‘The most important question is not ‘how?’ but ‘why?’: A multi-method exploration of a blended e-learning approach for teaching statistics within undergraduate psychology

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Abstract

Research methods and statistics are cornerstones of undergraduate psychology degrees. However, many students find the subject uninteresting and anxiety provoking, while educators find it challenging to teach. This multi-method action research project explored how e-learning activities within a blended learning context affected students’ experience of learning statistics. Data were gathered with first year undergraduate students via a survey (N=89), two focus groups (N=12), and interviews with educators (N=2). The e-learning activities were valued by students and staff, owing to the interactive, flexible approach to learning they afforded. The blended strategy provided an opportunity for students to develop intrinsic motivation to learn statistics, completing a range of activities to develop competence with autonomy. Social support from peer-networks and tutor feedback during face-to-face sessions facilitated deeper learning. These findings are timely, given increases in online teaching resulting from changing higher education landscapes and the Covid-19 pandemic.

Keywords: statistics; research methods; e-learning; technology-enhanced learning; blended learning; self-determination theory; self-regulated learning.

Background

An understanding of and active engagement in research methods is a cornerstone of evidence-based under-graduate psychology degrees (Levant, 2005; Perlman & McCann, 1999; Trapp et al., 2011). Analysis is a fundamental component of the research process; students require the ability to select, conduct, report, and interpret statistical analysis. These statistical skills are fundamental to the development of psychological literacy, equipping students with the critical thinking and scientific reasoning skills required to actively engage in evidence-based psychological research and practice within their degree programme and in future careers (American Psychological Association, 2016; Norcross et al., 2006; Trapp et al., 2011). Furthermore, studying research methods facilitates the development of broader practical and transferable skills, such as in searching for, appraising and applying relevant evidence to aid problem solving, which are of benefit to both graduates and their employers (BPS, 2017). However, many students find statistics uninteresting, anxiety provoking, and intimidating (Bourne, 2014; Conners et al., 1998; Quilter & Harper, 1988; Snelgar et al., 2005). This can have a detrimental impact on academic performance, increase levels of academic procrastination, and prohibit students from seeking help and support (Gundlach et al., 2015; Onwuegbuzie, 2004; Vahedi et al., 2012). Many students also question the relevance of learning statistics, and as a result may engage only at a superficial level (Murtonen et al., 2008). Indeed, students with lower levels of understanding of the relevance of statistics and who lack confidence in their ability to interpret statistics, are less likely to perform well in this area (Hanna & Dempster, 2009). Additionally, extremes in ability are particularly pronounced in statistics compared to other subject areas, resulting in classrooms with highly variable student ability (Hudark & Anderson, 1990). In combination, these factors mean that educators often find the teaching of statistics uniquely challenging (Conners et al., 1998).

Numerous approaches have been recommended for responding to the challenges of teaching statistics within higher education. Giving students the opportunity to complete hands-on activities (i.e. ‘learning by doing’) has been suggested as a method for promoting motivation (Conners et al., 1998; Garfield & Ben-Zvi, 2007). When students gain direct, varied, and repeated experience of applying statistical ideas, they can learn to critically analyse and apply their statistical knowledge in novel situations (Garfield & Ben-Zvi, 2007). Analytical activities that are clearly located within the broader research process (e.g. experimental design, data collection, application of findings) help to avoid a narrow focus on the technical process of conducting statistical tests (Scott Jones & Goldring, 2015; Yilmaz, 1996). Peer-learning activities that are tutor-supported and involve small-group collaborative problem solving are thought to be especially effective within statistics teaching, encouraging opportunities for discussion of complex ideas and expression of understanding. Such approaches facilitate deeper and mutual learning for students who are finding the subject challenging as well as high achievers (Derry et al., 2000; Garfield & Ben-Zvi, 2007; Keeler & Steinhorst, 1995; Magel, 1998; Potthast, 1999; Pritchard & Woollard, 2010).

Formative feedback refers to non-evaluative information provided to a learner in response to completion of a task or activity, which supports students in modifying their thinking or behaviour in order to improve their learning (Schute, 2008). As such, it facilitates self-reflection, encouraging active involvement in assessment, and promoting

learner autonomy in higher education (Boud, 2000; Brew, 1999; Juwah et al., 2004; Nicol & Macfarlane-Dick, 2006). However, feedback that is not delivered immediately following a task is not well suited to learning procedural skills such as statistical analysis and can even be detrimental to skill acquisition for those who are less motivated, or find the task challenging (Schute, 2008). As such, ongoing and immediate feedback that allows students to engage in repeated reflection and to re-attempt the task may be most appropriate (Garfield & Ben-Zvi, 2007). Finally, given variability in students' ability in statistics (Hudark & Anderson, 1990), adopting an approach that allows students the flexibility to work at their own pace and at a time and location of their choosing may enable students to tailor their learning experience to their individual needs (Beetham & Sharpe, 2013; Garrison & Kanuka, 2004).

Changes in the context of higher education (e.g. marketisation, internationalisation, widening participation) have resulted in larger, more diverse student cohorts with increasing expectations for high quality 'value for money' teaching (Bunce et al., 2017; Trapp et al., 2011; Winstone & Bretton, 2013). Recent increases in online teaching in response to the Covid-19 pandemic (Burns et al., 2020) have raised additional implications for learning and teaching. This changing higher education landscape can be a barrier to the implementation of evidence-based approaches for teaching statistics within psychology degrees. However, the use of digital technologies, which have transformed the learning and teaching environment within higher education, may provide a means of meeting these challenges (Beetham & White, 2013; Jordan, 2013).

E-learning incorporates many of the pedagogical recommendations for enhancing the provision of teaching statistics within higher education. It provides an individual and flexible approach to instruction, allowing students to complete activities via electronic media at a time and location of their choosing, and at their own pace (Bull & Danson, 2004; Bull & McKenna, 2000). It also provides opportunity for varied and repeated of experience of applying statistical ideas within interactive, hands-on, and contextualised activities, allowing students to engage in repeated practice of tasks with immediate formative feedback (Bull & Danson, 2004; Bull & McKenna, 2000; Miller, 2008). E-learning has proved popular with undergraduate students and has been found to be more effective than static, paper-based instructional techniques in enhancing student learning for higher-order, conceptual statistical knowledge and software usage (Hoffler & Leutner, 2007; Lloyd & Robertson, 2012; Parson et al., 2009; Van der Meij & Van der Meij, 2014). As such, e-learning shows promise in teaching statistics to undergraduates.

Although potentially beneficial, using e-learning as an outright replacement for face-to-face teaching may be problematic due to low levels of student motivation and confidence, and high levels of anxiety around statistics (Cybinski & Selvanathan, 2005). In a comparative evaluation, final grades of undergraduate students taught statistics via distance e-learning were no lower than students who attended face-to-face classes, although the e-learning student group were significantly less satisfied with the experience (Summers et al., 2005). A 'blended' approach to learning, integrating e-learning activities with traditional classroom methods, can both augment the advantages of face-to-face interaction (e.g. rich dialogue with tutors, peer learning, collaborative problem solving, etc.) and provide additional learning opportunities (e.g. formative feedback, interactivity, etc.), (Bonk & Graham, 2005; Boyle, 2005; Garrison & Kanuka, 2004; Means et al., 2013). Thus, blended learning may provide a way of effectively teaching statistics within the context of undergraduate psychology programmes, whilst maintaining student satisfaction.

This paper presents an action research project focussing on the development and evaluation of a blended learning approach involving lectures, e-learning activities, and group-based seminars designed to teach first year undergraduate psychology students how to conduct, report, and interpret statistical analysis in the second semester of 2016. Two related studies examined the impact of this blended learning approach for statistics. The first study focuses on the impact that the use of an e-learning activity had on the student experience. The second study examines in greater depth staff and student perspectives on the broader blended learning strategy to teach statistics. Both studies received approval from the University of Worcester's Ethics Committee.

Study 1: Examining student perceptions of e-learning activities

This study sought to explore first year undergraduate psychology students' perceptions of the e-learning activities designed to teach them about statistics. Specifically, the study sought to answer two questions:

1. To what extent are the e-learning activities positively evaluated by students in terms of usability, usefulness, satisfaction, and intention for future use?
2. What are the barriers to effective use of e-learning activities and how could this resource be improved?

E-learning intervention

The e-learning materials were embedded within the University's Virtual Learning Environment (VLE) as part of a level four 30-credit module entitled 'Introduction to Psychological Research Methods', a mandatory module for first year psychology students on a British Psychological Society (BPS) accredited programme. The module offers an introduction to statistics, teaching students how to select, conduct, report, understand, and interpret a range of tests

with seven topics: descriptive statistics, exploring assumptions, parametric tests of difference, non-parametric tests of difference, parametric tests of correlation, non-parametric tests of correlation, and ANOVA tests.

Seven e-learning activities ('e-activities') were created using Articulate Storyline 2 software (www.articulate.com). These e-activities teach students how to conduct and interpret statistical tests using the software package IBM SPSS and how to report their findings in line with American Psychological Association guidelines.

The overarching aim of these e-activities is to provide opportunity for independent, flexible, and repeated engagement in interactive formative tasks which involve applying statistical ideas within contextualised activities. Each e-activity begins with a formative multiple-choice quiz (MCQ) to test students' understanding of theory and concepts underlying the statistical tests. Students receive immediate corrective feedback and are given the opportunity to review their results or re-try questions. Students are then given details of a psychological experiment which provides a contextual setting for conducting the statistical test in the activity. A 'how to guide' provides video guidance with annotated captions. Students can re-play, re-wind, and pause these tutorials. Learning of the material covered in the 'how to guide' is then applied in the 'try it for yourself' section, where students interact with the SPSS software interface to conduct the statistical analysis. Short-answer questions with model answers are used to test students' ability to interpret and report the analysis. MCQs with immediate feedback are also embedded throughout and 'information point' icons are used to provide students with explanations of key terms and concepts.

Data gathering

A survey was administered via paper-and-pencil, to reduce any technology-related participation barriers and sampling bias. Quantitative questions were adapted from previous research aligned to the technology acceptance model and the five-category model of e-learning evaluation (Al-Adwan et al., 2013; Malhotra & Galletta, 1999; Stergiolas et al., 2002). The 25 items (see Figures 1 – 5) examined perceived ease of use, perceived usefulness, intention to use, perceived impact on learning, and satisfaction. These were scored on a four-point scale from 1=strongly agree to 4=strongly disagree. Four open-ended qualitative questions allowed students to make in-depth, general observations about the impact they felt the e-activities had on their learning, what the most and least helpful aspects of the e-learning activities were, and any suggestions for improvement. Recurrent patterns in qualitative data were identified using inductive thematic analysis, as outlined in Braun and Clarke's six stage analytic approach (2006). All 142 students who attended teaching were invited to participate, 89 of whom completed the questionnaire (63 per cent response rate).

Findings

Positive endorsement for the quantitative items was high across all domains of e-learning evaluation: perceived ease of use (Fig. 1), perceived usefulness (Fig. 2), intention to use (Fig. 3), impact on learning (Fig. 4), and satisfaction (Fig. 5). Levels of positive endorsement were highest (>95 per cent) for items examining overall ease of use, ease of operating the e-activities, clarity of structure and organisation, overall usefulness, and interactivity of the e-activities. Levels of positive endorsement were lowest (<70 per cent) for items examining confidence in research methods, reporting statistical tests, interest whilst completing e-activities, enjoyment whilst completing e-activities, engagement with research methods, and provision of useful feedback.

Four recurrent themes were identified: 1) developing independence, 2) learning by doing, 3) increased confidence, and 4) usability.

Developing independence

Students particularly valued the flexible approach to learning. This flexibility allowed them to tailor the e-activities to their own style and pace of learning: 'I could access them at any time. I found this meant I could complete them at my own pace and at a time when I could focus. This made it more likely that the information would sink in'. Students also liked having the opportunity to monitor their own progress using the embedded formative tasks, whilst still 'being able to go back over things' if they forgot something, felt confused, or didn't understand something in a lecture or textbook. This flexible, individualised approach increased students' sense of independence. As one student put it, 'it has been like a teacher but at home, enabling me to help myself independently'.

Learning by doing

Students emphasised the interactive nature of the e-activities, which they felt enhanced their learning experience. One student commented 'I really like that we got to interact with it (the e-activities) and not just read lots of information'. Overall, students felt that this 'learning by doing' approach was particularly useful for developing their procedural

Figure 1: Percentage of student responses to quantitative survey items examining the perceived ease of use of the e-learning activities (N=89).

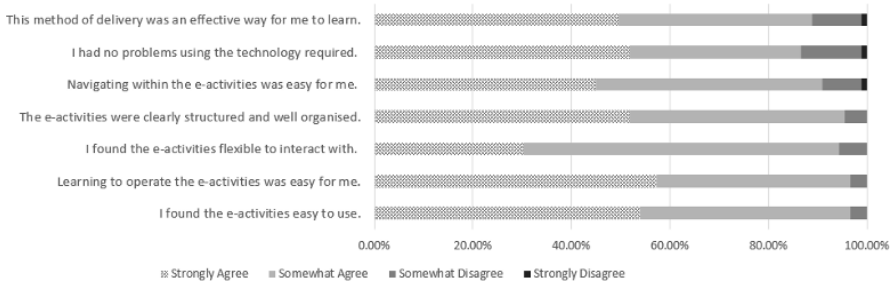


Figure 2: Percentage of student responses to quantitative survey items examining the perceived usefulness of the e-learning activities (N=89).

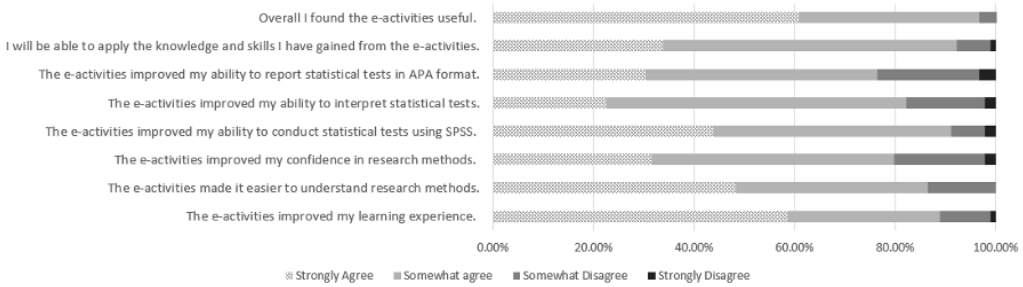


Figure 3: Percentage of student responses to quantitative survey items examining intention to use the e-learning activities (N=89).

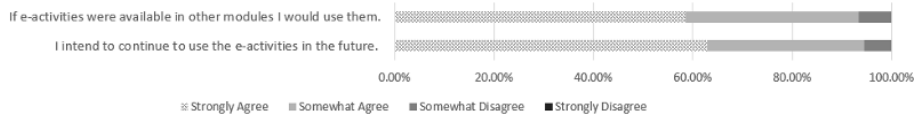


Figure 4: Percentage of student responses to quantitative survey items examining the perceived impact on learning of the e-learning activities (N=89).

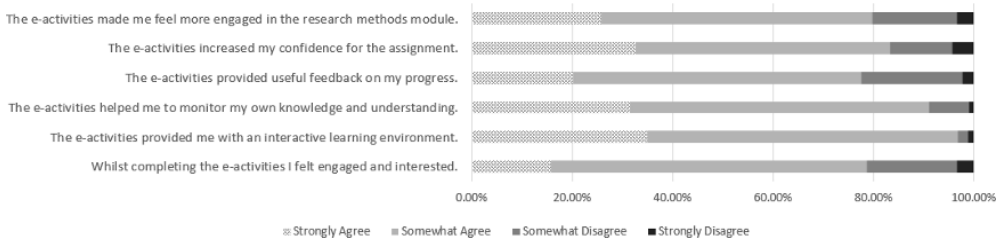
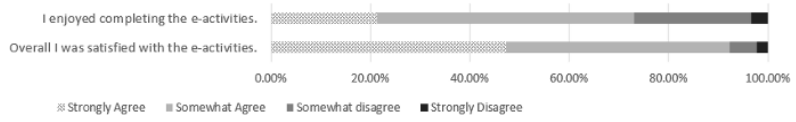


Figure 5: Percentage of student responses to quantitative survey items examining satisfaction with the e-learning activities (N=89).



skills around completion of data analysis and using a statistical software package. Students highlighted that it was ‘easier to learn from actually experiencing and trying things’. As well as promoting active engagement, this interactive approach helped to ‘cement’ student’s learning by ‘helping the information to sink in’.

Increased confidence

Overall, the e-activities increased students’ confidence and ability in using SPSS and conducting statistical tests: ‘they helped me to understand how to use SPSS and made it possible for me to successfully conduct various tests. Without them SPSS seemed extremely complex’. Independent engagement in interactive tasks seemed especially helpful for reinforcing the knowledge gained in lectures and helping students to feel they had a clearer grasp of important, but challenging, concepts. As one student commented ‘they helped me to understand the information given in lectures better. Although I listen in lectures, the information doesn’t really sink in unless I go over it again in a more

interactive way'. This in turn helped students to feel more confident when completing the module assignment: 'It helps understanding and increases confidence in the portfolio'. Students commented that they found being able to revisit the materials when completing assignments reassuring: 'I was able to follow the walkthrough activities alongside my assignment questions'. However, increased understanding and confidence seemed to be more apparent for procedural skills of conducting and reporting statistics, as students highlighted gaps in 'higher level' knowledge around selection and interpretation of statistical test. One student commented 'I know what the results should look like but I don't know what it means', whilst another noted that the e-activities 'didn't provide much information about why the test was appropriate for that particular scenario'.

Usability

Students found that the clear and simple step-by-step instructions made the e-activities easy to use by 'breaking the information down' and providing 'small steady steps and clear explanations of what to do'. However, students also felt the materials were time-consuming and that access to the e-activities, as well as navigation through the e-activities, reduced their usability. In addition, a small number of students found engaging with technology intimidating, noting that 'learning through the computer doesn't help me due to the fact that I am not a big fan of technology'.

Conclusions

These findings show that students found the e-activities easy to use. This was due to the clear and simple step-by-step instructions that broke the tasks down into manageable chunks, a strategy which has been found to scaffold student learning with digital environments (Sharma & Hannafin, 2007). However, students did highlight a need for improved usability of the materials within the VLE and a simpler method of navigating through the e-activities. Although these seem like relatively minor problems, it is imperative that these are addressed as issues that hinder ease of use are often significant barriers in the adoption of e-learning (Beetham & Sharpe, 2013).

Students found the e-activities a useful resource and felt they had a positive impact on their learning experience, improving their statistical analysis abilities. Students also felt confident in their ability to apply the knowledge and skills gained from the e-activities, especially in their summative assignment. That being said, students felt the e-activities had less of an impact on their ability to interpret and report analysis than their ability to conduct analysis, highlighting gaps in these 'higher order' areas of knowledge. This 'procedural' understanding of statistics is common within introductory modules and can be overcome through focussing on students understanding of underlying concepts within small group activities (American Statistical Association, 2005). Thus, it is important to employ seminar activities alongside e-learning to foster understanding of these more advanced skills (Bonk & Graham, 2005).

It has been suggested that interactive, practical activities are well suited to teaching data analysis as they give students the opportunity to practice skills-based learning outcomes, promote active engagement, and facilitate deeper learning (Bernstein, 2018; Carver et al., 2016). In line with this, students found the interactive nature of the e-activities helpful in promoting learning because they provided opportunity to engage in practical activities and offered ongoing feedback on their progress. It is, however, important to note that engagement and interest during the e-activities was relatively low and that several students did not feel that the e-activities made them feel more engaged in the research methods module. This may be reflective of the low levels of engagement seen across introductory research methods classes (Conners et al., 1998). However, feedback indicates that the time taken to complete the e-activities may also have reduced levels engagement, due to boredom and fatigue.

Aspects of the method of online delivery for the e-activities were received positively. As found in previous research (Al-Adwan et al., 2013; Park, 2009), students particularly liked the flexibility and convenience afforded as well as the opportunity to engage in repeated practice. However, the digital format was a barrier for a small number of students, who found the technology intimidating. Although many current UK undergraduates are digitally capable, consideration must be given to those who are less familiar with technological advancements (Fry et al., 2009). This can be achieved through the provision of alternative formats of learning or delivering training in the use of technology used within teaching (Beetham & Sharpe, 2013).

Study 2: The impact of e-learning within a blended learning context

This study examined the broader impact of a blended learning approach involving the integration of lectures, e-learning activities, and seminars designed to teach statistics in first year undergraduate psychology. The study examined how the blended learning strategy impacted on students' experience of and approach to learning statistics. This study sought to answer the question 'in what ways do the features of a blended learning approach facilitate or inhibit the learning of statistics, from student and tutor perspectives?'.

Blended learning strategy

The blended learning strategy was designed to teach statistics as part of a level four 30 credit introduction to research methods module, as previously discussed. The strategy involved three key components. First, a weekly two-hour large group lecture delivered key concepts and practices to the whole group (approximately 170 students, 22 lectures in total). These interactive lectures provided students with an understanding of the broad research framework within which statistics is embedded in the field of psychology (e.g. psychology a science, using experiments in psychology, collecting and analysing qualitative data, quantitative data collection and analysis, report writing in psychology, psychological tests). These lectures also introduced theory underpinning specific forms of statistical analysis. Second, students engaged in independent 'e-activities' as previously described. Finally, students attended 14 smaller group seminars, attended by 25 to 30 students. These were one hour in duration and provided peer learning activities, allowing students to apply knowledge and skills learnt within lectures and e-activities by conducting statistical analysis on datasets from fictional experiments, interpreting findings through discussion, and summarising key results in a report format. The activities were tutor facilitated, with staff checking understanding, providing corrective feedback, and offering general support and guidance. Students were also provided with written feedback in the form of standardised 'example answers', designed to clarify the content, depth, and quality of analysis, interpretation, and reporting expected. Additional module support was provided via bookable one-to-one tutorials and a peer-led discussion forum in the VLE.

Data gathering

The study sought to synthesise staff and student perspectives on the blended learning approach adopted. A convenience sample of 12 students enrolled on the research methods module participated in two focus groups (N=6 per group), each lasting one hour. Focus groups were used as they produce rich data and allow for the collection of in-depth 'naturalistic' insight into the experience of a group (Carlsen & Glenton, 2011; Kitzinger & Barbour, 1999; Wellings et al., 2000). Two module tutors also participated in individual semi-structured interviews, each lasting 45 minutes. Interview schedules consisting of open-ended questions and minimal prompts (Kvale, 1996) were used in interviews and focus groups to explore participants' experiences of learning or teaching statistics using the blended learning approach. The key emphasis was on open reflection of personal experience, with participants being asked 'what has been your experience of using lectures, e-activities, and seminars to learn about/teach statistics?'. Follow-up questions focussed on eliciting information about what students and staff most and least liked about the approach, what they felt was most or least helpful, how this impacted students' learning, barriers to learning, and anything they would change about this approach. Interviews and focus groups were facilitated by the second author and were audio-recorded and transcribed verbatim. Analysis followed Braun and Clarke's (2006) six step approach to thematic analysis, with a focus on the experiences and the meanings associated with these experiences (i.e. 'contextualised' thematic analysis).

Findings

All participants held broadly positive attitudes towards the blended learning approach to studying statistics, although there were variations in the degree to which this approach facilitated or inhibited students' learning. Four themes were identified: 1) small steps, big picture, 2) learner autonomy, 3) social support for learning, and 4) authentic curiosity.

Small steps, big picture

The blended learning approach provided a clear, structured, and trustworthy framework within which to learn statistics. The structured nature of the approach meant that students experienced repetition of concepts and procedures within lectures, e-activities, and seminars, facilitating understanding and confidence: '…we've got two hours in lectures, so then they go into (an example) really in-depth. And then in the (e-activities), we'd have . . . another example . . . And then in the seminar, we normally get another example, as well. So then, if we're doing it three times, hopefully in the same week, then we've got the opportunity to ask questions . . . that can be quite useful' (Student). Tutors also found repetition helpful, commenting that this scaffolded approach to learning helped students develop increased independence and confidence in decision-making skills. They also recognised that this could sometimes lull students into a false sense of security, with some taking a more passive role or failing to recognise misunderstandings. '…students will say 'yes, I'm fine', but when you start probing them on why they've done things and how they've gone about it, you see that no – they're actually not clear on what they're doing'.

Students liked the way the approach consistently drew together key aspects of a vast and daunting topic and broke it down into smaller constituent parts: 'It is just breaking down these steps that we have into even smaller steps. You

have this big step and then you have the different little steps from this step' (Student). Students felt that providing clear and discrete step-by-step guidance meant information was more easily understood and digested: 'I think it was really helpful… because it shows you exactly how to write something, and where to write it, or how to actually phrase what you're trying to say, like correctly in APA formatting' (Student). Although tutors also felt that this approach was beneficial, they noted that students sometimes needed guidance in making contextual connections, particularly in relation to how statistics fits within the broader context of psychological research: 'research methods isn't just about the analysis, it's about the whole research process' (Tutor). They felt students varied on their development of a more holistic understanding of statistical analysis, with those more engaged in the learning activities showing a deeper level of learning.

Learner autonomy

Students and tutors felt the flexibility afforded within the blended learning approach allowed students to tailor their learning experience to their individual needs and preferences. The completion of independent e-activities in the week-long gap between the lectures and seminars was reported as particularly useful. This gave students time to digest the information delivered in lectures, complete the e-activities at a time of their choosing and in an environment they felt comfortable in, and then attend the seminars having considered the subject matter and identified questions or uncertainties. Following this, students were able to 'dip in and out' (Student) of the resources as needed (e.g. when completing assignments, if confusions arose in later sessions, revision of concepts). As one student highlighted, 'it's [the module materials] split into sections, so you can just go to a particular section that you want to go to and go through that section again'.

Students particularly liked the control this approach gave them, allowing them to work at their own speed, tailor their learning according to their own preferences, and fit their learning around other life commitments. The ability to develop individualised learning routines was especially important to international students, students with work or childcare commitments, and students with specific learning needs. As one international student commented 'Some of us do it really fast, some of us take time. I know for international students it would take time to translate. I personally translate a lot of things, because I'm still trying to understand… I want to understand it in my own language…'.

Tutors felt that, although some students engaged independently with the e-learning activities from the start, others needed tutors' scaffolding to develop a more active approach to their learning: 'it's giving them the materials, but emphasising that independence, that they are the learner, we can't just... tell them what things are, because a lot of them will expect you to tell them what... the answers should be... It's finding that balance with them' (Tutor). Tutors also felt that students sometimes needed external prompting to recognise the progress they had made as independent learners during the module: 'I've noticed that when they first were faced with the tasks in the seminars, right at the beginning, they were like 'this is so difficult'. But now... they were coming up with really good answers and then they kind of realise, okay… they're used to this process and they've learned as they've gone along'.

Social support for learning

The social aspects of learning that arose in face-to-face contexts (i.e. lectures and seminars), provided a positive, constructive learning experience for some. Students who had formed strong peer-networks found opportunities for face-to-face interaction in seminars especially transformative, fostering both their confidence and higher-order knowledge. Indeed, some students felt that greater opportunity for peer-collaboration would be beneficial to their learning in the long term: 'I just think we need to work together a bit more... I think it would help if we sort of gained a better understanding with other people, than just trying to understand it ourselves' (Student). Students spoke of relying on each other and the benefit of seeing others' ideas and interpretations of the same issues. If peers could not help them understand, and they could not find an explanation in the learning materials, they would then seek support from a tutor. Owing to the face-to-face nature of the seminars, these tutor-led discussions and explanations were valued because they were individual and nuanced: 'I find it helpful... that we ask each other questions as well, and we can try and figure it out between us. Then, if we still don't get it, then we can get a tutor to come over, and explain it in a different way. So, I find that being with peers helps' (Student).

In contrast, for some students an underlying anxiety relating specifically to statistics was compounded by social anxiety. These students felt unable to engage in large- or small-group discussions, or to talk with tutors to clarify areas of confusion. This was particularly pronounced in large group lectures: 'With the lecture, there is a load of people, so you don't really want to talk if you are not confident. In a seminar, there are less people, but… you are still hiding. And if no-one says anything… that sets the standard. If no-one else is going to say anything, I won't either' (Student). A key barrier to participation was feeling isolated or alone. Some spoke of not talking to anyone during the seminars and therefore not seeing how they provided a differentiated learning experience to the independent e-activities: 'If I miss a seminar I will just do it at home. I am not going to miss a lot...' (Student). As a result, they relied more heavily on support from online discussion forums, although they recognised that it was harder for tutors to advise them on

complex issues through this medium.

Authentic curiosity

Broad differences in students' learning motivation and goals were identified in both student and tutor perspectives. As one tutor noted 'you find that you've got two different types of students: one that just gets through tasks really quickly and hopes for the best, and then you get others that want to know why certain things work and in what certain way, and what these statistics actually mean'.

Students with surface learning goals focussed more closely on procedural aspects and completion of the tasks. These students were strategic in their approach to learning, choosing to focus on key procedural tasks covered in teaching. Extrinsic motivation was evident, learning only as much as was needed to pass their assessments. Students with these goals typically showed less curiosity, preferring to passively receive information delivered within teaching sessions. Many even deliberately avoided opportunities to 'learn by doing' within seminars and e-activities. Some completed the e-activities without deeper understanding of what they were doing or why: 'sometimes it's kind of like... you've got to do this, and this, but I don't actually understand why I'm doing that' (Student). Students found this lack of understanding intimidating, which demotivated them and created a barrier to further engagement.

This learning approach is in stark contrast to those students with deeper learning goals. These students took a more holistic and intrinsically motivated approach, showing authentic curiosity to learn not only the procedural aspects of statistical analysis, but also why and when they should be used, what insights statistical findings provide, and how statistics fit within broader research paradigms. As one student commented 'basically, the most important question is 'why?', not 'how' but 'why?'. These students identified that different aspects of the blended learning approach (i.e. lectures, e-activities, and seminars) served different purposes for them. For example, e-activities tended to help develop technical competence ('how') whilst lectures and seminars tended to help answer 'why' questions (i.e. higher order knowledge) through discussion and active experimentation. These students viewed any confusion or complexity faced as a challenge and thus continued to engage in the learning process: '...it was just a bit hard to fully understand everything at first, but after you do it a couple of times, it makes more sense. So, it's not a problem, it's just it's something new obviously, so it's going to take you a while to fully understand it' (Student). They were also more proactive in seeking opportunities to clarify understanding of the subject material: '..some students… had actually gone off and done their own… reading around certain things to try to understand it themselves. And, they'd then brought that along and asked why the (e-activity) was slightly different to other things that they'd read. So it was… highlighting a little bit more depth to their learning' (Tutor).

Conclusions

This study found that students valued the structure and format of the blended learning approach, with opportunities to learn in small steps within the bigger picture, with autonomy, curiosity, and social support. This is particularly important given that previous research has identified that knowledge gains across the study of statistics may be influenced more by the content and presentation of a course, than by students' prior statistical ability (Delucchi, 2014). Indeed, as has been found previously, the clarity of the e-learning materials and their role within a broader range of blended learning activities were particularly prized (Swan, 2001), because they allowed for learning experiences to be tailored to individual needs, pace, and lifestyle (Arora et al., 2011; Beetham & Sharpe, 2013; Garrison & Kanuka, 2004). However, some students found this level of flexibility and autonomy daunting and struggled to manage their time and effort effectively. Therefore, introductory research methods modules should also scaffold students' approaches to planning and prioritising tasks.

Similar to previous research, this study suggests that the early stages of learning on the blended module were characterised by confusion and questioning, but that this improved over time (Poelmans & Wessa, 2015). However, the degree to which this improvement was felt by students was greater for those who held 'deeper' learning goals. These students' approaches were characterised by greater authentic curiosity about the purpose of and approaches to statistical analysis, which is congruent with the 'conceptual' element of Scott Jones and Goldring's (2015) 'Technical-Conceptual-Pedagogic-Practical' learning model. Students evidencing this approach appeared more comfortable with 'having a go' at learning activities, facilitating the development of conceptual knowledge and confidence. In contrast, tutors spoke of finding it more challenging to support 'technical' students (i.e. those focused procedural knowledge) to see the relevance of statistics to the wider study of psychology. Tutors felt this inhibited these students from making important connections between different statistical concepts. A method which may enhance the perceived relevance and engagement might be for students to develop case scenarios which better reflect their own lives (Garfield & Ben-Zvi, 2007). Ultimately, the present research suggests that the social support element of the blended learning environment was vital for scaffolding students' ability to see the 'bigger picture' and to reassure them that engaging in learning activities would foster this.

Statistics anxiety is a key factor in students' experience of learning statistics and is associated with poorer academic outcomes (Slootmaeckers et al., 2013). However, much previous research into the causes of statistics anxiety has focused on dispositional (e.g. attitudes and self-concept), course-related (e.g. course evaluation), and person-related (e.g. gender) variables (Slootmaeckers et al., 2013). The present research suggests that social anxiety (i.e. persistent and severe fear of being humiliated in front of peers) should also be considered as an important cause of statistical anxiety. Indeed, social anxiety has been found to have serious negative consequences for learning more broadly (Topham et al., 2016). Furthermore, the present study's findings suggest feeling isolated on a blended learning statistics module can reduce engagement and inhibit learning. This is important to consider in light of the Covid-19 pandemic, where feelings of isolation and disconnectedness may be particularly pronounced in higher education (Burns et al., 2020). Therefore, there is a need within blended learning approaches to facilitate development of meaningful interpersonal peer relationships. Indeed, for students with stronger peer-networks, peer-learning was found to be particularly transformative, supporting previous findings that it is associated with deeper learning and more effective acquisition of knowledge and skills (Dancer et al., 2015; Pritchard & Woollard, 2010). Exploring methods of fostering peer-networks, perhaps through such activities as the jigsaw classroom (Aronson & al, 1978) – whether facilitated online or face-to-face, may be beneficial for developing this.

Discussion and future directions

Taken together, the two studies indicate that e-learning activities as part of a blended learning strategy can result in a positive experience for psychology students when learning statistics. Specific exploration of the experience of e-activities designed to teach statistical analysis found that they were well received by first year undergraduate students. They were perceived as useful and engaging, allowing students to take control over where and when learning could take place and offering opportunities for practice and feedback. However, e-learning alone has previously been found to negatively affect student satisfaction (Summers et al., 2005) and this study identified barriers to engagement in e-activities, including the digital format, boredom, fatigue, and isolation. A level 4 module would seem to require greater scaffolding of learning with external regulation to support the development of learner autonomy as students transition to higher education. Additionally, the e-activities primarily fostered development of procedural statistical skills. Thus, individual, asynchronous e-learning does not seem to provide a comprehensive teaching package enabling students to develop a clear understanding of statistics. The present research suggests that situating e-learning activities within a blended learning strategy can meet these needs more effectively. Students and tutors identified numerous potential benefits of blended instruction over purely online methods, with opportunities for regular feedback, interpersonal support from peers and tutors, and development of higher order skills and understanding, all within a flexible learning environment.

Theoretical models of learning help to explain these patterns of findings and could guide the development of blended learning strategies. Self-Regulated Learning (SRL) refers to a pro-active, systematic approach to learning whereby learners engage in a cyclical process of forethought, performance, and self-reflection, and accept individual responsibility for their own acquisition of knowledge (Zimmerman, 1990; Zimmerman & Tsikalas, 2005). Students who engage in SRL involving cognitive (i.e. rehearsal, elaboration, critical thinking), behavioural (i.e. organisation, time and study environment management) and meta-cognitive strategies (i.e. learning regulation, effort regulation) experience lower levels of anxiety and have more positive attitudes toward statistics (Kesici et al., 2011). More broadly, self-regulated learners tend to be more persistent, resourceful, and confident in their academic studies than their counterparts (Pintrich, 1995; Zimmerman & Schunk, 2001). Research indicates that aspects of SRL can be taught and that blended learning approaches may be particularly well suited to this process (Bandura & Schunk, 1981; Zimmerman, 1990). Results from this study support this, with students who were more engaged with the learning activities employing SRL strategies and developing a more comprehensive and coherent, higher order understanding of statistics. Self Determination Theory (Ryan & Deci, 2000) posits that intrinsic motivation is fostered by an environment that allows learners to develop competence, exercise autonomy, and experience supportive relationships. Staff and student perspectives on the blended learning approach in this study highlighted the ability of blended learning approaches to maximise opportunities for fostering intrinsic motivation. Students with enhanced intrinsic motivation may also be more likely to develop the use of SRL strategies (Nicol & Macfarlane-Dick, 2006). Thus, a focus on motivation and independence for learning may provide a key framework for the design of successful blended learning approaches. Scaffolding SRL should be explicitly embedded within the wider course structure, with opportunities for reflection on personal motivators and approaches to learning generally and learning of statistics specifically. Initially at level 4, students may need additional support with time management and self-reflection. Feedback and support over time would aim to reduce the need for this tutor-led input.

Many of the features of the blended learning module identified by students and tutors as important to the learning of statistics are congruent with the concept of 'transformational teaching' (Slavich & Zimbardo, 2012). Transformational teaching is characterised by tutors taking the role of facilitators in students' learning, whilst aiming to promote students' personal development and attitudes towards learning. Features of the module congruent with

transformational teaching include creating opportunities for: modelling and mastery experiences, challenging and encouraging students, personalising attention and feedback (i.e. in e-activities and face-to-face seminars), and promoting reflection. An overlooked area for development, which may help to promote intrinsic motivation, may be to grow a clearer 'shared vision' (Slavich & Zimbardo, 2012) for the module. For example, helping students to better understand logic underpinning the blended learning design of the module and the importance of interaction in face-to-face/synchronous online situations may improve engagement.

For psychology students to become active researchers, the objective when teaching statistics should be the development of higher order knowledge and conceptual understanding rather than technical knowhow alone (Scott Jones & Goldring, 2015). As one student put it, 'The most important question is not 'how?' but 'why?'. Educators must also ask themselves this question when designing instructional strategies. The findings of this multi-method action research project suggest that the use of e-learning activities within a well-crafted blended learning strategy may help educators to engage their students in meaningful, independent, and deep learning.

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