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An Experiment with Online and Paper Assignments: Grades, Completion Rates and Student Preferences

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Abstract:

With the growth of online assignment tools across many courses in higher education, questions remain as to the impact of such tools on student learning and engagement. In this paper we present an experiment that attempts to measure these effects, as well as a survey aimed at gauging student preferences for traditional or online assignment formats. The results of this experiment comparing online assignments with paper assignments are mixed. Students that complete paper assignments get a higher mark. However, students are more likely to complete an online assignment. These conflicting advantages require the educator to make trade-off when determining the assignment format to use. When in doubt the educator might consider using technology as the results of a student survey presented in this paper revealed that the students preferred the online assignments – a result in line with the literature. While the evidence is not conclusive it would appear that the reason for the preference is the ease with which they can complete the assignments.

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Introduction

An indication of the current preoccupation with the influence of technology on education can be taken from the discussion of massive online courses (MOOCs) at the World Economic Forum in Davos, Switzerland in January 2013. Reporting on the event the *New York Times*, of 27th January 2013, noted that "Coursera, at Stanford, for example, has existed just a few months and now has 214 courses attracting 2.4 million students from 196 countries". On 15th March 2013 the *Financial Times* also gave a cautious welcome to a bill submitted to the California legislature requiring public universities to recognize credits from online providers. Most of the debate on technology in education focuses on how technology facilitates a more widespread delivery of education. A smaller part of the debate discusses the implications of technology for assessment. A good illustration of the treatment of delivery and assessment of education in the popular debate can be found, in an article by Nathan Heller, in *The New Yorker* magazine of 20th May 2013.

The purpose of this paper is to document an experiment conducted into the benefits of online versus paper assignments. The experiment was conducted on the take-home assignment assessment element of an undergraduate managerial economics course. There were eight assignments. In total these eight assignments counted for 25% of a student's final grade in the course. The students were sorted into four groups. Each of the four groups was assigned two paper assignments and six online assignments, e.g. Group 1 completed the first and fifth assignment by paper and completed the other six assignments online. For any given assignment, one group was allocated a paper assignment while the other three groups were allocated an online assignment, e.g. Assignment 1 was completed by Group 1 on paper and by Groups 2, 3 and 4 online. The paper assignments were identical to the online assignments.

The experiment makes it possible to compare the online and paper assignments by (i) the marks students receives on the assignments and (ii) the assignment completion rates. After the eight assignments were completed, students were surveyed about the views on the paper and online assignments. The results of this survey can be used, in conjunction with the student assignment marks and assignment completions, to provide a wider view of online versus paper assignments.

There are five sections to the paper. It begins with a brief review of the literature. This is followed by a description of the experiment. The following section presents the assignment completion rates and assignment scores for the course. The results of a student survey are then presented. A final section is devoted to a discussion of the results.

1

Some Relevant Literature

This section reviews some of the relevant literature on assessment and e-assessment. In particular, it draws attention to the importance of feedback and the role of the learner. This section very briefly examines: the literature on formative assessment and feedback; the role of the learner and the importance of self-regulating and strategic behaviour; the sustainability of assessment and the role for e-assessment; the student perspective on e-assessment; and, e-assessment in economics.

Formative Assessment and Feedback

One of the most influential pieces of literature on assessment in the last decade and a half is Black and Wiliam (1998). This review article surveyed a decade of literature since the publication of two other substantial review articles by Natriello (1987) and Crooks (1988). The overriding message that comes through from Black and Wiliam (1998) is the importance of feedback and the involvement of students via formative assessment. The involvement of students in formative assessment moved the issue of feedback on from Sadler (1989) where three elements required for student to benefit from feedback were identified. These three elements are student knowledge of (i) the desired level of performance; (ii) the current level of performance; and, (iii) how to act to close the gap between current and desired performance. Black and Wiliam argued that the involvement of students in the assessment was crucial to the effectiveness of feedback. Specifically they noted the importance of how the students both received and responded to feedback. In effect they placed relatively greater emphasis on internal cognition, motivation and behaviour of students than had the previous literature.

The Role of the Learner: Self-regulating and Strategic Learners

A decade or so on from Black and Wiliam (1998), David Boud and Nancy Falchikov brought together some of the leading contributors to the field of assessment in their edited volume *Rethinking Assessment in Higher Education* (Boud and Falchikov, 2007). The contributions to this volume highlight how the role of the learner has assumed even greater importance in the literature since Black and Wiliam (1998). Not only has the role of the learner increased, the perspective from which the discussion is presented has changed. The newer perspective locates the learner "self" in the centre. There is much greater emphasis on self-assessment and on the groups to which the learner belongs in terms of peer-assessment and communities of practice (Tan, 2007; Falchikov, 2007). Boud and Falchikov (2007) bring together the more recent perspectives on assessment under the heading of assessment as informed judgement.

A feature of the recent literature, closely related to self-assessment, is the emphasis on self-controlling or self-regulating aspect of assessment. An excellent schema of the more encompassing recent approach is presented in Nicol and Macfarlane-Dick (2006). In this schema the feedback model of Sadler (1989) is extended to a model of self-regulated learning where feedback principles support and develop the self-regulation of students. Included in this more detailed view of the motivational channels through which formative assessment works is a more nuanced view of the learner and their approaches to learning. While Black and Wiliam (1998) titled a sizable subsection of their article 'Strategy and Tactics for Teachers', the more recent literature addresses the issue of the strategic behaviour of the learner (Struyven, Dochy & Janssens, 2005; Nicol & Macfarlane-Dick, 2006; Dochy, Segers, Gijbels & Struyven, 2007). The strategic learner being the latest addition to the two more traditional classifications of approaches to learning, namely, those who adopt either the surface approach to learning or the deep approach to learning. It was strategic learners that Biggs (2003) had in mind when he argued for a strategic or constructive alignment of assessment with the learning objectives.

Sustainable Assessment

Self-assessment and peer-assessment have the added advantage of making assessment more sustainable (Boud, 2000; Byrnes & Ellis, 2006; Hounsell, 2007). This is an important consideration because, as Knight (2002: p277-8) points out, "[j]udgements are economic processes" and "considerations of cost" can skew assessment. It is in this area that advocates of e-assessment suggest it has offers certain advantages "through the development of a number of interactive tasks that can be automatically marked" (Whitelock, 2010: p334). Such automated assessment and feedback is clearly located within the Nicol and Macfarlane-Dick (2006) model of self-regulated learning. Nicol and Macfarlane-Dick (2006: p202) say "external feedback to the student … might be provided by the teacher, by a peer or by other means (e.g. a placement supervisor, a computer)". While some critics argue that most e-assessment only imitates traditional assessment, others claim e-assessment can be so much more depending on the design and context in which it is used (Elliott, 2007; Nicol, 2007; Draper, 2009; Whitelock, 2010).

Student Perspective on e-Assessment

Consistent with the greater emphasis on the learner perspective on assessment there has been some literature that has focused on the student perspective on assessment (Struyven, Dochy & Janssens, 2005; Gijbels & Dochy, 2006; Bartram & Bailey, 2010) and e-assessment (Dermo, 2009). Struyven, Dochy and Janssens (2005: p336) argue that if "students' perceptions of the learning

environment are such an important variable in student learning, students' views may offer us a way forward for improving our educational practice". In their study of Australian universities, Gosper, Malfroy and McKenzie (2013) find that current use of technology is below preferred use in virtually all cases. In terms of e-assessment they found that the two lowest items of usage of Learning Management Systems was for "Return assignment online" and "Submit assignment online". In both cases the students wanted much greater usage.

e-Assessment in Economics

In recent years there has been a widespread growth in the use of technology in economics education. Two of the more widely used delivery and assessment technologies used in economic education are Aplia and MyEconLab. For the purposes of comparing with the experiment in this paper, it is useful to consider a number of papers have been published that examine the effectiveness of Aplia. Some found a positive effect from the use of Aplia (Collins, Deck & McCrickard, 2008; Nguyen & Trimarchi, 2010), some found a negative effect from the use of Aplia (O'Dea and Ring 2008), and some found no effect (Lee, Courtney & Balassi, 2010; Hernandez-Julian & Peters, 2012). Lee et al (2010) argued that anecdotal evidence suggested student preferred Aplia to paper assignments. Hernández-Julián and Peters (2012) reported summary statistics from a short student survey that suggested students preferred the Aplia assignments to paper assignments.

In terms of engagement with technology more generally, Butters and Walstad (2010) present a remarkable steady increase in the uncompleted questions in the second half of a paper MCQ test compared to a computer test. When discussing the implications for instruction they suggest, following Kingston (2009), that students find computer testing a more positive experience than paper testing. These findings are consistent with Lee et al (2010) and Hernández-Julián and Peters (2012). Fluck, Pullen and Harper (2009) find that the evidence in favour of computer examination testing is more mixed. However, some of the problems reported were specific to the time and place of their case study. The authors viewed some of the issues as one that their experience could be used to eliminate.

To summarise, the relevant elements of the literature suggest: feedback is important for learning and technology has an important role in facilitating feedback; the behaviour of the learner and their preference for assessment format can have an impact on learning.

The Assignment Experiment: Online Versus Paper

Aplia is a computer application designed to replace traditional paper-based assignments in economics. Its ability to present the dynamics of diagrams and graphs is critical to its use in economics. It provides facilities for formative and summative assessment. Aplia also scaffolds student learning by providing a facility that students can access when they are experiencing difficulties. This "Help" (or "Hints") facility comes in the form of drop-down menus.

In 2008-9 the assessment in intermediate managerial economics course was redesigned in an effort to (i) integrate Aplia more fully into the course and (ii) evaluate the benefits of Aplia compared to the tradition paper based approach. The course was delivered in the first (fall) semester of 2008-09. The vast majority of students were in the second year of various degree programmes and all had taken a principles of economics course in their first year at University. The course was taught to two groups both of whom met three times a week for 50 minute lectures.

The course was assessed by assignments and a final (or end-of-year) examination. The eight assignments counted for 25% of a student's final grade and the final examination counted for the remaining 75%. To provide a benchmark for students in their evaluation of e-assessment using Aplia, each student completed six of the eight assignments by Aplia and two of the eight assignments via the traditional pen and paper method. The paper assignments were identical to the Aplia assignments.

The students were sorted alphabetically into four different groups. Each of the four groups was assigned two paper assignments and six Aplia assignments. For example, Group 2 completed the second and sixth assignment by paper and completed the other six assignments on Aplia. For each assignment, one group was allocated a paper assignment while the other three groups were allocated an Aplia assignment. For example, Assignment 1 was completed by Group 1 on paper and by Groups 2, 3 and 4 on Aplia. The students had access to all the learning supports provided by Aplia regardless of their group or assignment number. A schema of the assignment structure is provided in Figure 1.

The Aplia results were made available immediately after the submission deadline. The paper assignments were graded by one person and were returned within one week of the submission deadline. The student survey was completed on the last week of term when the students had completed their assignments and had been given their results.

FIGURE 1: Assignment Stage of Assessment

ASSIGNMENT TOPICS	Group 1 Family Names: A to Fah	Group 2 Family Names: Far to Ke	Group 3 Family Names: Ki to Nol	Group 4 Family Names: Noo to Z
1. Demand	Paper	Aplia	Aplia	Aplia
2. Consumer Choice	Aplia	Paper	Aplia	Aplia
3. Production	Aplia	Aplia	Paper	Aplia
4. Costs	Aplia	Aplia	Aplia	Paper
5. Perfect Competition	Paper	Aplia	Aplia	Aplia
6. Monopoly and Pricing Strategies	Aplia	Paper	Aplia	Aplia
7. Monopolistic Competition	Aplia	Aplia	Paper	Aplia
8. Game Theory and Information	Aplia	Aplia	Aplia	Paper

Assignment Scores and Completion Rates

It is possible to compare the assignment formats based on the completion rates for each assignment format and the marks students received for each assignment. Table 1 shows that the average score per assignment is higher for the paper assignments in six of the eight assignments (A1, A2, A3, A5, A7, A8).

Table 1: Difference in Assignment Marks for Students who complete Aplia and Paper Assignments

	Aplia	Paper	Difference
A1	58.61	69.03	-10.42
A2	53.38	53.75	-0.37
A3	64.68	73.67	-8.99
A4	65.56	62.97	2.59
A5	57.50	66.05	-8.54
A6	63.21	52.22	10.99
A7	58.46	69.98	-11.53
A8	68.22	69.88	-1.66

The variation across both students and sections in assignment scores entails that our data can be analysed econometrically using panel data techniques. Our approach is to estimate assignment scores as a function of whether the student did the assignment on Aplia or on paper using a fixed effects regression. This allows us to robustly gauge the impact of assignment type on the eventual

assignment score, controlling for any unobserved heterogeneity within the individual such as ability. The results of the fixed-effects model are reported in Table 2. We included a dummy variable for each section to capture common differences across sections. Three of these dummies are significant indicating the particular economic topic covered and/or the questions asked can have an impact on the student's assignment score.

Table 2: Fixed-effects model on assignment performance with Aplia/paper dummy

Constant	31.88***
Aplia/paper dummy	−1.40***
Dummy for Section 2	-4.2***
Dummy for Section 3	2.7***
Dummy for Section 4	1.23
Dummy for Section 5	−.69
Dummy for Section 6	−.32
Dummy for Section 7	−.53
Dummy for Section 8	3.1***
Observations	1,802
Sigma_u	7.73
Sigma_e	8.5
Rho	0.44

Notes: Dependent variable is the score that a student received on assignment; Aplia/paper dummy is specified with 1 = assignment completed on Aplia and 0 = assignment completed on paper.
*$p < .1$; **$p < .05$;***$p < .01$

The negative coefficient on the Aplia/paper coefficient indicates that completing an assignment on paper entailed a significantly higher assignment score than those completed on Aplia. The magnitude of the coefficient infers that students may gain an additional 1.4 marks by completing an assignment on paper. This corresponds to roughly a 2.8% variation as the particular assignments were marked out of 50. These results support those in Table 1.

Table 3: Completion Rates of Assignments

	Aplia	Paper	Difference
A1	92.46	88.89	3.57
A2	92.02	86.21	5.81
A3	92.12	85.29	6.83
A4	87.88	73.97	13.91
A5	92.96	69.44	23.52
A6	93.90	72.41	21.49
A7	90.64	83.82	6.82
A8	94.44	68.49	25.95

Table 3 presents the completion rates for each assignment. The completion rate for all eight assignments was higher for the Aplia assignment. The information in Table 3 presents a puzzle when combined with the information in Tables 1 and 2. Although the average score is higher for the paper format on most of the assignments, the completion rate for Aplia assignments is higher for all eight

assignments. Why would students complete more of the assignments with the lower score per assignment? One possible reason is that there is a lower cost to completing and submitting an Aplia assignment compared to a paper assignment. Students could be making a trade-off between reward and effort.

Our experiment again allows us to investigate this relationship in a more robust manner using econometric estimations. We follow the analysis seen in Table 2 and utilise the panel data format to estimate a fixed effects logit model with a dependent variable of assignment completion. This allows us to investigate the relationship between assignment delivery mode and assignment completion, controlling for any unobserved individual heterogeneity. Table 4 presents the results of this specification with section dummies as well as the Aplia/paper dummy included as explanatory variables. There is a positive and significant relationship between assignment completion and delivery of the assignment on Aplia rather than on paper, controlling for possible individual heterogeneity and assignment section. Therefore, the method by which the assignment is completed has a significant impact on a student's performance on the corresponding assignment.

The results in Table 4 imply that students are more likely to engage with Aplia (technology) than paper assignments. This confirms statistically the evidence presented in Table 3. The larger completion rate for online assessment versus paper assessment is consistent with Butters and Walstad (2010).

Table 4: Fixed-effects logit model on assignment completion with Aplia/paper dummy

Aplia/paper dummy	1.65***
Dummy for Section 2	-.09
Dummy for Section 3	-0.39
Dummy for Section 4	-1.02***
Dummy for Section 5	-.67**
Dummy for Section 6	-.31
Dummy for Section 7	-.63*
Dummy for Section 8	-61*
Observations	984
Psudeo R^2	.15

Notes: The dependent variable is a dummy variable equal to 1 if the assignment was completed and 0 if it wasn't; Aplia/paper dummy is specified with 1 = assignment completed on Aplia and 0 = assignment completed on paper.
*$p < .1$; **$p < .05$; ***$p < .01$

To summarise, students who completed the assignments on paper tended to get higher marks. However, the completion rates were higher with Aplia. From the educator's point of view there is a trade-off. Given the preference for greater levels of technology use then the educator should probably use the online assessment where there is greater student engagement.

Results of a Student Survey

The students were surveyed about their experience with online and paper assignments. The timing of the survey is crucial for the interpretation of the results. The students were surveyed at the end of the course after they had completed their assignment, got their assignment results, but before the examination. It is also important to remember that the paper and Aplia assignments were identical.

Based on the themes from the literatutre the student survey results are interpreted under three broad headings:

1. Do students prefer completing assignments by paper or e-assessment?
2. Do students believe they learn more from paper or e-assessment?
3. What approach to learning did the students take?

The literature suggests that the first question is important because the perception of the learning environment is important for student learning. The second question is central to the issue of e-assessment. The third question is an attempt to examine if the students adopt a strategic approach to their learning.

Do students prefer completing assignments by paper or e-assessment?

The completion rates clearly suggest student prefer Aplia assignments. The survey result tend to confirm this fact. Table 5 presents the results of the student survey questions that were directed to establishing why students preferred one assignment format over another. Of the students who preferred Aplia, 47.5% listed the drop down menus as the main reason they preferred Aplia. In other words, they appreciated the help it gave them towards completing their assignment. A more positive spin on the response could be that Aplia scaffolds student learning. In such a scenario the learning might have taken place in the preparation for the assignment rather than in the completion of the assignment. Given that the Aplia drop down menus were also available to those doing the assignment on paper, then, one possible explanation for the gap between the assessment scores and the stated preference for Aplia, is that the learning occurred in the preparation for completion of the assignment, rather than the format on which it was completed.

Table 5: Possible Reasons for Preferences

If you prefer Aplia assignments to paper assignments please select which of the following reason is most important to you.

%	Response Options
47.5	I prefer Aplia because the drop down menus typically gave me an idea of the answer to some questions
25.8	I prefer Aplia because I learn more from them than the paper assignments
18.4	I prefer Aplia because I get a mark on my assignment much quicker than when I do a paper assignment
8.2	I prefer Aplia because I don't have to bother about going to lectures or to the economics department to collect and hand in my assignment
100.0	

If you prefer paper assignments to Aplia assignments please select which of the following reason is most important to you.

%	Response Options
56.2	I prefer paper assignments because I think they are better preparation for exam conditions
29.2	I prefer paper assignments because I learned more from doing them than the Aplia assignments
13.5	I prefer paper assignments because I don't have to worry about internet access when completing my assignment
1.1	I prefer paper assignments because they are easier to complete
100.0	

Which of the following statements do you most agree with?

%	Response Options
59.5	I found the Aplia assignments much easier to complete than the paper assignments
24.6	Both kinds of assignments were equally easy to complete
9.7	Other
6.2	I found the paper assignments much easier to complete than the Aplia assignments
100.0	

Given the importance of feedback for learning it might seem strange that only 18.4% claimed that it was speedier feedback that was the main reason they preferred Aplia. The Aplia feedback was available immediately after the submission deadline.

Of those who prefer paper assignments, 56.2% claimed that they preferred the paper assignment because they felt it better prepared them for the examination. A consistent explanation of the data in Table 5 is that students prefer Aplia because it prepares them for the assignments and they prefer the paper assignments because they believe they prepare them better for the examination. The student answers are in keeping with Butters and Walstad (2010) who suggest that practice with the format of an assessment results in better performance. The idea that the paper assignments helped with the examination preparation needs to be interpreted carefully. The students knew that the end-of-course examination would be on paper and that computers would not be used. However,

given that the assignments were identical it is difficult to understand the advantage that a paper assignment might provide.

Do students believe they learn more from paper or e-assessment?

Table 6 presents the results of the survey questions that sought to elicit the student perspective on the impact of Aplia on their understanding in the course. A total of 82.8% of students felt that the Aplia assignments had a positive effect on their understanding of the course. It is possible that there is a response bias in these answers because students were not asked to compare Aplia with an alternative. When students were asked to compare their learning from the alternatives, Aplia still came out on top. The answers to the second question presented in Table 6 show that the students felt they learned more from the Aplia assignments by a ratio of almost 2 to 1 (40.5% compared to 20.3%). The strength of the student preference for Aplia is somewhat surprising given the higher assignment scores for paper presented in Tables 1 and 2 above.

Why did the students claim to have learned more from Aplia? When completing the survey the students had received their assignment scores and these scores suggest that paper assignments contributed to greater learning for those students who submitted a given assignment. It is possible that it was the "help" facility (or practice assignments) that produced these student survey responses.

TABLE 6: Comparisons of Aplia and Paper Assignment

Did Aplia's assignments have an effect on your overall understanding of the topics covered in the course?

%	Response Options
82.8	Aplia's assignments had a positive effect.
13.8	Aplia's assignments had no effect.
3.4	Aplia's assignments had a negative effect.
100.0	

Which of the following statements do you agree with?

%	Response Options
40.5	I learned more from the Aplia assignments than the paper assignments
35.7	I learned more or less the same from the paper assignments as the Aplia assignments
20.3	I learned more from the paper assignments than the Aplia assignments
3.4	Other
100.0	

What approach to learning did the students take?

The literature on assessment raises the issue about the role of the student in assessment. One strand of this literature discusses the self-regulating and strategic behaviour of the learner. Students might have some target score in mind and might seek to minimise their efforts to achieve that score. In this respect Aplia might be the more efficient system. Table 7 shows that 59.5% of the students claimed that they found the Aplia assignment easier to complete. Only 6.2% of those who responded to the survey said that they found the paper assignments easier to complete. These percentages probably reflect the ease of submission rather than the each of completion as Aplia's drop down menus were available to both sets of students. The paper assignment had to be delivered to a collection box in the Department of Economics whereas the Aplia assignment could be delivered from anywhere with internet access.

Table 7 provides further evidence that the students take a strategic approach. These questions were designed to establish how the student used Aplia. Table 7 shows that students attempted to complete the assignment directly and only invested the minimal amount of resources in accessing the answers. Only 7.5% of students went first to the lecture notes whereas 56% went first to the Aplia practice assignment. This self-proclaimed student behaviour is well known to scholars in the education community.

Table 7: Student approach to using Aplia

Which of the following best describes your approach to your assignments in Managerial Economics this semester?

%	Response Options
44.1	I dive into the assignment first and then reference the practice assignments and my own lecture notes and/or the assigned readings in the textbook as needed
26.4	I first scan the assignments to find out what I need to know and review the practice assignments, my lecture notes and/or assigned readings in the textbook to help me to complete the assignments
22.4	I review the practice assignments, my lecture notes and assigned readings in the textbook before attempting my assignments
7.1	Other
100.0	

When you are having difficulty with an assignment which of the following options are you most likely to use for help?

%	Response Options
56.0	Refer to the corresponding question in the practice assignments
21.5	Refer to the textbook
15.0	Ask a friend or somebody in the class
7.5	Refer to the lecture notes
100.0	

Another interesting result is that approximately one in twelve students (8.2%) claim that the primary reason for preferring Aplia was that it allowed them to skip lectures. This is consistent with Hernández-Julián and Peters (2012) who find that online assignments resulted in lower attendances.

Summary and Conclusions

This paper presented the results of an experiment comparing paper assignments with online assignments. The experiment provided data on assignment scores and completion rates. It was supplemented by a student survey. The evidence from the experiment and the survey results illustrate the complex issues involved in the use of technology in assessment.

The experiment provided evidence that paper assignments deliver higher marks for those who complete them. This is in contrast to Hernandez-Julian and Peters (2012) who found no evidence that assignment scores differed between Aplia or paper formats. Our results might suggest technology is damaging student learning. However, our results illustrate that students are less likely to complete paper assignments. The greater willingness of students to engage with Aplia assignments enhances student learning. These results are consistent with the findings of others (Butters & Walstad, 2010; Hernandez-Julian & Peters, 2012). Therefore, the educator is presented with a trade-off. Paper assignments result in higher marks per assignment but students are likely to complete more Aplia assignments.

The higher marks for paper assignments, combined with the greater completion rate for Aplia assignment, presents a slight puzzle. It is a puzzle because researchers in economics tend to model students as maximizing their marks. The focus on assessment scores is the dominant approach to determining the effectiveness of educational technology in economics. To quote Sosin, Blecha, Agarwal, Bartlett and Daniels (2004: p253), "[e]conomists typically analyze the impact of instructional innovations by testing for significant differences in student performance between a test and control course using a production function explaining student performance". However, this approach has some limitations as pointed out by William Becker who says that "education is a multi-product output that cannot be reflected in a single … test score" (Becker, 1997: p1464). He lists other problems with the measurement of student performance by a test-score – one of which is that test scores are only one part of a student's decision making system. One possible interpretation of our findings is that students like Aplia because it scaffolds their efforts in completing their assignment. An alternative interpretation is that students are minimising effort.

The result from the student survey results presented in Tables 5, 6 and 7 are not inconsistent with view that the online assignments provide a better student experience. The main reason students gave for preferring Aplia is the drop-down menus that scaffold student assessment. Students also stated that they found the Aplia assignments easier to complete. These views were consistent with the student behaviour on submission rates. Other answers suggested that the students appreciated the supports offered by the Aplia's course management. This softer information helps us better understand student behaviour – even when it may not be fully in their best educational interest.

It should be noted that the assignments in the experiment were identical. The development of technologies like Aplia and MyEconLab has helped educators in economics. That said, there are limits to the type of assignments that can be completed via such technologies, e.g. they are unable to grade text answers.

Our examination of the assignment scores, assignment completion rates, and student survey results paints a complex picture of the relationship between technology and learning. Our results suggest that there is a nuanced trade-off between paper and online assignment formats for the educator to negotiate.

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