a substantial amount of heterogeneity among students in regards to their preferences for online assignment systems without graphic interface[3]. The results from the CL or the LCM models can be used to develop particular 'types' of assignment systems with corresponding prices. Thus an instructor who was using an assignment system that was essentially the same as our status quo option could estimate how much money her students would be willing to pay for a different assignment system relative to the status quo (base case) assignment, if the instructor believed that her students had similar preferences to those in our sample. See Flannery et al, 2013b for some examples.

Table 7: WTP Estimates for assignment attributes in the latent class model

	Class 1	Class 2	Class 3	Class 4	Weighted Average WTP
	WTP (€)	WTP (€)	WTP (€)	WTP (€)	WTP (€)
High feedback	14.62 (6.3)**	63.02 (9.28)**	99.74 (53.25)	15.34 (1.7)**	42.12
Moderate feedback	3.3 (7.4)	42.7 (6.9)**	73.6 (53.3)	9.96 (1.87)**	27.87
High exam relevance	18.5 (6.9)**	109.6 (11.9)**	207.1 (110.5)	28.8 (2.03)**	78.29
Moderate exam relevance	18.07(5.9)**	66.8 (8.09)**	168.1 (93.28)	21.0 (1.84)**	58.2
Assignment form online with graphical aids	-12.6 (7.5)	-20.9 (5.55)**	139.5 (88.5)	3.7 (1.76)**	18.57
Assignment form online with no graphical aids	-16.8 (7.9)*	-11.5 (6.02)	130.6(75.6)	1.7 (1.76)	17.7
Practice assignments available	4.1 (4.08)	20.29 (3.54)**	57.8 (34.8)	5.7 (1.24)**	18.43
Speed of getting back assignment result is fast	11.3 (7.46)	1.55 (4.65)	151.05 (87.7)	4.0 (1.73)**	32.56
Speed of getting back assignment result is moderate	-9.6 (8.06)	-0.93 (5.1)	109.6 (71.9)	2.68 (1.92)	18.48

Standard Error in parentheses, ** indicates significant at 95% level.

Discussion

The desire to align student and instructor perceptions and expectations with regard to assessment

[3] These results are available from the authors upon request.

in higher education is well established (Price et al. 2011; Birenbaum, 1997, 2007). With the development of online delivery methods, a more individualized and heterogeneous package of assessment and assignments for students within the same course may become more feasible. In such an environment it is important for educators to learn as much as they can about what students think about different aspects of the learning process. We think that the DCE approach is a fruitful method for eliciting information about preferences for aspects of the learning process such as assignment systems that has not been used very extensively in education research to date.

Our study illustrates the advantages of the DCE method over other techniques for eliciting preferences such as the standard end-of-course evaluations that generally asks fairly simple categorical or Likert-style questions. We are able to learn far more about the nuances of preferences using a DCE. The results suggest that there is scope to design alternative assignment systems to satisfy differences in preferences. In fact the idea of "students as consumers of education" suggests that student preferences for the delivery of their education will become increasingly important. Our study may also have marketing implications with respect to assignment delivery tools as we illustrate variation in the amount that students were willing to pay for assignment systems based on their attributes. The differences in preferences across universities may also help to inform different pricing strategies and prove more efficient in the market for these types of products.

More generally, technological advances such as MOOCs may mean that universities compete globally for students, as geographical proximity becomes less important. It seems plausible to us that students will have much more freedom to choose different elements of their educational experience including assignment systems that they think are most suitable for their particular style of learning and/or most suitable to help them pass a particular course. Course providers, be they traditional third level institutions or new entities such as Udacity or Coursera, need to be mindful of the preferences of students in designing courses in this rapidly evolving education environment.

Obviously, educators have concerns and priorities that are broader than simply meeting the preferences of students (U.S. Department of Education, 2010) and we are not arguing that students' preferences for assignment systems should be the only information used to make decisions in universities. Students may focus too narrowly on 'studying for the exam' and neglect other aspects of the learning process. Students' preferences may not be based on a full understanding of the benefits of education. Notwithstanding that, we believe that it is still useful to learn more about the trade-offs that students are prepared to make regarding different attributes of the learning process and that a DCE is a useful way of doing so.

We are confident that there are other aspects of the education and learning process that DCEs could be used to analyse. For example, in medical education it might be interesting to explore students' preferences for types of feedback on clinical practice where the attributes of the feedback process could include issues such as whether the feedback is given one-to-one or to a group and whether a structured or conversationalist approach is used. It would also be interesting to use the approach to examine what course and university attributes are used by prospective students when they are deciding upon which course to apply for. An individual who is keen on undertaking an undergraduate programme in business might make his decision based on the modules offered in different programmes as well as factors such as distance from his home to the alternative universities offering the courses and the ranking of the universities in terms of reputation and scholarly achievements. Finally, a DCE that analysed the preferences of lecturers for alternative assignment attributes would be an interesting complement to the work presented here and provide a better understanding of the compatibility or otherwise between student and teacher perspectives. We anticipate more research on education issues using this technique and expect that such research can facilitate the educational dialogue between educators and students that Carless (2006) called for.

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