

1 **Title:** Student Use and Perception of Technology Enhanced Learning in a Mass Lecture Knowledge-Rich Domain
2 First Year Undergraduate Module

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22 **Abstract**

23 The purpose of this study was to examine student use and perceptions of technology enhanced
24 learning tools (TELTs), including their value for learning. Students enrolled onto a 12-week
25 undergraduate science module had access to four TELTs each week, (i) a recording of the
26 lecture (Panopto™), (ii) an animated mini review of the lecture (ShowMe), (iii) a multiple
27 choice quiz hosted on Blackboard® (MCQ), and (iv) a module Twitter feed. Ninety-five
28 students completed a survey at the end of the module, which included quantitative and
29 qualitative questions, to examine whether they perceived the TELT to be useful for their
30 learning. Analysis of the quantitative data suggest that Twitter was used significantly less than
31 the other three TELTs ($p < 0.001$) with less people agreeing that it helped their learning ($p <$
32 0.001), whilst ShowMe and MCQ had a greater occurrence of an ‘agree’ rating compared to
33 Twitter and Panopto ($p \leq 0.002$). A thematic analysis of the qualitative responses identified
34 assessment as a common theme across all four TELTs, being a positive factor for Panopto,
35 ShowMe and MCQ, but negative for Twitter. Students highlighted ShowMe as being
36 particularly useful for simplifying information. Based on this study TELTs similar to ShowMe
37 (i.e. animations) are most recommended as this was one of the two highly rated TELTs
38 (alongside MCQ), but may have more potential for crossover with other subjects, and students
39 found it useful for more than just assessment.

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41 **Key words:** Social network; animations; assessment; TEL; e learning

42 **Introduction**

43 Technology enhanced learning (TEL) has the potential to enhance the student experience by
44 facilitating self-paced learning, lowering inhibition thresholds for asking questions, and

45 allowing access to learning on an as-and-when basis (Kamath, 2015), all of which are factors
46 that may contribute to informal and incidental learning outside of the formal learning space
47 (Peart, Johnstone, Brown, & Bangani, 2014). There is a body of research examining the role
48 of the teacher in facilitating TEL, and a reservation or anxiety from staff has been described
49 with respect to the technology acceptance model (Blackwell, Lauricella, & Wartella, 2014;
50 Gong, Xu, & Yu, 2004; Louw, 2015; Teo, Lee, & Chai, 2008). Such problems may present a
51 barrier to the promotion of TEL to support student learning. However, an aspect that has been
52 less researched is the contribution of students to the impact of TEL, and in particular their
53 perspectives on TEL tools (TELT). There is a wealth of information on student perceptions of
54 a selection of 'learning objects' (LO) and 'web based learning tools' (WBLT) (Cochrane, 2005;
55 R. Kay, 2011; R. H. Kay & Knaack, 2009; Nurmi & Jaakkola, 2006; Vargo, Nesbit, Belfer, &
56 Archambault, 2003). Such studies can provide a useful insight for LO and WBLT developers,
57 but the implication from a teaching perspective is somewhat limited unless the teacher is likely
58 to use that very specific tool in their teaching. For example Cochrane (2005) evaluated two
59 audio engineering LOs (interactive mixing desk and microphone chooser) and Nurmi and
60 Jaakkola (2006) evaluated three LOs to teach fractions, the Finnish language and electrical DC
61 circuits. Such tools are typically designed to be used in the classroom, and as a result do not
62 promote extra-curricular and informal/incidental learning.

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64 It may be more beneficial from a teaching perspective to understand the benefits of more
65 generic TELTs, which staff can have more control over, implemented over a longer period of
66 time. However current examples are limited, and are focused primarily upon an institution
67 virtual learning environment (VLE) or social networking. Šumak et al. (2011) collated
68 Electrical Engineering and Computer Science students' perceptions of using a general virtual
69 VLE (Moodle) and reported that perceived usefulness was a strong predictor of intention to use

70 the VLE. This again has limited scope today as the use of a VLE is now commonplace within
71 Higher Education. However, the identification of perceived usefulness as a predictor of
72 acceptance is important as it can direct research to now determine what characteristics students
73 consider useful, or indeed how students define 'useful'. Junco et al. (2011) incorporated Twitter
74 into a semester long module for pre-health professional majors, where students were
75 encouraged to continue class discussions, organise study groups, and connect with each other
76 and with staff. They concluded that the use of Twitter successfully increased student
77 engagement, which may present a promising development for a wide range of teachers as the
78 uses could be incorporated into any subject of study. However, the authors did not provide any
79 data on the student perception of the use of Twitter, therefore it is unclear *why* the students
80 engaged with Twitter, and without knowing this it is difficult to predict what other TELTs may
81 be well accepted.

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83 Lecture capture is another example of a generic TELT available to teaching staff. A narrative
84 review identified that students use lecture capture to review content, but there is mixed
85 evidence as to its effect on student grades and attendance (Karnad, 2013). This practice has
86 been examined specifically in higher education science students, namely in the areas of
87 veterinary medicine (Danielson, Preast, Bender, & Hassall, 2014) and pharmacy (Marchand,
88 Pearson, & Albon, 2014). Danielson et al. (2014) reported that students perceived lecture
89 capture to be most useful for learning in content driven lecture sessions compared to group
90 work sessions, particularly for reviewing segments flagged in their notes, recapping a fast
91 lecture, studying for examinations, and reviewing content missed due to absence. Staff agreed
92 lecture capture to be beneficial for students to review lecture content, but identified reduced
93 attendance as a risk. Marchand et al. (2014) also identified reduced attendance as a concern for
94 staff, however neither study reported actual attendance data so it is unknown if the staff

95 concerns were realised. In a letter to the editor Lach and McCarthy Jr. (2015) challenged the
96 findings of Marchand et al. (2014) stating that attendance should not be a concern, as
97 attendance is not a learning outcome and does not guarantee that learning will occur. They
98 argue that staff focusing on the possible negative effect upon attendance may shadow the
99 opportunities afforded by technology.

100

101 A form of TELT currently more researched in younger ages is the use of electronic whiteboards
102 to simplify and share information (Castek & Beach, 2013; Maher, 2013). The potential for
103 these to support learning in higher education has received little attention in the literature, other
104 than being described as a useful tool for in the moment teaching (Archibald, Macdonald, Plante,
105 Hogue, & Fiallos, 2014). Using such a tool to deliver a short summary video of the lecture may
106 act to reinforce learning from the lecture, rather than replace it. Simplifying the lecture content
107 in such a way may also help students direct their learning, and has been proposed as a way to
108 help students overcome troublesome knowledge, as they present scientific mechanisms in the
109 absence of other barriers such new terminology (Peart et al., 2014).

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111 An understanding of student perceptions of different TELTs could be of benefit for a number
112 of reasons; (i) identification of shared characteristics between well perceived TELTs may help
113 predict what tools are likely to work in future, (ii) targeting particular types of TELTs may act
114 to reduce staff anxiety by reducing choice and preventing over saturation with TELTs, (iii)
115 contribute to the planning of departmental and institutional TEL strategies. The objective of
116 this study was to integrate four different TELTs that the teaching staff could control into a
117 semester long undergraduate sport and exercise science module, with the aim of examining
118 student use and perceptions of the TELTs. Of particular interest was their views on accessibility,
119 use and value for learning.

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121 **Method**

122 **Participants**

123 The study focused on a 12-week Level 4 (first year Undergraduate) module called Energetics
124 of Exercise, which included 210 students from BSc Applied Sport and Exercise Science, BSc
125 Sport, Exercise and Nutrition and BSc Psychology with Sport Sciences. The summative
126 assessment for the module consisted of three multiple-choice examinations throughout the
127 semester. All procedures were approved by the institution's ethics committee, and all
128 participants were provided with verbal and written information to ensure informed consent.

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130 **Experimental Approach**

131 The module was delivered primarily in a traditional manner with a one-hour lecture each week
132 accompanied by two hours of additional contact time in a seminar, laboratory, or computer
133 class. Alongside this traditional approach all of the students, irrespective of whether they chose
134 to take part in the study, also had voluntary access to four different TELTs to support their
135 learning each week. The TELTs were chosen with the intention of each serving a different
136 function, to allow an insight into for what purpose students accessed the TELTs, as opposed to
137 which TELT they preferred for a given purpose. It was also deemed important that the student
138 could use each in his or her own time without the reliance of another person.

- 139 1. A Panopto™ recording of the lecture which allowed the students to download a video
140 file (Fig 1A). This was chosen as a simple TELT that would require no technological
141 knowledge or extra-curricular effort from the staff, with the purpose of allowing
142 students to recap the lecture content.

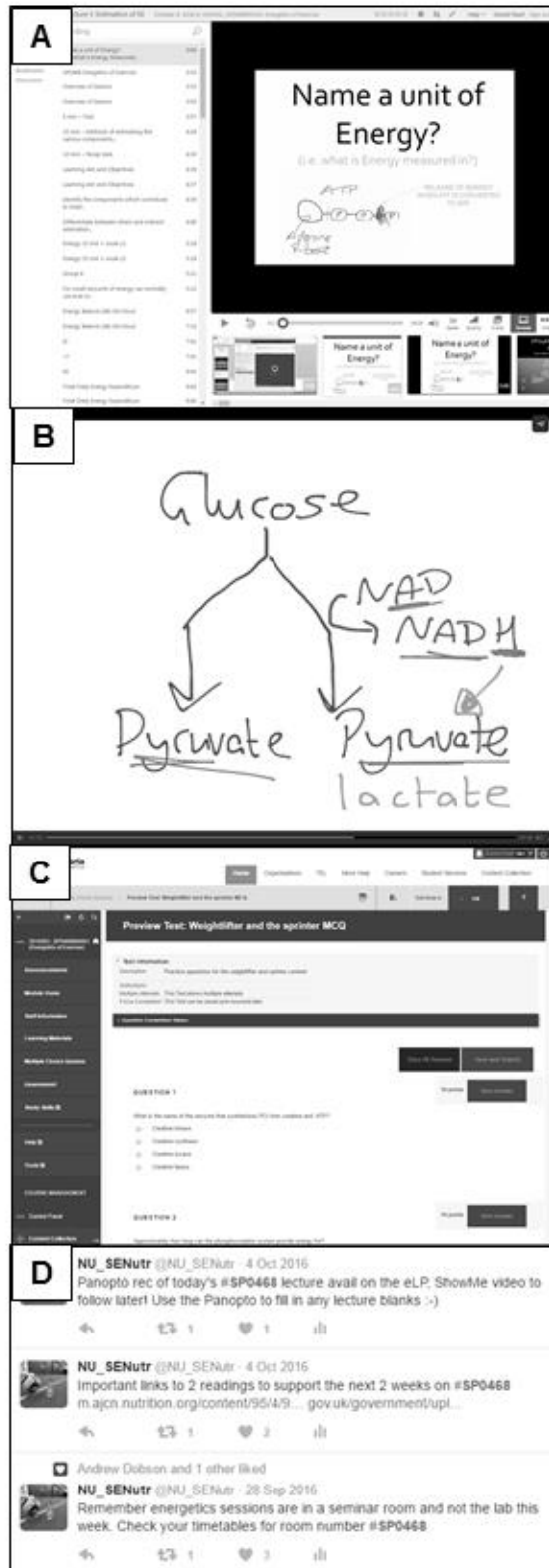
- 143 2. An animated mini review of the lecture using an interactive whiteboard mobile
144 application (ShowMe), which consisted of a <5-minute video developed by the lecturer,
145 focusing on what the lecturer deemed to be the essential part of the lecture (Fig 1B). It
146 was anticipated that the students would use these videos to recap on the main points as
147 a start of, or alternative to, further reading.
- 148 3. A multiple choice quiz (MCQ) hosted on the VLE (Blackboard®) (Fig 1C). Devised by
149 the lecturer, these quizzes mimicked the summative assessment for the module to
150 provide the students an opportunity for formative assessment.
- 151 4. A module Twitter feed sharing relevant information (Fig 1D). Previous studies have
152 identified Twitter as a tool to facilitate student engagement in a course, and encourage
153 student discussion (Gikas and Grant, 2013; Junco et al., 2011).

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155 **Survey Design and Analysis**

156 Student perceptions of the four TELTs were collected via an online survey in week twelve of
157 the module (95 respondents). The survey used was adapted from the technology acceptance
158 model (TAM) survey (Šumak, Heričko, Pušnik, & Polančič, 2011) and a similar learning
159 technology survey from Rossing et al. (2012) to include quantitative (7-point likert scale) and
160 qualitative responses (Table 1). Questions that were deemed the most appropriate to the current
161 study, with a focus on their use were selected from each of these inventories, and as the
162 inventories were adapted both internal reliability and construct validity were checked. Both
163 measurements were found to be satisfactory, determined by a Cronbach Alpha score >0.7, and
164 the average variance extracted >0.5. Given this, the median response for the six questions was
165 taken as the overall score. This overall score was then classified as '*did not use*', '*disagree*' (1-
166 2), '*unsure*' (3-5), and '*agree*' (6-7). A contingency table analysis with post-hoc tests on the

167 adjusted residuals was used to compare the ratings of each TELT. To account for multiple
168 comparisons the threshold for significance was $p < 0.003$. All statistical analysis was performed
169 using PASW Statistics 22.0 for Windows (SPSS, Inc., Chicago, IL, USA). The qualitative data
170 was analysed via a thematic analysis, with raw quotes from the survey added to first order
171 themes that sat under the common second order themes of 'positives' and 'improvements'.



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173 Fig 1. Screenshots of Panopto (A), ShowMe (B), MCQ (C) and Twitter (D). ALSO

174 SUBMITTED AS A SEPARATE FILE.

175 Table 1. A representation of the questions included in the online questionnaire.

Why did you access X? <input type="checkbox"/> To recap weekly content <input type="checkbox"/> To prepare for the exam <input type="checkbox"/> For general interest <input type="checkbox"/> I did not use it <input type="checkbox"/> Other....							
How did you access X? <input type="checkbox"/> Phone/tablet <input type="checkbox"/> PC/Laptop <input type="checkbox"/> I did not use it <input type="checkbox"/> Other....							
Where did you access X? <input type="checkbox"/> At University <input type="checkbox"/> At home <input type="checkbox"/> While travelling <input type="checkbox"/> I did not use it <input type="checkbox"/> Other....							
Question	I strongly disagree	I disagree	I somewhat disagree	Cannot decide	I somewhat agree	I agree	I strongly Agree
I find X useful for learning.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
X helped me develop confidence in the subject area.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I find X easy to use.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Using X is a bad idea (negative).	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
X makes learning more interesting.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I would like to use X in future modules	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
What in particular did you find useful about X? Is there a way that the use of X could be improved?							

(X denotes where the name of the relevant TELT was inserted)

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177 **Results**

178 Data describing the use of each TELT is displayed in Table 2. Significant cells in the
 179 contingency table were ‘Twitter – did not use’ ($p < 0.001$), ‘Twitter – agree’ ($p < 0.001$),
 180 ‘ShowMe – agree’ ($p = 0.002$) and ‘MCQ – agree’ ($p < 0.001$) (Fig 2). These results suggest
 181 that Twitter was used significantly less than the other three TELTs with less people agreeing
 182 that it helped, whilst ShowMe and MCQ had a greater occurrence of an ‘agree’ rating compared
 183 to Twitter and Panopto.

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187 Table 2. Frequency of student responses on whether each TELT was useful to support their
 188 learning. Agree = median score 6-7; unsure = median score 3-5; Disagree = median score 1-2.

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TELT	Did not use	Disagree	Unsure	Agree
Panopto	21	2	27	45
	<i>Adj. residual</i> -2.1	-0.2	1.0	1.1
Show Me	21	1	20	53
	<i>Adj. residual</i> -2.1	-1.0	-1.0	3.1*
MCQ	19	1	16	59
	<i>Adj. residual</i> -2.6	-1.0	-2.1	4.5*
Twitter	55	5	31	4
	<i>Adj. residual</i> 6.7*	2.1	2.1	-8.7*

$\chi^2 (9, N = 380) = 87.76, p < 0.001$

* $p \leq 0.002$

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199 A thematic analysis has been presented in Table 4. One main finding was that a first order
 200 theme shared across all TELTs was that of assessment preparation. This theme was identified
 201 as a positive for Panopto (*'helped prepare for the exam'*), ShowMe (*'can pick out main points*
 202 *for exam revision'*) and MCQ (*'helped to know what to expect on the exam'*). Specific reasons
 203 for these TELTs being perceived as useful for assessment could have been to help check
 204 understanding (MCQ; *'helps you find out what you actually know'*), tailor and personalise the
 205 delivery (Panopto; *'can jump to specific points'*) and provide information in a different format
 206 (ShowMe; *'easier to understand than the lectures'*). Conversely the theme of assessment was
 207 identified as an area for improvement with Twitter (*'not clearly linked to the exams'*). In fact,
 208 the only positive theme for Twitter was convenience (*'easy to access links'*).

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210 Table 3 A summary of student access to the TELTs.

	Panopto	ShowMe	MCQ	Twitter
<i>Why did you access X?</i>				
To recap weekly content	7 (7%)	44 (46%)	37 (39%)	7 (7%)
To prepare for the examination	7 (7%)	63 (66%)	74 (78%)	7 (7%)
For general interest	10 (11%)	5 (5%)	11 (12%)	10 (11%)
<i>How did you access X?</i>				
Phone/tablet	16 (17%)	26 (27%)	27 (28%)	16 (17%)
PC/laptop	10 (11%)	64 (67%)	72 (76%)	10 (11%)
<i>Where did you access X?</i>				
At University	8 (8%)	40 (42%)	39 (41%)	8 (8%)
At home	21 (22%)	64 (67%)	72 (76%)	21 (22%)
While travelling	2 (2%)	3 (3%)	5 (5%)	2 (2%)

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216 Table 4 Thematic analysis of qualitative responses for each TELT.

Raw Quotes	First Order	Second Order	TELT
Able to pause at any point to make notes / Can jump to specific points	Tailor lecture delivery and pacing	Positive	Panopto
Good for exam revision / Helped prepare for the exam	Assessment		
Microphone poor / Missing video / Logging in was difficult	Technology limitations	Improvements	
<i>A good quick recap / It condenses all of the information / Short and concise / Straight to the point / Short, sharp and accurate summary</i>	<i>Time efficient</i>	<i>Positive</i>	<i>ShowMe</i>
<i>Gives step by step views / Makes complicated information compact and easy to understand / The verbal and visual information at the same time is useful / Simplifies lectures / Easier to understand than the lectures</i>	<i>Delivery of information</i>		
<i>Easy to use / Easy to find the information</i>	<i>Convenient</i>		
<i>Can pick out main points for exam revision</i>	<i>Assessment</i>		
<i>Some videos too short / Lecturer sometimes quiet / Sometime talk too fast</i>	<i>Lecturer delivery</i>	<i>Improvements</i>	
Useful to see the types of questions / Good tool for revision / You can practice for the exam / Prepared you for the exam / Helped to know what to expect on the exam	Assessment	Positive	MCQ
Helps recap / Helps you find out what you actually know / Helped check where I may have been wrong with my notes / Shows what you know and what you don't / Can track my learning	Confirming understanding		
More questions / Links to webpages relating to the subject area / Not just multiple choice questions / A variety of questions	Content	Improvements	
<i>Easy to use / Easy to access links</i>	<i>Convenience</i>	<i>Positive</i>	<i>Twitter</i>
<i>Everyone should follow each other / Should share content / Make students more aware</i>	<i>Interaction</i>	<i>Improvements</i>	
<i>Give more examples / Have a specific page / Make more links available /</i>	<i>Content</i>		
<i>Not clearly linked to the exams</i>	<i>Assessment</i>		

218 **Discussion**

219 The purpose of this study was to implement different TELTs into the delivery of a first year
220 undergraduate science module, and collect student perceptions of their use and perceived value
221 for learning. It was found that approximately 80% of the students surveyed accessed Panopto,
222 ShowMe and MCQ to support their learning. However less than half of the cohort accessed
223 Twitter, significantly less than the other three methods. Furthermore, only 4% of students
224 agreed that it helped them with their studies, which is again in stark contrast to the other three
225 methods (Table 2). This is despite students identifying it as a convenient way to get information
226 (Table 4). Previous authors have advocated the use of Twitter to support Higher Education
227 students, including Junco et al. (2011) who observed greater levels of engagement in students
228 assigned to a Twitter group as opposed to a control. Gikas and Grant (2013) also reported
229 generally positive student perceptions of using Twitter, including being able to embed learning
230 within their normal lives and the ability to have discussions with classmates. Interestingly
231 interaction was a theme under suggested improvements in the current study, with students
232 commenting that *'everyone should follow each other'* and that they should *'share content'*. A
233 possible reason for the lack of interaction was a lack of student awareness, with one student
234 commenting an improvement would be to *'make students more aware'*. However, the way in
235 which staff made students aware of Twitter was no different to the other TELTs. Furthermore
236 staff regularly updated the Twitter feed with both course specific information and relevant
237 sources for further learning e.g. recent articles linked to that week's course content, but no
238 students posted their own tweets. The fact that Twitter was accessed more on mobile devices
239 may suggest that it was used more for keeping up to date rather than active engagement. Of
240 note is that the intervention implemented by Junco and colleagues used Twitter as a sole source
241 of information (e.g. discussion board, announcements page, reading lists etc.), with no
242 competing TELTs being used simultaneously. It may be that the use of Twitter in the current

243 study was influenced by the fact that the traditional VLE was also being used for the roles
244 described by Junco et al. (2011), or that three other TELTs were available at the same time so
245 students directed their attention elsewhere. These factors may have had more of an influence if
246 students were unfamiliar with the workings of Twitter.

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248 A possible reason for the other three TELTs being used by a greater proportion of students is
249 the perceived link to assessment, with the thematic analysis identifying this as a positive theme
250 for ShowMe, MCQ and Panopto, but an area for improvement for Twitter (Table 4).
251 Furthermore, ShowMe and MCQ had a greater proportion of students 'agree' compared to
252 Panopto (Table 2), which may again be linked to assessment as these were the two TELTs used
253 predominantly to help prepare for the examination (Table 3). A reason for ShowMe being rated
254 higher than Panopto may be due to the delivery of information. Whilst students liked being
255 able to alter the delivery and pace of the lecture using Panopto, the ShowMe videos offered an
256 alternative delivery that helped to simplify content (Table 4). Moreover, the delivery on
257 ShowMe was suggested to be convenient and time efficient for the student. The use of the
258 ShowMe App has been described in past work as a way for students to create notes and share
259 ideas at primary and secondary level (Castek & Beach, 2013; Maher, 2013). It has also been
260 suggested to be popular for clinical teaching within medical residences, specifically for
261 annotating notes and producing quick diagrams for 'in the moment' teaching (Archibald et al.,
262 2014). This latter point is the most related to the use of the App in this study i.e. to simplify
263 information. Research has highlighted the use of animations in other formats as a positive way
264 to support science teaching, with authors reporting enhanced self-efficacy and enjoyment in
265 elementary schools (Barak, Ashkar, & Dori, 2011), and improved retention of information in
266 university students (Lin & Atkinson, 2011). Of note is that the animations used by Barak et al.
267 (2011) and Lin and Atkinson (2011) were specific LOs used in a formal learning environment,

268 whereas the current study is novel in that the animations were produced by the teaching staff
269 and could be accessed outside of the formal learning environment. It is advised that those
270 looking to implement a similar strategy to the current study consider their clarity of speech
271 when producing the videos, as this was commented on by some students (Table 4).

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273 It is perhaps clear why the MCQ was rated highly by the students, as it mimicked the summative
274 assessment of the module. Some of the comments in the ‘confirming understanding’ theme
275 suggest it may have also been of benefit for formative feedback (*‘can track my learning’*)
276 (Table 4), however what is unclear is whether this TELT would have been perceived as useful
277 if the mode of summative assessment had been different i.e. an essay or report. Another factor
278 that may explain the positive perception of the MCQs is that this was the only TELT that
279 required the student to take an active part. However no students alluded to this in the
280 questionnaires.

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282 As students appeared to be extrinsically motivated by assessment, TELTs were not used a lot
283 for general interest (Table 3). All of the TELTs had the capacity to be used on mobile devices,
284 however they were used primarily on PCs/laptops (Table 3). This may suggest that the potential
285 for incidental or informal learning was not enhanced by using the TELTs. Each TELT was
286 accessed mostly at home, therefore perhaps promoting extra-curricular study as it was hoped
287 that the ShowMe videos would, but still in a formal and structured fashion. However, these
288 points are speculative as we have no comparison to their learning habits prior to the study.
289 Furthermore ‘general interest’ is quite vague and open to individual interpretation. Perhaps this
290 would have been better termed ‘further study’ or ‘further understanding’.

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In summary the current study has identified shared characteristics between the TELTs that students engage with and perceive to be useful. Such characteristics include links to the summative assessment and offering an alternative method of content delivery to the traditional lecture. Previous research has shown that time is a barrier for staff to incorporate TELTs into their teaching (Reed, 2014), so an appropriate practical message may be to start with one type of TELT. Based on this study TELTs similar to the ShowMe App are most recommended as this was one of the two highly rated TELTs (alongside MCQ), but has more scope for crossover with other subjects as the students found it useful for more than just assessment. Moreover the lecturer has full control over the content, so can make each animation specific to the current topic of study. Further work should look at the potential transfer of animations for learning in other subject disciplines, and investigate if there are any alternative TELTs for meeting the same purpose of simplifying information. It should be considered that this paper describes only those students that completed the survey (45% response rate), and the perceptions of the other students enrolled on the module are unknown. Furthermore, we cannot discount that using the TELTs in combination may have influenced the perception of each TELT, and we relied upon student self-reported usage for each TELT. Future work should monitor the actual use of the TELTs using tracking statistics, and look to examine predictive validity of student perceptions of TELTs to gain more insight into what student perception means for learning and academic performance, and what the implications are for teaching staff.

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