This is a pre-publication version of the following article: Walklet, E., Davis, S., Farrelly, D., & Muse, K. (2016). The impact of Student Response Systems on the learning experience of undergraduate psychology students. *Psychology Teaching Review*, *22*(1): 35-48

The impact of Student Response Systems on the learning experience of undergraduate psychology students

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Abstract

Student response systems (SRS) are hand-held devices or mobile phone polling systems which collate real-time, individual responses to on-screen questions. Previous research examining their role in higher education has highlighted both advantages and disadvantages of their use. This paper explores how different SRS influence the learning experience of psychology students across different levels of their programme. Across two studies, first year students' experience of using Turningpoint clickers and second year students' experience of using Poll Everywhere was investigated. Evaluations of both studies revealed that SRS have a number of positive impacts on learning, including enhanced engagement, active learning, peer interaction, and formative feedback. Technical and practical issues emerged as consistent barriers to the use of SRS. Discussion of these findings and the authors' collective experiences of these technologies are used to provide insight into the way in which SRS can be effectively integrated within undergraduate psychology programmes.

Keywords: (5)

Student Response Systems; Large Group Teaching; Feedback; Engagement; Technology Enhanced Learning

Introduction

Within higher education, effective delivery of psychology teaching and learning is facing a number of challenges. Recent social and financial changes (e.g., widening participation, higher tuition fees, reduced resource funding) has resulted in larger, more diverse cohorts of students with increasing expectations for high quality teaching and support, delivered through a 'value-for-money' curriculum (e.g., Cormack et al., 2014; Trapp et al., 2011; Winstone & Bretton, 2013). As the student experience is now at the centre of practice development, psychology programmes in the UK have sought new opportunities and methods to meet such challenges.

The use of technology-enhanced learning in teaching practice can help to address some of the challenges currently facing psychology teaching within higher education. The benefits of utilising technology to facilitate formative assessment and promote engagement are increasingly reflected in Higher Education Strategy (Higher Education Funding Council for England [HEFCE] 2009). However, with a plethora of different technological tools available (e.g. virtual learning environments, social media, podcasts) it is important that the practical application and value of these tools is appropriately and fully understood.

Student response systems (SRS) are an example of such a technology that is increasing in popularity and usage in psychology teaching (Kay & LeSage, 2009). These are hand-held devices such as ‘clickers’ (e.g. TurningPoint) and mobile phone polling systems (e.g. Poll Everywhere) which collate real-time, individual responses to on-screen questions. They provide immediate formative feedback on learning in an anonymised format which allows lecturers to reflect, review and recap material using a student-centred approach. Research suggests that use of this technology can improve achievement, attention to in-class material, motivation to attend sessions, and promote active learning and critical thinking through peer interaction (Caldwell, 2007; El-Rady, 2006; Gauci, Dantas, Williams, & Kemm, 2009; Keough, 2012; Mayer et al., 2009; Poirier & Feldman, 2001; Preszler & Dawe, 2007).

Negative outcomes of SRS have, however, also been identified (Kay & LeSage, 2009; Kirkwood & Price, 2014). For lecturing staff, this includes financial and time implications for set up and delivery and the ability to learn and effectively utilise new technologies, whereas for students this includes adjusting to new methods of teaching and perceptions of being monitored. Furthermore, previous research has often been anecdotal and lacking in depth and methodological rigour (Fies & Marshall, 2006). Landrum (2015) recently conducted a teacher-ready research review on SRS, and also concluded that questions about how best to use these are yet to be addressed. As a result, the suitability and feasibility of using SRS across different pedagogical contexts is yet to be established. For instance, it is unclear whether SRS are practical for developing core skills in students across all levels of undergraduate study.

Consequently, this paper aimed to provide an in-depth analysis of the impact of SRS on the learning experience of undergraduate psychology students, specifically in large group settings. This was achieved through two studies which examined the use of different SRS platforms used for different pedagogical purposes across two discrete cohorts of psychology undergraduate students. Specifically, Study 1 explored the use of TurningPoint 'clickers' in a first year module to provide formative feedback on progress using multiple choice quizzes (MCQs). Study 2 explored the use of Poll Everywhere mobile phone polling technology in a second year module to promote student engagement through a mixture of open-ended and fixed-choice polls. Ultimately, it is hoped that the findings presented here will lead to practical recommendations and applications for SRS use in psychology teaching.

Study 1

Clickers are hand-held devices from which a range of fixed response options can be selected. Often used as an adjunct to MCQs, clickers electronically transmit responses to computer software (in this instance, TurningPoint) which then collates and presents results back to the audience. This technology enables students to anonymously interact in large lectures, check their understanding, and obtain immediate formative feedback. They also enable instructors to monitor and respond to the progress of students within large classes (Patry, 2009; Poirier & Feldman, 2001).

This study focussed specifically on using clickers to enhance formative feedback, which is integral to quality teaching and development of self-regulated learners in Higher Education (Nicol & Macfarlane-Dick, 2006). This is particularly pertinent for the participants in this study who were psychology degree students in their first year, where core skills and foundation knowledge are garnered (QAA 2010). Previous research has found that clickers are particularly valued by introductory psychology students (Patry, 2009) and are associated with an increase in exam performance in this group (Poirier & Feldman, 2001). However, little is known about how this technology-enhanced activity impacts on the learning experience and the factors which may help or hinder its usefulness.

In light of the above, study 1 sought to examine student perceptions of clicker quizzes as a formative feedback tool in an Introduction to Psychology module. The following research questions were investigated:

1) Do students feel that multiple choice clicker quizzes have a positive impact on their learning experience?

2) What are the barriers to effective use of clicker quizzes and how could the use of clicker quizzes be further improved?

Intervention

Introduction to Psychology is a 30-credit, mandatory module for first year psychology students on a British Psychological Society (BPS) accredited programme. The module aims to introduce students to the general history, key theoretical approaches, practical applications and ethical issues of core areas of psychology, including developmental, biological, cognitive, social and individual differences psychology. The assessments for this module comprise of an essay and a multiple choice examination.

A series of five formative MCQs were scheduled at the end of each core topic in the module. These were delivered at the end of session by the module team. Each test consisted of 10 to 15 MCQs assessing different aspects of learning, such as knowledge and application (See figure 1). Pairs of students were provided with a clicker and advised to discuss the answers together before responding. This approach was taken on the basis that peer discussion may promote additional active learning when using clickers (Morling, McAuliffe, Cohen, & DiLorenzo, 2008). Answers were provided once all students had responded, and discussion was invited around why particular answers were correct or incorrect. The whole activity took between 20-30 minutes. After the lecture, the questions and answers were uploaded to the Institution's virtual learning environment so that students could revisit them, in preparation for the end of module summative MCQs.

Insert figure 1 here

Data gathering

To examine student perceptions of use of clicker quizzes an online, mixed-methods survey was administered. All 143 students registered on the module were emailed an anonymous survey hosted by SurveyMonkey, 59 (41%) of which responded. The survey contained seven quantitative questions, assessing the extent to which the use of clickers (1) provided useful feedback progress, (2) clarified understanding, (3) promoted peer discussion, (4) encouraged further study, (5), increased confidence for the assessment, (6) increased overall engagement and, (7) increased overall learning. Each item was rated on a 4-point Likert scale where 1 = strongly agree and 4 = strongly disagree. Additionally, four open-ended qualitative questions asked students (1) how they felt the clicker quizzes impacted on their learning, (2) the most helpful and (3) least helpful aspect of the activity and (4) suggestions for improvement.

Evaluation

As table 1 indicates, overall agreement ("Strongly Agree" and "Agree") was particularly high for the items on useful feedback on progress (91.53%), clarification on understanding (89.84%) and promoting peer discussion (91.53%). Overall, the majority of students agreed with all items, with increased confidence in assessment (62.72%) scoring the lowest.

Insert table 1 about here

Qualitative analysis of the open-ended questions comprised of the 'framework technique' (Ritchie & Spencer, 2002). This simple approach was chosen as the intention of the analysis was not to provide a detailed exploration of personal experience (as is the case in approaches such as interpretative phenomenological analysis) or to generate a theory of a phenomena grounded in the data (as is the case in approaches such as grounded theory), but to offer a simple framework which described the key advantages and disadvantages of using clickers (Braun & Clarke, 2006). Analysis involved four key stages (Ritchie & Spencer, 2002). First, emergent themes from the questionnaire were used to identify an initial thematic framework. Second, the thematic framework was systematically applied to the data, with the questionnaires being annotated according to the initial thematic framework. Third, the data was rearranged within a chart according to themes (i.e. the content of the recording notes was distilled into a summary and entered into a chart of key themes). Fourth, a final 'map' of key themes was created by aggregating patterns of data, weighing up the importance and dynamics of issues, searching for an overall structure in the data and synthesising the findings**.** The number of students whose views were represented within each theme was also noted (i.e. the number of students who 'endorsed' the theme). One of the author's (KM) took the lead in the analysis. However, all authors discussed emerging findings and worked together to refine the emerging framework. Several methods were used to reduce the impact of researcher bias, including awareness of preconceptions, sharing preconceptions between researchers and ensuring that all interpretations were supported by participant-derived data. The final identified thematic structure is outlined in table 2.

Students expressed a number of positive impacts that the use of clickers had on their engagement and learning experience. In particular, a large number of students felt that the clickers enabled them to engage in self-monitoring, thus highlighting their learning needs and encouraging further independent study within these areas. It was felt that the clickers facilitated peer learning through discussion with peers regarding the correct answers and that the anonymity encouraged increased engagement. Students also reported increased confidence both in terms of general subject knowledge and the MCQ assessment. However, although some found that identifying mistakes or gaps in knowledge helped them to recognise areas for improvement, others found this experience somewhat discouraging. The main barriers students faced when using the technology were technical problems that meant the clickers did not work during class and the amount of time taken to distribute, set-up, and collect the clickers. Students felt their experience with the clickers could have been further improved by more frequent use of the technology within class, providing the opportunity for individual participation, and providing in-depth verbal and written explanations as to which answers were correct and incorrect and why.

Insert table 2 about here

Conclusion

Overall, students valued the use of clickers in their learning experience. This was reflected in both the quantitative and qualitative data. Clickers were perceived as effective for providing formative feedback, clarification of learning, stimulating peer discussion, encouraging further independent study, and increasing overall engagement and learning. Additionally, anonymity removed barriers to participation. However, technical difficulties and time taken for set up and delivery were perceived as problematic by students and staff. Furthermore, it is worth noting that confidence in assessment received the lowest endorsement in the quantitative survey items. The qualitative data suggests that providing further in-class discussion around answers may address this issue. Additionally, students highlighted that they would like the MCQs to be used more regularly and to enable individual participation.

Study 2

As with clickers, the Poll Everywhere SRS allows students to respond to in-class questions, with results collated in real-time and displayed on-screen. However, in contrast, responses can be sent in any setting that has internet access or network coverage using mobile phones, tablets or laptops (via SMS messaging, web browser, or Twitter). In addition to answering fixed response questions, Poll Everywhere also allows students to respond to open-ended questions using free text.

Previous research suggests that using Poll Everywhere to deliver fixed-choice response questions promotes engagement and provides opportunity for formative feedback (Voelkel & Bennett, 2014). Nevertheless, the impact of using the technology to enhance student engagement via *open-ended* questions has not yet been explored. This form of delivery may be particularly advantageous for improving engagement in the large lecture context via peer-to-peer and tutor-peer discussion. Providing opportunity for meaningful interaction is considered central for fostering a sense of ‘belonging’ in students and a positive learning experience (Thomas, 2012). Moreover, providing opportunities for active, engaged discussion in second and third year undergraduates is particularly important given the need to develop critical thinking, judgement and autonomy in learning at these stages (QAA, 2010) – all of which can be boosted through interaction with others.

The current study therefore investigated the impact of fixed-choice and open-ended Poll Everywhere questions on students' engagement and learning experience. The following research questions were examined:

1. How many poll responses are received and does this vary as a function of question type (open–ended vs. fixed-choice)?

2. Do students feel that Poll Everywhere has a positive impact on their learning experience?

3. What are the barriers to effective use of Poll Everywhere and how could the use of this technology be further improved?

Intervention

Mobile phone polling technology Poll Everywhere was integrated into 13 teaching sessions over the course of a single semester. Sessions were spread across two core Psychology modules: Social & Developmental Psychology; Cognitive & Biological Psychology. These are 30-credit, mandatory modules for second year psychology students on a British Psychological Society (BPS) accredited programme. A mixture of fixed-choice response (i.e., knowledge-checking) and open-ended (i.e., free-text discussion) questions was used at different time points during teaching sessions (see Figure 2 for examples). To facilitate peer learning, students were encouraged to participate in discussion and submit a response. Students responded to questions using mobile phones, tablets or laptops (using SMS messaging; web browser or Twitter to submit a pre-defined response code).

Insert figure 2 about here

Data gathering

Poll participation data, attendance across the lecture series, and a student evaluation survey were used to assess the impact of Poll Everywhere on student engagement and the student learning experience more generally. Out of the 157 students enrolled in the course, ninety-two students (17 males, 71 females, 4 undeclared; mean age 21.33, SD 3.73 years) completed the evaluation survey at the end of the module, yielding a 59% response rate.

The survey consisted of 17 items (measured on a Likert scale where 1= 'strongly agree', through to 5= 'strongly disagree') adapted from previous research studies (Gauci et al., 2009; Voelkel & Bennett, 2014) to facilitate comparison with existing literature. This was distributed in paper-based format to students at the end of the lecture series. A paper-based method was chosen to overcome any technologically-related barriers to participation. Items tapped *attitudes towards the use of the technology* (e.g., "I would like to see more use of online polling in my lectures"), *impact on learning experience* (e.g., "I was more engaged/interested in lectures where polling occurred") and the *learning process* (e.g., "polling in the lectures improved my problem-solving, critical-thinking, and analytical skills"). Four open-ended items were also included to allow students to make general observations about the use of the technology – including potential reasons for non-participation and/or dissatisfaction with the technology that might not otherwise be detected using the closed-answer format (e.g., "If you did not participate in all polling questions, what were your reasons for not doing so?").

Evaluation

Table 3 shows how many poll responses were received within each learning session, as a function of attendance and question type. On average, 15.9% of those who attended class submitted a response to the online polling activities following group discussion. Rate of submission did not significantly differ according to type of question posed; students were equally likely to respond to fixed-choice (n = 12) = 16.67%, SD = 4.54) and open-ended discussion questions (n = 10) = 19.1%, SD = 8.37; t_{20}= 0.87, p = 0.40). Web entry or text message were the two most popular methods of participating in polls (Twitter less so). On average it took students 6 minutes to respond to polls however this varied according to question type; fixed-choice = 3 minutes; open-ended questions = 7 minutes.

Insert table 3 about here

As can be seen from table 4, responses were generally positive with the majority of students agreeing that the use of polling activities improved the *learning experience*, particularly perceived engagement (e.g., enjoyment, stimulation, interest, participation) although this was less successful in encouraging attendance. Regarding the *learning process*, students valued immediate feedback on their learning and increased opportunities for reflection and poll-led discussion with peers. However, polling was perceived as less useful for promoting higher-level cognitive skills (e.g., critical thinking). *Attitudes towards use* were positive; students agreed that they would like to see polling used more often in other classes and they would like this to be linked to assessment.

Insert table 4 about here

Qualitative analysis of these questions used the ‘framework technique’ (Ritchie & Spencer, 2002) as per study 1. The final thematic structure is outlined in Table 5. Students highlighted the positive impact of the online polls on their engagement in class. In particular, a large number of students commented that the anonymity removed barriers to participation they had previously faced (e.g. embarrassment). Students commented that the polling changed the way in which they learnt by facilitating peer learning through discussion and sharing of ideas. Students also felt that the polling promoted deeper learning and increased their confidence in the subject material. However, a large number of students highlighted technical problems as a significant barrier to participating in the polling. Some participants also identified motivational barriers to participation, namely that they did not want to submit answers to questions when they could see others responses or that they just did not see the benefit to participating. Students felt that the polling experience could have been further improved by including more open-ended and more challenging questions and by moving at a quicker pace.

Insert table 5 about here

Conclusion

The number of student responses to the online polls was relatively low, with no variation in participation according to question type. However, qualitative feedback indicated this was not indicative of engagement with the activity as students were actively involved in the discussion process and often chose to submit a single group response, rather than individual responses. For open-ended polls, students also noted that at times they felt they had nothing further to add to responses which had already appeared on screen. Technical issues were also highlighted as a barrier to response submissions (particularly wifi access), which may have also reduced the capacity to respond individually. Overall students rated the use of Poll Everywhere favourably. In particular, students felt that the use of polls improved engagement, in part due to the anonymity afforded by the technology. It also promoted peer learning and provided increased opportunities for formative feedback. Whilst more complex open-ended questions were well received, students did however comment that the fixed-choice response questions were less useful for promoting higher level critical thinking skills.

General Discussion

The aim of this paper was to assess the suitability and feasibility of using two different student response technologies (clickers and Poll Everywhere) in large group settings, across first and second year undergraduate psychology teaching. Overall both forms of SRS were positively received. Specifically, students highlighted that SRS enhanced engagement, promoted active learning, provided additional opportunities for formative feedback and reflection, and facilitated peer interaction. This is consistent with previous literature examining the beneficial impact of SRS in large group teaching (Caldwell, 2007; El-Rady, 2006; Gauci, Dantas, Williams, & Kemm, 2009; Mayer et al., 2009; Poirier & Feldman, 2001; Preszler & Dawe, 2007; Voelkel & Bennett, 2013).

Both studies highlighted that anonymity in responding facilitated engagement. This concurs with literature, which has suggested that anonymous activities are particularly helpful for engaging shy students (Banks, 2006). However, anonymity conferred by SRS is limited to initial participation (i.e. answering the question). .It is notable that in study 1, some first year students felt unable to seek clarification or further guidance about the correct answers after completion of the MCQ, due to the large group setting. The need for clarification may be particularly important in the context of formative fixed-choice response questions, where there is a clear right or wrong answer. Of interest, second year students in study 2 reported that they preferred open-ended discussion questions as these promoted broader discussion and critical thinking. This shows a clear contrast between the perceived learning needs of students at different levels of study and underscores the importance of tailoring the design and selection of SRS activities to individual student groups.

Students across both studies identified peer discussion as a positive aspect of the SRS activities. This concurs with previous research, which suggests that the opportunity for meaningful interaction is central for student engagement and a positive learning experience (Thomas, 2012). Indeed, such peer-based learning activities within the context of SRS have been found to promote active learning and critical thinking (Gauci, Dantas, Williams, & Kemm, 2009; Morling et al. 2008) and thus may be of benefit. It is noteworthy that even when given the opportunity to respond individually to PollEverywhere questions (study 2), students often chose to provide a group response. Despite this, some students in study 1 said that they would have valued the opportunity to provide individual responses to the MCQs to allow them to monitor their individual progress. This is important since previous research also indicates that using clickers for individual, self-monitoring of progress is related to an increased ability to 'feed forward' and apply the learning in subsequent assignments (Ludvigsen, Krumsvik, & Furnes, 2015). It is, therefore, important to strike a balance between offering opportunities for engaging in peer-learning and providing space for individual self-reflection when using SRS within large group teaching.

Across the two types of SRS and both cohorts of students, technical and practical issues emerged as the most consistent barriers to students' endorsement of the technology. This is in keeping with previous research which has highlighted the problems of long-set up and delivery times and the need for staff training (Kay & LeSage, 2009; Kirkwood & Price, 2014). In light of these issues, recommendations for practice based on the authors' collective experiences of these technologies are outlined in table 6 below, which perhaps builds upon recent preliminary recommendations for SRS use (Landrum, 2015).

Insert table 6 about here

In conclusion, this paper has highlighted a number of benefits, challenges and implications for practice in using SRS to enhance the learning experience of undergraduate psychology students. Importantly, our findings suggest that appropriate SRS activities vary as a function of the content and duration of teaching sessions, the level of study, and students' individual learning preferences. To this end, SRS should be implemented with careful consideration of these factors and as part of a multifaceted approach to learning and teaching in psychology.

References

Banks, D. A. (2006). *Audience Response Systems in Higher Education: Applications and Cases.* Hershey, PA: Information Science Publishing.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*, 77–101.

Caldwell, J. E. (2007). Clickers in the large classroom: Current research and best-practice tips. *CBE-Life Sciences Education*, *6,* 9–20.

Cormack, S., Bourne, V., Deuker, C., Norton, L., O'Siochuru, C., & Watling, R. (2014). The future of pedagogical action research in psychology. *Psychology Teaching Review*, *20,* 95–109.

El-Rady, J. (2006). To Click or Not to Click: That's the Question. *Innovate: Journal of Online Education*, *2*, 6.

Fies, C., & Marshall, J. (2006). Classroom response systems: A review of the literature. *Journal of Science Education and Technology*, *15*, 101–109.

Gauci, S. a, Dantas, A. M., Williams, D. a, & Kemm, R. E. (2009). Promoting student-centered active learning in lectures with a personal response system. *Advances in Physiology Education*, *33*, 60–71.

Higher Education Funding Council for England (2009). *Enhancing learning and teaching through the use of technology: A revised approach to HEFCE'S strategy for e-learning*. [Online] Available from: http://www.hefce.ac.uk/media/hefce1/pubs/hefce/2009/0912/09_12.pdf [Accessed 29 May 2015].

Kay, R. H., & LeSage, A. (2009). Examining the benefits and challenges of using audience response systems: A review of the literature. *Computers & Education*, *53*, 819–827.

Keough, S. M. (2012). Clickers in the classroom: A review and a replication. *Journal of Management Education, 36,* 822–847.

Kirkwood, A., & Price, L. (2014). Technology-enhanced learning and teaching in higher education: what is “enhanced” and how do we know? A critical literature review. *Learning, Media and Technology*, *39,* 6–36.

Landrum, R. E. (2015). Teacher-ready research review : Clickers. *Scholarship of Teaching and Learning in Psychology*, *1*, 250–254.

Ludvigsen, K., Krumsvik, R., & Furnes, B. (2015). Creating formative feedback spaces in large lectures. *Computers & Education, 88*, 48-63.

Mayer, R. E., Stull, A., DeLeeuw, K., Almeroth, K., Bimber, B., Chun, D., … Zhang, H. (2009). Clickers in college classrooms: Fostering learning with questioning methods in large lecture classes. *Contemporary Educational Psychology*, *34*, 51–57.

Morling, B., McAuliffe, M., Cohen, L., & DiLorenzo, T. M. (2008). Efficacy of personal response systems (’clickers') in large, introductory psychology classes. *Teaching of Psychology*, *35,* 45–50.

Nicol, D. J., & Macfarlanel-Dick, D. (2006). Formative assessment and self-regulated learning: a model and seven principles of good feedback practice. *Studies in Higher Education*, *31*, 199–218.

Patry, M. (2009). Clickers in large classes: From student perceptions towards an understanding of basic practices. *International Journal for the Scholarship of Teaching and Learning*, *3*, 17.

Poirier, C. R., & Feldman, R. S. (2001). Promoting active learning using individual psychology classes. *Technology and Teaching*, *34*, 194–197.

Preszler, R., & Dawe, A. (2007). Assessment of the effects of student response systems on student learning and attitudes over a broad range of biology courses. *CBE-Life Sciences …*, *6*, 29–41.

Ritchie, J., & Spencer, L. (2002). Qualitative data analysis for applied policy research. In A. M. Huberman & M. B. Miles (Eds.), *The Qualitative Researcher's Companion* (pp. 305–329). London: Sage Publications.

The Quality Assurance Agency for Higher Education (2010). *Subject benchmark statement: Psychology*. [Online] Available from: http://www.qaa.ac.uk/en/Publications/Documents/Subject-benchmark-statement-Psychology.pdf [Accessed 29 May 2015].

Thomas, L., (2012). *Building student engagement and belonging in Higher Education at a time of change: A summary of findings and recommendations from the What Works? Student Retention & Success Programme.* UK: Higher Education Academy. Retrieved from: https://www.heacademy.ac.uk/sites/default/files/What_works_summary_report_1.pdf

Trapp, A., Banister, P., Ellis, J., Latto, R., Miell, D., & Upton, D. (2011). *The future of undergraduate psychology in the United Kingdom*. doi:10.1037/e717892011-001

Voelkel, S., & Bennett, D. (2014). New uses for a familiar technology: introducing mobile phone polling in large classes. *Innovations in Education and Teaching International*, *51*, 46–58.

Winstone, N., & Bretton, H. (2013). Strengthening the transition to university by confronting the expectation-reality gap in psychology undergraduates. *Psychology Teaching Review*, *19*, 2–14.

Table 1: Student responses to questions about the impact of clicker tests (study 1)

The use of clickers for in-class formative MCQs in PSYC1430 has:	**Strongly Agree**	**Agree**	**Disagree**	**Strongly Disagree**
Provided me with useful feedback on my progress	N = 20 33.90%	N = 34 57.63%	N = 5 8.47%	N = 0 0%
Helped me to clarify things I had not understood	N = 21 35.59%	N = 32 54.24%	N = 5 8.47%	N = 1 1.69%
Encouraged me to discuss my ideas with peers	N = 27 45.76%	N = 27 45.76%	N = 4 6.78%	N = 1 1.69%
Encouraged me to engage in further study	N = 12 20.34%	N = 38 64.41%	N = 9 15.25%	N = 0 0%
Increased my confidence for the end of module exam	N = 12 20.34%	N = 25 42.37%	N = 21 35.59%	N = 1 1.69%
Increased my overall engagement in this module	N = 12 20.34%	N = 36 61.02%	N = 11 18.64%	N = 0 0%
Increased my overall learning in this module	N = 16 27.12%	N = 32 54.24%	N = 11 18.64%	N = 0 0%

Table 2: Final thematic structure resulting from qualitative analysis (study 1)

Superordinate Theme	**Subordinate Theme**	**No. of students *n* = 59[1]**	**Illustrative quotations**
1. Impact on engagement & learning	Enabled self-monitoring to highlight learning needs and encourage independent study	34 (57.63%)	"I can monitor my progress and recap on my areas of weakness that this highlights" "It provides you with formative feedback in terms of the areas that need improving or revising" "Encouraged me to complete the additional reading and seek clarification on areas I seemed to struggle with"
	Making mistakes: A double-edged sword	12 (20.34%)	"Being able to hear an explanation for the correct answer, so if you got the answer wrong you can learn from it." "We are given the correct answer after and this is explained to us in order to help us understand." "Made me slightly discouraged when I got answers wrong, when I was completely sure I knew the answer"
	Facilitated peer learning	8 (13.56%)	"You get to see what everyone else has said and you get to compare your answers to everyone else" "It helps you gauge how other people learn and remember different bits of information." "They motivate me to talk to my peers about the module"
	Reaffirmed knowledge & boosted confidence	6 (10.17%	"Made me feel more confident about my knowledge of the module" "Help me recap what I have learnt in the lectures"
	Anonymity increased engagement	5 (8.47%)	"It's anonymous so there's no judgement if you get the answers wrong"
	Assessment	4	"They helped me understand the types of questions that could arise in the MCQ exam"

	confidence	(6.78%)	"I feel it is a chance to be asked questions, similar to what we may expect in the MCQ exam, so it is very helpful in preparation and confidence in the exam"
2. Barriers to engagement with technology	Technical problems	7 (11.86%)	"At time clickers didn't work so we had to improvise and put our hands up instead for answer choices which was quite embarrassing"
	Time consuming set-up	4 (6.78%)	"Can sometimes take up a little time in the lecture with the distribution of the clickers"
3. Areas for improvement	Follow-up on incorrect answers	15 (25.42%)	"Some answers not being explained, sometimes confusing me further" "The least helpful thing about the clickers is that they don't offer an explanation or feedback on the answers to the questions if you got them wrong it just gives a percentage of who voted for what answers" "Make it easier to ask any questions that I don't understand rather than feeling like I can't in a bigger group"
	Increased usage	14 (23.73%)	"Maybe to include a few more questions to test deeper knowledge of subjects." "Do them more regularly to reinforce what's been learnt and help us to identify weak areas."
	Enable individual participation	14 (23.73%)	"When sharing with people you don't know, choosing an answer can be difficult" "Have one [clicker] each as sometimes you can disagree with your partner" "Allow students to answer individually, so they can more effectively assess their own performance."

[1] Number of students whose views were represented within each theme (i.e. the number of students who 'endorsed' the theme). These categories are not mutually exclusive. Thus participants' may have endorsed more than one theme.

<u>Table 3: Rate of responding & response patterns as a function of attendance and question type (study 2)</u>

Lecture	**Question type**	***N* respondents**	**Twitter**	**Web**	**Phone**	**Duration (mins)**	**Attendance**	**% Respondents**
Attachment	Fixed	17	N/A	0	17	3	130	13.08
	Fixed	16	N/A	1	15	5		12.31
	Fixed	13	N/A	1	12	2		10.00
	Fixed	10	N/A	2	8	3		7.69
	Fixed	14	N/A	1	13	2		10.77
	Fixed	14	N/A	2	12	3		10.77
Social Understanding	Fixed	28	3	10	15	2	117	23.93
Role of family	Fixed	20	3	10	7	3	105	19.05
	Fixed	16	4	7	5	8		15.24
	Open	12	3	8	1	14		11.43
Pro-social behaviour	Open	25	5	13	7	6	No data	
Appetite	Fixed	22	2	12	8	3	102	21.57
	Fixed	21	2	11	8	4		20.59
Assessment workshop 1	Open	6	1	3	2	6	116	5.17
	Open	5	2	2	1	11		4.31
Mental health	Open	15	4	6	5	3	No data	
	Open	21	8	6	7	14		
	Open	26	6	17	3	3		
Biopsychology of Emotion	Fixed	15	0	10	5	2	66	22.73
Assessment workshop 2	Open	4	0	3	1	17	101	3.96
Assessment workshop 3	Fixed	28	1	18	9	14	100	28.00
	Fixed	20	2	15	3	13		20.00
Drugs	Fixed	17	1	9	7	2	41	41.46
Cognitive Development	Open	4	0	2	2	5	22	18.18
	Open	14	1	9	4	4		13.73
Average		**16.12**	**2.53**	**7.12**	**7.08**	**6.08**	**90**	**15.90**

Note. Lectures listed chronologically throughout the semester; Fixed = multiple-choice question; Open = free-text discussion question;

Table 4: Frequency data showing attitudes towards the value of using online polling to improve the student learning experience (study 2)

Area/Item	**% Agree**	**% Disagree**
Learning experience		
More engaged/interested	69.5	10.9
Intellectually stimulating	68.5	18.4
Enjoyment	**75.3**	13.5
Encouraged attendance	52.7	8.8
Confidence to participate	66.3	18.0
Participated more often	60.9	16.3
Learning Process		
Improved understanding of key concepts	63.0	13.0
Effective learning	57.6	18.5
Encouraged reflection	64.1	17.4
Problem-solving, critical thinking and analytical skills	39.2	23.9
Discussion with peers	**80.4**	6.5
Liked immediate feedback on learning	**78.3**	7.6
Attitudes towards use		
Liked free text polls	69.3	17.0
Liked MCQs	**71.7**	13.0
Waste of time – more lecturer input	16.3	66.3
Tied to assessment	37.0	17.4
Greater use in future	50.0	6.7

Table 5: Final thematic structure resulting from qualitative analysis (study 2)

Superordinate Theme	**Subordinate Theme**	**No. of students** ***n = 84***[1]	**Illustrative quotations**
1. Impact on engagement & learning	Anonymity increased engagement	26 (30.95 %)	"I can express myself and my thoughts without the stress of speaking out loud in class." "I could answer wrong without being judged." "You were able to ask questions and give answers that you wouldn't usually have confidence to do"
	Facilitated peer learning	18 (21.43 %)	"The variety of answers, if you didn't think of something someone else did!" "Seeing the views of others and building on their ideas." "Gets people discussing the answers"
	Encouraged active participation	16 (19.05 %)	"I contributed more and felt more engaged in lecture." "It made the lectures more interactive and easier to engage in"
	Promoted deeper engagement with material	15 (17.86 %)	"Thought provoking questions helped understand the topic" "Breaks up the information and allows you to think and process" "It gave a good insight into the topic question by breaking down the subject at hand so it could be processed and understood better"
	Improved understanding and confidence	9 (10.71 %)	"The immediate feedback, and helps to go over the topics to make sure we understand. Makes me more confident that I understand what has been taught." "They helped make sure you truly understood the topic you were learning and could assess/apply it for yourself" "By testing my knowledge, I actually learnt (as I stored the information properly) and engaged more in the lecture"

2. Barriers to engagement with technology	Technical problems	42 (50 %)	“The signal issue makes it difficult to participate in the poll” “Not being able to connect to WIFI”
	Seeing others responses was inhibiting	8 (9.52 %)	“Other people had already submitted the answer I was going to say (on open questions)” “Didn't feel the need as other people were answering them”
	Not seeing the benefit	7 (8.33 %)	“I don't enjoy the polls, I feel they are a waste of valuable time” “I just did not feel encouraged to join in the polling” “Sometimes I had nothing to say”
3. Areas for improvement	Challenge us more!	11 (13.10 %)	“Make them more thought-provoking” “Tougher questions to get us thinking about them more”
	More open-ended questions	9 (10.71 %)	“Do more open answered questions to give a more varied response with lots of people’s ideas” “Use more open-ended as these get you thinking and critiquing more than multiple choice”
	Quicker pace	7 (8.33 %)	“Less time needed to answer multiple choice questions” “Less discussion time”

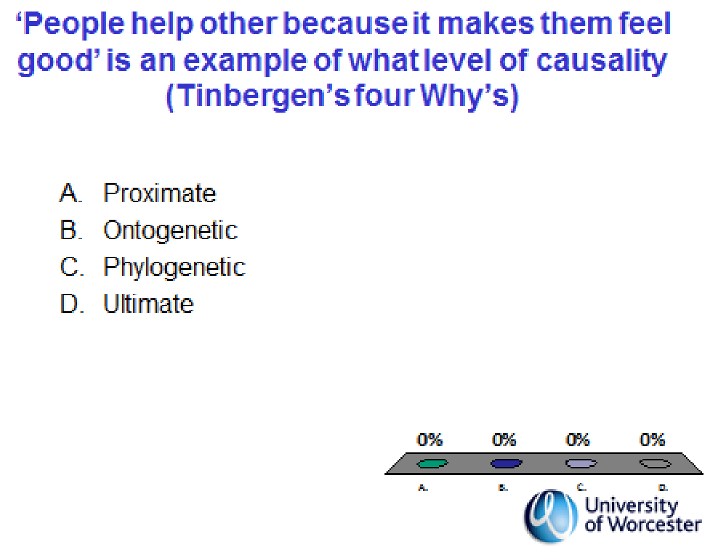
[1] Number of students whose views were represented within each theme (i.e. the number of students who ‘endorsed’ the theme). These categories are not mutually exclusive. Thus participants’ may have endorsed more than one theme.

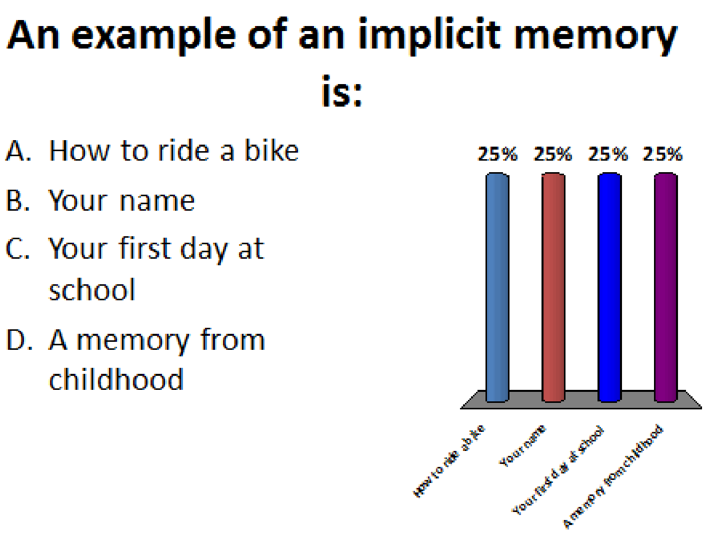
Table 6: Recommendations for practice

	TurningPoint Clickers	**Poll Everywhere**
Practical guidelines	• Hand out clickers at the start of the lecture to minimise disruption. Allow sufficient time at the end to collect them back. • Use clickers for a series of MCQ type questions rather than one-off questions. • Encourage discussion before responding irrespective of whether students have individual clickers or are sharing clickers in a pair. • As students can submit their responses instantly, less time is required for responding. We would recommend 1 minute as a maximum but be guided by the response figure on the screen to judge this. • Responses will not appear until voting is closed. Depending on the structure and function of MCQs, the correct answers can be revealed and discussed after every question. Alternatively, students can submit answers for each question and the instructor can then reveal and discuss the correct answers collectively.	• To minimise disruption, we would recommend the number of polls in sessions be limited to a maximum of 2 and allow a response time of no more than 3 minutes for MCQ type questions or up to 6 minutes for discussion questions. • Include a mixture of discussion (free text) and MCQ (closed responding) questions. • Consider using MCQ for conceptual checking of information *not* pre-presented on slides (students may have copies) to encourage higher-level cognitive engagement with material. Similarly, do not reveal ‘answer’ on upcoming slides – use responses to guide verbal discussion of answer. • Consider using standalone web-platform to collate responses and reveal after everyone has participated (not synchronously). • Consider reminding students to bring mobile devices (including laptops/tablets) to sessions as web entry was a popular method of poll-participation.

System requirements	• TurningPoint software is required to create the MCQs and administer them; therefore software must be downloaded in teaching rooms. Furthermore, a USB port is required for the dongle which enables communication with the clickers. • Staff training is essential given the complexity involved in the design and delivery of clicker MCQs.	• Training & set-up time is required. Tutors will need training in how to develop questions and run polling in class. Decide whether to use the add-on App or screen shots/web platform to collate & display results. • It is necessary to ensure that there is access to reliable Wireless Internet connection in the teaching venue.

Figure 1: Example 'TurningPoint' clicker questions





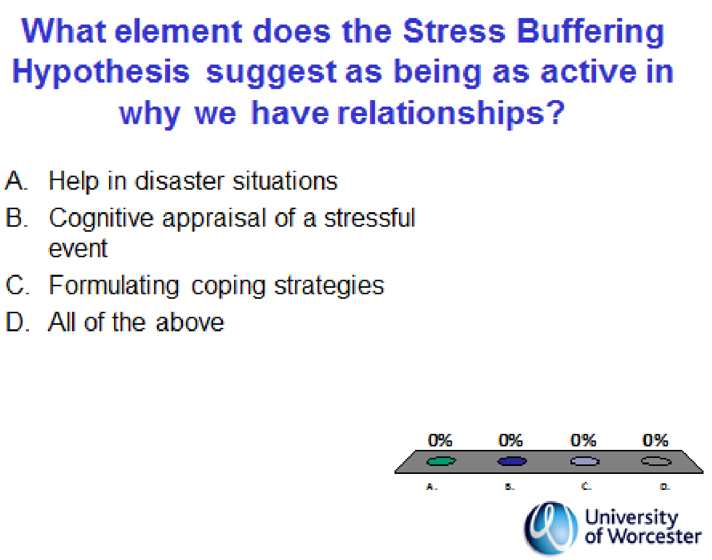
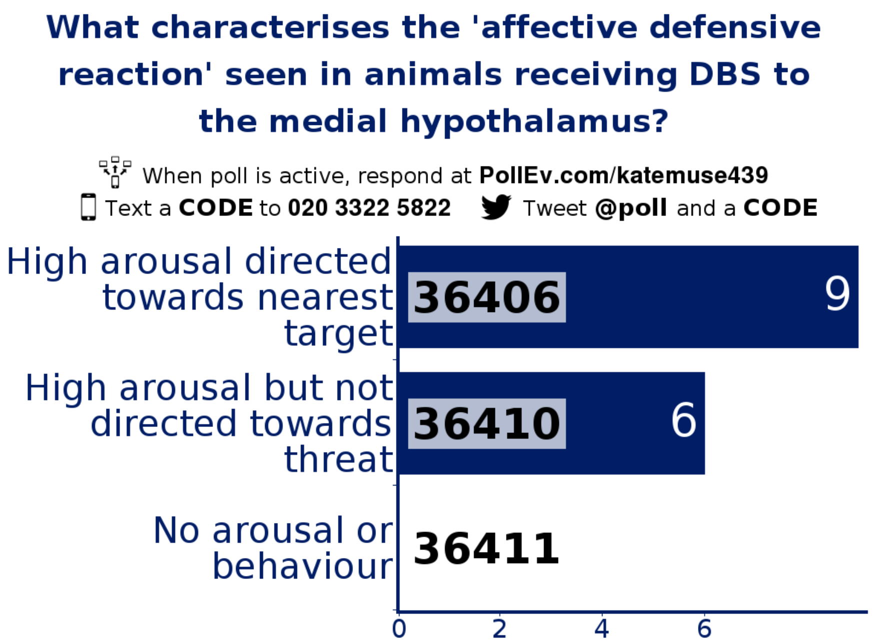
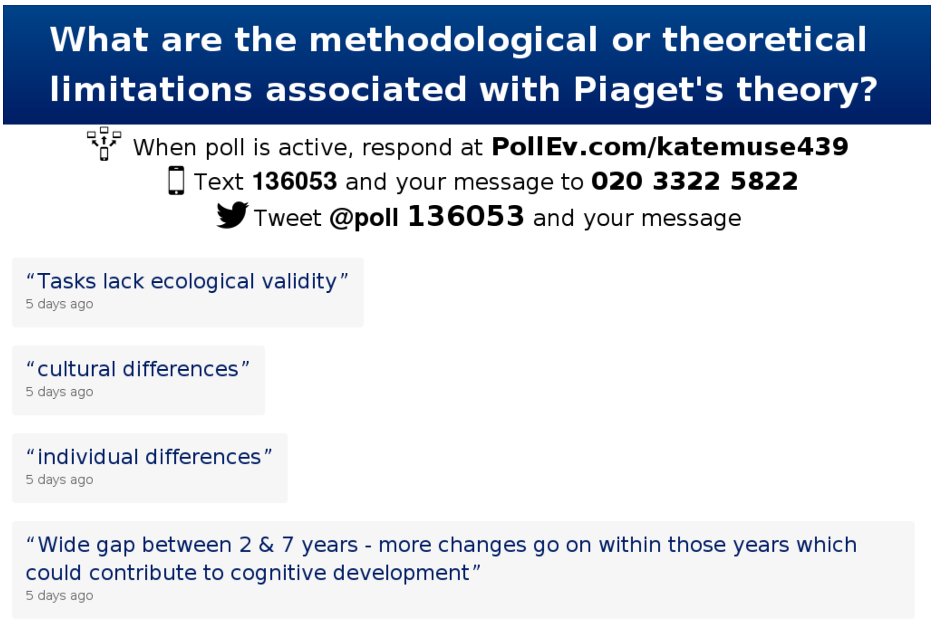


Figure 2: Example 'Poll Everywhere' questions

1. **Example fixed-choice, knowledge-checking question**



2. **Example open-ended/free text discussion question**



3. **Discussion-based fixed response questions (posed after class discussion)**

‘Joe and Tim watched the children in the playground. Without saying a word, Joe nudged Tim and looked across at the girl playing in the sandpit. Then he looked back at Tim and smiled. Tim nodded, and the two of them started off toward the girl in the sandpit.’

What’s happening here? Discuss with the person sitting next to you and then text your answer to the poll.