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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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Abstract

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

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

Introduction

Technology enhanced learning (TEL) has the potential to enhance the student experience by 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.

Method

Participants

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

Experimental Approach

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

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

2. An animated mini review of the lecture using an interactive whiteboard mobile application (ShowMe), which consisted of a <5-minute video developed by the lecturer, focusing on what the lecturer deemed to be the essential part of the lecture (Fig 1B). It was anticipated that the students would use these videos to recap on the main points as a start of, or alternative to, further reading.

3. A multiple choice quiz (MCQ) hosted on the VLE (Blackboard®) (Fig 1C). Devised by the lecturer, these quizzes mimicked the summative assessment for the module to provide the students an opportunity for formative assessment.

4. A module Twitter feed sharing relevant information (Fig 1D). Previous studies have identified Twitter as a tool to facilitate student engagement in a course, and encourage student discussion (Gikas and Grant, 2013; Junco et al., 2011).

Survey Design and Analysis

Student perceptions of the four TELTs were collected via an online survey in week twelve of the module (95 respondents). The survey used was adapted from the technology acceptance model (TAM) survey (Šumak, Heričko, Pušnik, & Polančič, 2011) and a similar learning technology survey from Rossing et al. (2012) to include quantitative (7-point likert scale) and qualitative responses (Table 1). Questions that were deemed the most appropriate to the current study, with a focus on their use were selected from each of these inventories, and as the inventories were adapted both internal reliability and construct validity were checked. Both measurements were found to be satisfactory, determined by a Cronbach Alpha score >0.7, and the average variance extracted >0.5. Given this, the median response for the six questions was taken as the overall score. This overall score was then classified as *'did not use', 'disagree'* (1-2), *'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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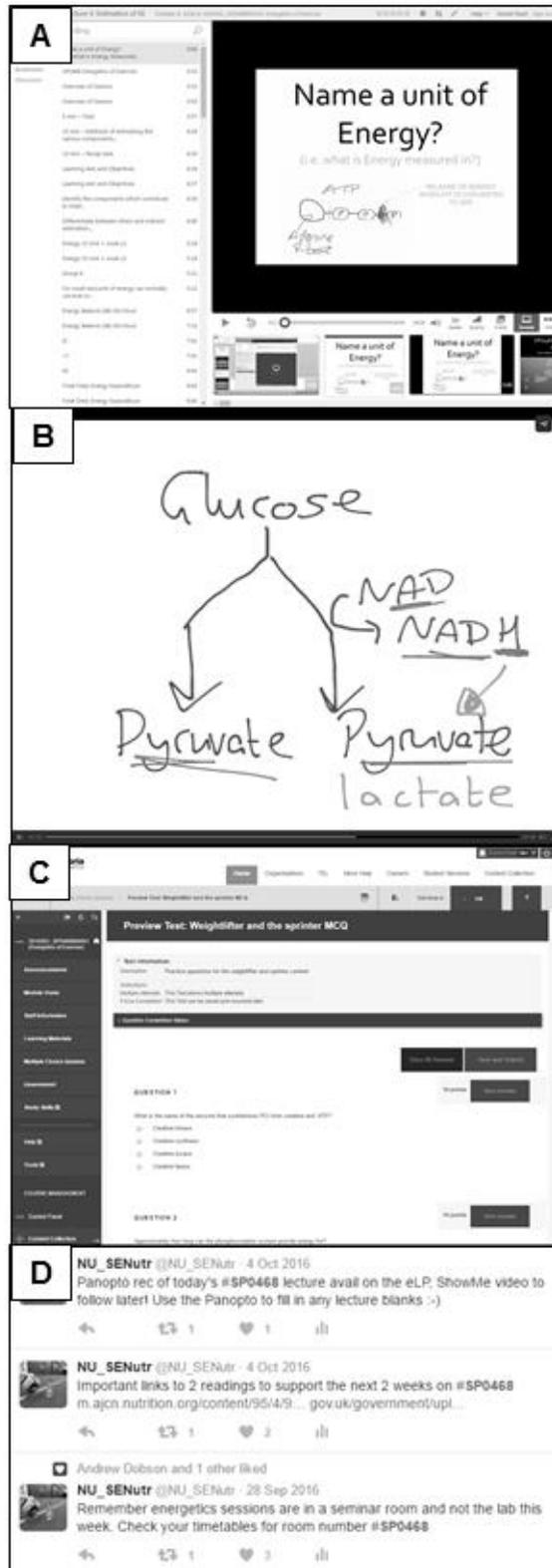
Fig 1. Screenshots of Panopto (A), ShowMe (B), MCQ (C) and Twitter (D). ALSO
SUBMITTED AS A SEPARATE FILE.

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

| Why did you access X? |
| ☐ To recap weekly content ☐ To prepare for the exam ☐ For general interest ☐ I did not use it ☐ Other…. |
| How did you access X? |
| ☐ Phone/tablet ☐ PC/Laptop ☐ I did not use it ☐ Other…. |
| Where did you access X? |
| ☐ At University ☐ At home ☐ While travelling ☐ I did not use it ☐ 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.	☐	☐	☐	☐	☐	☐	☐
X helped me develop confidence in the subject area.	☐	☐	☐	☐	☐	☐	☐
I find X easy to use.	☐	☐	☐	☐	☐	☐	☐
Using X is a bad idea (negative).	☐	☐	☐	☐	☐	☐	☐
X makes learning more interesting.	☐	☐	☐	☐	☐	☐	☐
I would like to use X in future modules	☐	☐	☐	☐	☐	☐	☐
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   **<u>Results</u>**

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
	Adj. residual	*-2.1*	*-0.2*	*1.0*	*1.1*
Show Me		21	1	20	53
	Adj. residual	*-2.1*	*-1.0*	*-1.0*	*3.1**
MCQ		19	1	16	59
	Adj. residual	*-2.6*	*-1.0*	*-2.1*	*4.5**
Twitter		55	5	31	4
	Adj. residual	*6.7**	*2.1*	*2.1*	*-8.7**

X^2 (9, N = 380) = 87.76, p < 0.001

* p ≤ 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 ('n*ot clearly linked to the exams').* In fact,

208   the only positive theme for Twitter was convenience *('easy to access links').*

209

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

	Panopto	ShowMe	MCQ	Twitter
Why did you access X?				
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%)
How did you access X?				
Phone/tablet	16 (17%)	26 (27%)	27 (28%)	16 (17%)
PC/laptop	10 (11%)	64 (67%)	72 (76%)	10 (11%)
Where did you access X?				
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	
A good quick recap / It condenses all of the information / Short and concise / Straight to the point / Short, sharp and accurate summary	*Time efficient*	*Positive*	*ShowMe*
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	*Delivery of information*		
Easy to use / Easy to find the information	*Convenient*		
Can pick out main points for exam revision	*Assessment*		
Some videos too short / Lecturer sometimes quiet / Sometime talk too fast	*Lecturer delivery*	*Improvements*	
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	
Easy to use / Easy to access links	*Convenience*	*Positive*	*Twitter*
Everyone should follow each other / Should share content / Make students more aware	*Interaction*	*Improvements*	
Give more examples / Have a specific page / Make more links available /	*Content*		
Not clearly linked to the exams	*Assessment*		

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Discussion

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

281

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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294 In summary the current study has identified shared characteristics between the TELTs that

295 students engage with and perceive to be useful. Such characteristics include links to the

296 summative assessment and offering an alternative method of content delivery to the traditional

297 lecture. Previous research has shown that time is a barrier for staff to incorporate TELTs into

298 their teaching (Reed, 2014), so an appropriate practical message may be to start with one type

299 of TELT. Based on this study TELTs similar to the ShowMe App are most recommended as

300 this was one of the two highly rated TELTs (alongside MCQ), but has more scope for crossover

301 with other subjects as the students found it useful for more than just assessment. Moreover the

302 lecturer has full control over the content, so can make each animation specific to the current

303 topic of study. Further work should look at the potential transfer of animations for learning in

304 other subject disciplines, and investigate if there are any alternative TELTs for meeting the

305 same purpose of simplifying information. It should be considered that this paper describes only

306 those students that completed the survey (45% response rate), and the perceptions of the other

307 students enrolled on the module are unknown. Furthermore, we cannot discount that using the

308 TELTs in combination may have influenced the perception of each TELT, and we relied upon

309 student self-reported usage for each TELT. Future work should monitor the actual use of the

310 TELTs using tracking statistics, and look to examine predictive validity of student perceptions

311 of TELTs to gain more insight into what student perception means for learning and academic

312 performance, and what the implications are for teaching staff.

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318   **<u>References</u>**

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