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AK and DM secured funding for the project. AK, KM, and DM collaboratively developed the study and KM conducted data collection. KM conducted the data analysis, with input from AK and DM. KM drafted an initial version of the manuscript, with AK and DM offering input and revisions. All authors collaborated to approve the final version of the manuscript.

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The authors have no conflicts of interest to declare.

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The raw data, analysis code, and materials presented in this article are not readily available in compliance with the study's ethical approval. Requests regarding the data should be directed to Amanda Krause, amanda.krause1@jcu.edu.au. No aspects of the study were pre-registered.

Abstract

Statistical literacy, one of the core skills embedded in tertiary psychology education, is best taught using active learning pedagogy. While a plethora of research has examined how the implementation of Emergency Online Learning (EOL) in response to COVID-19 impacted teaching and learning in general, limited research has considered how this change affected tertiary teaching of psychology statistics specifically. We conducted an exploratory, two phase, mixed-method study to consider how the implementation of EOL during COVID-19 impacted the teaching of research methods and statistics at tertiary institutions in Australia. A sample of 21 tertiary educators in Australia (52% females, 48% males), aged 26-55 years old (M = 39.75) completed an online survey, which included quantitative and qualitative items addressing experiences with online teaching and COVID-19 EOL. Of this cohort, we interviewed three educators about their experience teaching statistics; changes in teaching conditions from 2019 to the present; challenges and advantages of EOL; and student satisfaction, engagement, and performance. Overall, we found that previous experience with online learning was a better indicator of success in EOL that years of teaching in general. Educators also felt underprepared and under-resourced from their institutions. Many challenges of EOL were identified, with access to statistical software being the key challenge unique to teaching statistics. Overcoming technological inequities was recommended to improve EOL outcomes in the future.

Keywords: Research methods, statistics, psychology, tertiary educators, COVID-19

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Understanding quantitative and qualitative research methods is imperative to psychological research and practice (Counsell et al., 2016). The *International Declaration on Core Competences in Professional Psychology* (International Association of Applied Psychology and International Union of Psychological Science, 2016) identifies a set of core competencies that should be possessed by all psychologists providing services to clients. Among these competencies is "operates as an evidence-based practitioner", which requires an ability to consult and critically-evaluate psychological research. In Australia, comprehension of research methods and statistics is considered a foundational competency for psychology undergraduates by the Australian Psychology Accreditation Council ([APAC], 2019), hence all accredited undergraduate psychology programs include research methods and statistics content.[1] Despite its importance as a topic, psychology students report far less interest in research methods and statistics courses as compared to non-quantitative psychology courses (Uttl et al., 2013). Many undergraduate students hold negative attitudes toward research methods (Earley, 2014), viewing research methods courses as difficult (Murtonen, 2005) and the use of statistics as anxiety provoking (Chew & Dillon, 2014).

Before COVID-19, literature indicated that active learning—an approach to education that engages students in activities and discussions to facilitate learning and focuses on having the students play an active role in their learning—is the most effective method for teaching statistics (Allen & Baughman, 2016; Conners et al., 1998; Elliott et al., 2010; Freeman et al., 2014; Neumann et al., 2013). Active learning techniques for statistics include students

[1] At the time of writing, APAC lists 39 Australian universities and colleges/institutes with active accreditation to teach 3-year undergraduate psychology programs (APAC, 2022). An informal review by the third author indicates that all of these university programs include at least one dedicated research methods subject (and most include two to three). Further, 4th-year psychology programs (which are required as a step towards professional registration as a psychologist in Australia) are required to ensure that students carry out a research project investigating "a substantive individual research question relevant to the discipline of psychology" (APAC, 2019, p. 12).

collecting and interpreting their own data, participating in demonstrations of statistical concepts, or using real-life data for analyses, which have been shown to increase student engagement and enhance understanding (Neumann et al., 2013; Wathen & Rhew, 2019). Indeed, students prefer active learning over passive methodologies when learning statistics (Elliott et al., 2010); they also achieve better academic outcomes (Allen & Baughman, 2016; Freeman et al., 2014) and report higher confidence in their statistical abilities (Allen & Baughman, 2016; Conners et al., 1998).

Unfortunately, COVID-19 interrupted the regular delivery of education, forcing a shift toward Emergency Online Learning (EOL). EOL refers the implementation of distance learning models in response to an unforeseen emergency event (Müller et al., 2021). Unlike planned online learning, EOL meant that educators did not get the opportunity for long-term planning (Müller et al., 2021). Active learning principles can be much harder to implement in an online format, and even more so when given little time to prepare (Müller et al., 2021; Rutherford et al., 2021).

Generally, COVID-19 has negatively impacted students (Dodd et al., 2021). However, academic outcomes remained the same or improved in cases where educators were able to focus on student-content engagement and continue implementing active learning techniques that closely mimicked face-to-face teaching practices (Morgan et al., 2021; Riley et al., 2021). Other factors found to mitigate the negative effects of EOL include student-student engagement (Heinrich et al., 2020; Rajalingam et al., 2021) and student-teacher engagement, particularly when educators adopted empathetic approaches (Conklin & Garrett Dikkers, 2021; Goin Kono & Taylor, 2021).

EOL in response to COVID-19 has also considerably affected educators themselves. Educators felt less confident in their abilities to implement active learning principles in an EOL environment compared to face-to-face (Rutherford et al., 2021). Jelinska and

Paradowski (2021) found that while prior experience teaching online improved coping and engagement during EOL, the same was not true for years of teaching experience more generally. Better coping educators had less overall teaching experience compared to poorer coping educators, suggesting that newer teachers—with less established teaching styles—may be better able to adapt.

Although there is abundant information regarding how to effectively teach statistics and research methods and how teaching was affected by COVID-19, there are few studies that integrate these two concepts. Haardörfer and Livingston (2021) identified found four key challenges for statistics teaching during COVID-19: 1) the suddenness of the implementation of EOL was overwhelming for most educators, impacting the quality of content and delivery, 2) supporting students was more difficult in an online environment as educators were unable to directly supervise or instruct students, 3) technological problems, like poor Wi-fi connections and access to expensive statistical software, and 4) translating assessments from proctored exams to formats compatible with EOL.

Therefore, the present study aimed to identify how the implementation of EOL during COVID-19 impacted the teaching of research methods and statistics specifically (at either the undergraduate or postgraduate level). The present study employed a mixed-model design to identify challenges and impacts that occurred at tertiary institutions in Australia. Three research questions (RQs) guided our investigation.

RQ1: How does prior teaching experience (i.e., years of teaching experience, prior experience teaching online) influence educators' ability to effectively utilize online learning during COVID-19?

RQ2: Did research methods and statistics educators feel adequately prepared for and supported during EOL?

RQ3: What unique challenges does EOL for research methods and statistics present?

Method

Research Design

The mixed-methods study was conducted in two phases. The first involved the use of a cross-sectional survey, which was hosted online using Qualtrics. One-to-one, semi-structured interviews were conducted in Phase Two. A semi-structured format was selected as its flexibility is beneficial in smaller-scale research (Kallio, et al., 2016) and facilitates richer depth of data collection (Smith et al., 2015).

This research was approved by the Human Research Ethics Committee of James Cook University (#H8362). Responses were collected between March and July, 2021. Participation was voluntary; upon completion of the survey, participants were eligible to enter a prize draw to win one of four $50 AUD gift vouchers. Interviewed participants received a $50 AUD gift voucher.

Participants

Individuals were eligible to participate if they were involved in teaching research methods and statistics at Australian tertiary institutions in any capacity (e.g., as Lecturers, Tutors, Associate Professors, etc.) during COVID-19. Recruitment involved sharing the opportunity with numerous psychology organizations, inviting statistics educators directly, and snowball sampling.

Of the 21 survey respondents, 11 identified as female and 10 identified as male. Participants were 26 to 55 years old (M = 39.75, SD = 8.00), had at least two years of teaching experience in a tertiary institution (M = 12.19, SD = 6.73), and had at least one year of experience teaching research methods and statistics (M = 10.62, SD = 6.27).

We interviewed a subsample of three of the survey respondents. Noting that some information has been excluded to maintain confidentiality (Kaiser, 2009), Participant A was a

male, intermediate career academic, aged between 40 and 49; Participant B was a female, early career academic, aged between 20 and 29; and Participant C was a female, established career academic, aged between 50 and 59. Participants were purposely sampled for maximum variation (Glaser & Strauss, 1967), in terms of teaching experience/position. Recruitment for the interviews involved contacting the educators via email with a 100% response rate.

Materials and Procedure

Survey

Prior to commencing the study, participants indicated their consent to participate (via a yes/no question online). Completing the survey took approximately 30 minutes, and participants were debriefed via a final webpage.

Demographics and Teaching Experience. Participants were asked to report their age, gender, and country of employment. Participants were also asked to indicate: years of experience in tertiary teaching; years of experience teaching statistics and/or research methods; current teaching conditions (e.g., online, in person, blended); whether they have taught online prior to COVID-19 (yes/no); whether online teaching is their preferred method of delivery (yes/no); what statistical software, if any, they used to teach before and during COVID-19; and what statistical software, if any, they intended to teach with after COVID-19.

Attitudes Toward, and Perceptions of, EOL. Participants' perceptions of their proficiency with online teaching was measured using the Proficiency in Handling Online Teaching subscale of the Attitude towards Online Teaching and Learning for Higher Education Teachers scale (Sangwan et al., 2020). The scale consists of eight Likert-type items (where 1 = *strongly disagree* and 5 = *strongly agree*; example item: "I don't feel comfortable while preparing video lectures"). Higher total scores indicate lower perceived

proficiency with online teaching. In the current study, this measure displayed adequate internal reliability for exploratory research ($\alpha = .67$).

The degree to which EOL disrupted educators' traditional roles and sense of identity was assessed via the Identity Disruption subscale of the Faculty Readiness for Online Teaching scale (Cutri et al., 2020). The subscale consists of four Likert-type items (where 1 = *strongly disagree* and 5 = *strongly agree*; example item: "Online teaching challenges my sense of who I am as a teacher educator") and is scored such that higher scores indicate greater identity disruption. Reliability analysis indicated that one item ("I am interested in learning from experts in online teaching to transition my course and content to an online format [e.g., entirely online, blended, etc.]") was detracting from the scales' internal consistency and was thus excluded in the calculation of total scores. After exclusion of this item, the scale displayed acceptable reliability ($\alpha = .72$).

Three original items addressed participants' experiences teaching online during COVID-19: I was satisfied with the quality of my content; I was satisfied with my ability to delivery content; I utilised active learning. These items used a 5-point response scale (where 1 = *strongly disagree* and 5 = *strongly agree*). A series of original seven-point semantic differential scales (where lower anchor = 1 and upper anchor = 7) were also presented to gauge participants' attitudes to their online teaching during COVID-19: positive-negative; incompetent-competent; prepared-unprepared; driven-unmotivated; stressed-relaxed; and worried-calm. The positive-negative, prepared-unprepared, and driven-unmotivated items were reverse coded so that higher scores indicated more positive perceptions in all cases.

Open-Ended Items. Seven open-ended questions (see Appendix) provided participants the opportunity to expand on their experiences teaching statistics/research methods online with respect to the EOL transition.

Interviews

Eligible participants were emailed an information sheet and informed consent form and asked to return a signed copy of the consent form by email. Individual interviews occurred in July- August, 2021, and were conducted over Zoom and audio-recorded to facilitate verbatim transcription. Each interview took between 20-40 minutes.

The interview schedule asked participants: about their experience teaching statistics; what statistical software they use; how their teaching conditions changed from 2019 to the present; challenges and advantages of EOL; how prepared they were for EOL; student satisfaction, engagement, and performance; and what they would do differently if faced with a similar EOL situation in the future.

Data Analysis

Quantitative data were analyzed using correlations and t-tests. Thematic analysis was used to analyze the qualitative data (i.e., responses to the open-ended survey questions and the interview transcripts). We followed Braun and Clarke's (2006) six-phase framework: familiarization with the data set; generation of initial codes; search for themes; review of themes; definition and naming of themes; and reporting. The first author led the thematic analyses. Careful consideration was taken to ensure intent was not inferred by the author so each code could accurately represent the actual responses. The first author met with the second and third author on multiple occasions to critically refine and review the codes and themes before finalizing the reported themes.

Results

Phase One Findings

Teaching Practices

At the time of participating, 71.4% of participants were teaching statistics and research methods in a blended mode, with 23.8% remaining fully online. Only one participant had returned to an in-person format. Just over 60% of participants indicated that

they had utilized online learning in some capacity prior to COVID-19, but only 33.3% indicated that this was their preferred method of delivery. SPSS was the most commonly utilized software to teach statistics during COVID-19, followed by R (21.88%) and Stata (15.63%). Programs such as Jamovi, PSPP, SAS, JASP and Excel were all utilized by at least one participant. Most participants (71.4%) used the same software during EOL as they did prior to COVID-19, and 61.9% anticipated they would continue to use the same statistical software after EOL.

The Influence of Prior Teaching on EOL COVID-19 Experiences

To investigate RQ1, a series of independent samples *t*-tests compared those who had taught online prior to COVD-19 to those with no prior experience teaching online in terms of attitudes towards, and perceptions of, EOL. These analyses are presented in Table 1. A series of correlation coefficients were also computed to examine the association between years of teaching experience and attitudes towards, and perceptions of, EOL (also presented in Table 1). Sensitivity analysis indicated that the sample size would allow for the detection of large effects (Cohen's *d* of around |1.16| and an *r* of |.49|), with a power of .80.

As can been seen, those with experience teaching online prior to COVID-19 felt significantly more positive and competent regarding their teaching during COVID-19, compared to those with no prior experience teaching online. This group also experienced significantly less identity disruption. All of these differences represent very large effects, as evidenced by the Cohen's *d* values (Cohen, 1988). Large, negative correlations were observed between years of teaching experience and satisfaction with the quality of one's teaching content and the utilization of active learning during COVID-19-related EOL.

Qualitative Investigation of Whether Participants Felt Prepared for, and Supported During, EOL and the Challenges Posed by EOL for Statistics

We identified two top-level themes via thematic analysis of participants' responses to the seven open-ended questions: lecture and tutorial delivery (with three second level themes: positives, challenges, and delivery shifts) and educator support (with four second level themes: pre-existing infrastructure, administrative resources received, desired resources/support, and noted challenges). Table 2 presents quotes indicative of each subtheme.

Lecture and Tutorial Delivery. This theme encompassed the aspects of teaching statistics during COVID-19. Participants' responses indicate both positive and negative components of EOL. Noted positives included the fact that prerecorded lectures can be reused and promote student engagement and that the online modality affords flexibility for students to engage with material in way that is convenient for them. While participants noted that students engaged with asynchronous (prerecorded) content, they often reported that synchronous, online activities (like tutorials) were not well attended or engaged with.

Participants identified the lack of face-to-face interactions as a barrier to both student-teacher and student-student interactions. However, some participants mentioned using online tools to support engagement, such that, in some cases, students did use online communities, chat, and poll features. Moreover, educators who were used to walking around a computer laboratory or conducting an in-person lecture reported that it was challenging to gauge student understanding in online environments. A lack of face-to-face contact limited educators' ability to adjust content for struggling students, which affected overall satisfaction with content delivery. Additionally, participants identified accessibility to resources as a challenge— this included equipment necessary for online learning as well as learning

materials. Many named the access to and use of statistical software as a unique challenge to teaching and learning statistics online.

Interestingly, some respondents stated that the shift to teaching online was not a drastic change— in these instances, educators often had already been teaching in blended or online modes. This underpins the fact that most respondents expressed that they would likely continue using a blended delivery mode in the future, recognizing the positives of prerecorded/online lectures but still prioritizing face-to-face tutorials. It is, however, important to note not everyone had a positive experience nor would continue teaching in an online-only delivery mode.

Educator Support. This theme concerned the institutional and administrative support received during the transition to EOL. When considering whether this was sufficient, responses were mixed. For some, there was pre-existing infrastructure such that their teaching already involved blended or online delivery and support in the form of tutors and training was welcomed/appreciated. However, for others, institutional resources, training, or guidance was largely identified as lacking. These participants noted their desire for resources such as equipment and training relevant to online delivery to ease the pressure of EOL. Moreover, beyond resources—the prevailing challenge was that of being "stretched to capacity"—in other words, EOL required an extraordinary amount of time and effort, often not accounted for in workload models or permitting of research.

Phase Two Findings

Three themes were identified via thematic analysis of interview transcripts: Resources (with two subthemes: Student Resources and Educator Resources), Engagement (with two subthemes: Engagement During Synchronous Teaching and Non-Synchronous Engagement), and Experience.

Resources

Participants referenced the different ways both online and physical resources were affected by EOL. Regarding the subtheme of Student Resources, EOL changed the number of resources that could be made easily available to students. The online platform made it simpler to share videos, articles, and other resources in conjunction with standard teaching materials like lecture recordings. Some believed the ability to share more resources was advantageous,

> PB: My opinion of stat[istic]s and research methods is you just need to hear it said to you in a particular way […] so me being able to share a number of methods or a number of videos or a number of techniques via the online platform is really useful and something you can't really do face-to-face.

Conversely, others believed the increase in resources made it more difficult for students to discern what information was important (PC: "I think there was just an onslaught of information from so many sources and, you know, the sifting through it, they found that really difficult"). Participants also noted that statistics specific resources, like software programs, were difficult to access (PA: "You have to pay for a license [for SPSS]. Students can't access it when they want to").

Within the subtheme of Educator Resources, it was identified that more physical resources provided by institutions would have facilitated better learning (PA: "They tried to make things available to you, so you have headphones at home to record and stuff like that […] but I actually had to record all my talking into my laptop"). Even when resources were made available, it took an extended period of time for this to occur (PB: "after a few weeks we started […] being allowed to take stuff home to make things a little bit more comfortable"). All three interviewees noted being inadequately resourced.

Engagement

Participants cited student-student and student-content engagement as the main challenges EOL presented. Synchronous and non-synchronous materials presented different challenges. When referencing synchronous materials, participants believed student-content engagement decreased or was very difficult to gauge, which affected the ability of educators to deliver quality content (e.g., PB: “I move forward if I can see that you’re understanding, but through Zoom […] often you run an entire class and not actually hear or see anybody”; PA: “There’s no opportunity for students to ask questions or for me to go okay this slide is bad, I’ll change it next year or explain it better, you just don’t know what’s going on”). The ability to join Zoom classes whilst doing other activities was also a barrier to student-content engagement (PC: “people were probably far less engaged in online teaching sessions because they were trying to multitask”). Participants also mentioned that they believed their involvement as educators had to increase to encourage students to participate in classes (e.g., PB: “I’d say things like ‘This is for you not for me’ […] we had to say those things or really to encourage people not only to attend but to participate”; PC: “You had to work a lot harder to find out if you were getting through to people”). This highlights the difficulties educators experienced in trying to encourage student-content engagement in this modality. Another facet of engagement mentioned in synchronous classes was student-student engagement. Participants found that the social isolation of COVID-19 encouraged more student-student engagement during class time (PC: “I think some people may have been more likely to attend a tutorial because ‘oh my god another human being’”).

Participants believed students utilized non-synchronous materials well, especially when this was necessary to maintain academic achievement levels (e.g., PC: “I’d have frequent comments of people saying, ‘I had to read that three or four times before it sunk in’ […] it was harder to learn, so people put in more effort”; PB: “It might’ve benefitted some

people because they could download and listen to them [lecture recordings] in their own time and study at their own pace, and that is valuable").

Previous Experience

Given the short timeframe provided to transition courses from different modalities to EOL, participants believed previous experience with online teaching facilitated an easier transition (PA: "Having those years of experience, seeing what might work or might not work, being able to re-design assessments, somebody who is just starting out wouldn't have that experience or knowledge"). Interviewees noted that newer educators might have struggled with the nuances of online teaching, particularly how to appropriately facilitate synchronous classes (PB: "A lot of [new educators] had … quite a difficult transition to going online. Even just the awkwardness of them [new educators] turning on the camera, a lot of them didn't do that").

Interviewees distinguished between previous experience with online teaching and previous experience in general, such that newer educators may have had an advantage over more experienced educators with no online teaching experience (PA: "In some ways, it might have been easier for someone with less experience because they wouldn't have […] those expectations about how they normally do things"). Multiple participants clarified that educators who had not previously utilized online learning may not have been prepared for how difficult and time-consuming it can be,

> PC: We also see a lot of stigma about online [teaching] […] as if 'you're only having to do online teaching how hard can it be?' There was almost a little bit of smugness, like, yeah, now the rest of you know about my world, now you know how much harder it is.

Participants similarly perceived a lack of understanding from administrators. Many participants stated they had to work longer hours to deliver content as administrators had not adjusted their expectations to reflect the constraints of EOL.

General Discussion

The present study investigated how implementing EOL during COVID-19 impacted statistics and research methods educators. Regarding RQ1, which asked how prior teaching experience influenced educators' ability to effectively utilize online learning during COVID-19, the quantitative findings indicated that years of teaching experience alone was not a good indicator of success in EOL (and, in fact, was predictive of less satisfaction with teaching materials and less use of active learning strategies). Rather, previous experience with online teaching was linked to better EOL outcomes, like more feelings of positivity and competency and less identity disruption. Educators with experience in online learning may have also been able to better tailor active learning principles to the online modality (Morgan et al., 2021; Riley et al., 2021), increasing student-content engagement. In Phase Two, interviewees indicated that they thought more years of general teaching experience may impede success in EOL stating that it may make educators less adaptable. Jelinska and Paradowski (2021) similarly found that while online teaching experience can be a benefit during EOL, years of general teaching experience may act as an impediment to EOL success. Alternatively, the negative association between general teaching experience and EOL success may simply reflect less experienced instructors lacking a frame of reference with which to compare EOL outcomes against.

RQ2 asked whether research methods and statistics educators felt adequately prepared for and supported during EOL. Given the sudden nature of the change to EOL, it was not expected that educators would feel prepared (Müller et al., 2021) and this was clearly reflected in the results. Educators reported having minimal time to adapt coursework

for an EOL environment, and those without previous online experience reported feeling less competent overall with EOL. Moreover, educators felt under-resourced from their institutions, indicating low levels of institutional support. While individuals praised support from their colleagues, this could not replace institutional support in terms of providing physical resources. Lack of access to appropriate resources—like recording equipment, statistical software or sufficient Wi-fi—has been identified as a barrier to success during EOL (Goin Kono & Taylor, 2021; Haardörfer & Livingston, 2021).

Finally, RQ3 focused on challenges of EOL unique to research methods and statistics. Many difficulties identified—like the lack of face-to-face interaction and inability to gauge student engagement— pertained to all subjects in an EOL modality. Access to statistical software was the key challenge specific to research methods and statistics. Although the present findings showed that most educators would not change their current software program when moving back to blended or face-to-face modalities, numerous comments referred to the inaccessibility of these programs. This finding again reflects the impact of inequitable access to technology and software programs on positive EOL outcomes (Goin Kono & Taylor, 2021; Haardörfer & Livingston, 2021). Future research should explore why instructors may be reticent to move to more accessible software programs. For example, are instructors concerned about the time commitment required to update teaching materials? Does the availability of auxiliary resources (e.g., student-focused manuals and videos) factor into the decision of whether to switch?

It is also worth noting that other stressors resulting from COVID-19 may have been contributed to worse student outcomes. Our results indicate that educators continued implementing active learning strategies through EOL and that, generally, student achievement levels were maintained during EOL. However, for those who did find decreases in student achievement, this was typically justified either by regular fluctuations between

year groups, or by the effects of COVID-19 exacerbating the difficulties of learning statistics and research methods. This finding strongly supports Morgan et al.'s (2021) suggestion that EOL in itself is not detrimental to learning, but rather disruptions to the standard and expected structure of a course may lead to negative outcomes.

There are limitations to this study. Firstly, the small sample meant that the significance tests performed were underpowered to detect anything smaller than large effects (consequently, we advocate that additional research is needed to continue to tease out the influence of prior teaching, e.g., in terms of general experience, online experience, and use of active learning). Also, all participants worked in Australia. Relative to other countries (e.g., Brooks et al., 2020; Günther-Bel et al., 2020), the effects of COVID-19 in Australia during 2020 were lesser, so it is unclear whether statistics educators elsewhere may have experienced different or more severe challenges in their teaching. Certainly, our results do indicate that instructors can experience significant obstacles—even when operating in a context in which COVID-19 has been relatively well controlled. Future studies should aim to recruit more participants from outside of Australia, both increasing the sample size and diversity.

Another consideration is the use of a self-report design. Given the subjective nature of the survey questions (e.g., "I utilized active learning"), it cannot be ascertained whether responses were accurate. This self-report approach was taken given our focus on participants' subjective experiences and perceptions. Future studies could adapt a design similar to Rutherford et al.'s (2021), wherein active learning practices are clearly defined and measured, to investigate the ways in which subjective perceptions of teaching practices may differ from objective reality. Thirdly, by design, our focus on the effects of EOL from educators' perspectives did not permit thorough investigation of student-student and student-teacher relationships. Social engagement is an important indicator of student outcomes

(Conklin & Garrett Dikkers, 2021; Goin Kono & Taylor, 2021; Heinrich et al., 2020; Rajalingam et al., 2021) and so should be included in future studies.

In conclusion, both the present study and previous literature indicate the immediate impacts of COVID-19 on education were abundant. Our findings have implications not just for how to better carry out EOL into the future, but also for the teaching of statistics and research methods in an online environment more generally. These findings point to a number of recommendations for future practice. First, we recommend that institutions are more forthcoming with support and resources, as technological inequity was identified as a barrier to both student and educator success in the EOL context. Thus, educators should collaborate with institutions to ensure access to physical (e.g., computers, Wi-fi, and headphones) and educational resources. Moreover, we recommend that instructors consider moving away from popular, paid statistical software (like SPSS) in favor of free software programs (like Jamovi) to ensure equity of access. Implementing these suggestions, and those that come from additional research on how to best teach statistics and research methods online, will help to ensure quality education for Australia's future psychologists.

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Table 1.
Comparison of Perceptions and Attitudes Toward EOL Among Those With No Experience Teaching Online Prior to COVID-19 (n = 8) and Those With Prior Experience Teaching Online (n = 12) and Correlations Between Years of Teaching Experiences and Attitudes and Perceptions Toward EOL

	Possible Range	Overall Sample *M*(*SD*)	No prior experience teaching online *M*(*SD*)	Prior experience teaching online *M*(*SD*)	*t*	Cohen's *d*	Correlation with years of general teaching experience
I was satisfied with the quality of my content.[a]	1-5	3.65 (0.88)	3.63 (1.19)	3.67 (.65)	.10	.05	-.62**
I was satisfied with my ability to deliver content.[a]	1-5	3.85 (0.67)	3.75 (.89)	3.92 (.52)	.53	.24	-.004
I utilised active learning.[a]	1-5	3.65 (0.88)	4.00 (.93)	3.42 (.79)	-.58	.69	-.69***
Negative-**Positive**[b]	1-7	4.80 (1.40)	3.88 (.84)	5.42 (1.38)	2.82*	1.29	.12
Incompetent-**Competent**[b]	1-7	5.40 (1.00)	4.63 (1.06)	5.92 (.52)	3.66**	1.67	.10
Unprepared-**Prepared**[b]	1-7	4.70 (1.46)	4.25 (1.17)	5.00 (1.60)	1.14	.52	.20
Unmotivated-**Driven**[b]	1-7	4.70 (1.46)	4.00 (1.70)	5.17 (1.12)	1.87	.85	-.04
Stressed-**Relaxed**[b]	1-7	3.30 (1.08)	2.75 (.71)	3.67 (1.16)	2.00	.91	-.19
Worried-**Calm**[b]	1-7	3.85 (1.00)	3.38(.92)	4.17 (.94)	1.87	.85	-.30
Proficiency in handling online teaching[c]	8-40	25.85 (4.06)	26.88 (4.88)	25.16 (3.46)	-0.92	.42	.29
Identity disruption[d]	1-5	2.65 (0.88)	3.20 (0.71)	2.28 (0.79)	-2.68*	1.23	-.04

[a] Higher scores are indicative of greater agreement with statement; [b] Higher scores are indicative of greater identification with attribute in bold; [c] Higher scores are indicative of lower perceived proficiency; [d] Higher scores are indicative of great identity disruption.
Note. * $p < .05$; ** $p < .01$; *** $p < .001$

Table 2.

Themes Concerning Educators' Experiences of EOL For Statistics.

1st Level Theme	2nd Level Theme	3rd Level Theme	Illustrative Participant Quotes
Lecture and Tutorial Delivery	Positives	Prerecorded lectures	"Students who work really appreciate the possibility of going through the pre-recorded videos at their own pace and whenever they have time to do so."; "Mini-lectures covering key aspects were favored."; "use pre-recorded short lecture videos combined with increased weekly workshop times. Students and I prefer it."
		Online modality promotes flexibility/convenience	"Flexibility in terms of their schedule and other commitments."; "Convenience for students."
		Use of online engagement tools	"We used Zoom polls to quiz students during lectures/tutorials. This gave all students the opportunity to think of the answer themselves. Also gave me a good pulse-check."; "students are comfortable to talk in chat box online"; "More engagement with online learning communities (Facebook group and Microsoft Teams)"
	Challenges	Instructor cannot demonstrate/explain as in the classroom	"Demonstrating analyses and talking students through outputs and interpretation. This was more difficult with the only software available."; "The hardest adjustment for me was not being able to walk around a computer lab and check how students were progressing in the SPSS analyses in real time."; "it was difficult to judge how engaged students were and whether they were struggling with content"
		Attendance and participation concerns	"The attendance to live tutorials was poor, but the engagement with pre-recorded lectures was very good"; "Lack of participation in class"; "Less able to encourage participation"
		Student interaction and engagement	"Students who didn't engage were disadvantaged. Students suffered from lack of engagement with each other - lack of support from cohort."; "Harder to "keep track" of some students"
		Students unable to demonstrate/clarify their understanding	" the lack of face-to-face contact with students makes it difficult to know if they are comprehending the material being taught, they cannot easily ask questions if points need clarifying"
		Provision of learning materials (including software)	"Access to SPSS was an issue"; "The only unique barrier was that students could not actually run tests themselves if they did not have access to SPSS"; "some students did not have the required materials to adequately access online learning (internet speed, sound quality etc.)"
	Delivery shifts	No radical change to subject delivery	"The methods are show by example and then try for yourself. This does not change with online learning"; "No drastic change, since our uni has always operated with blended delivery"

		Future delivery plans	"I would continue with a blended format - mini lectures supplemented by in class teaching/tutorials"; "I plan to maintain the pre-recorded videos and to do interactive face-to-face tutorials"; "Not if the option to continue f2f was available"
Educator Support	Pre-existing infrastructure		"I worked for a regional university so the infrastructure and support was already there"; "my courses were already online"
	Administrative resources received		"Tutor support."; "The university provided several live workshops to implement online learning, most of them of very good quality."
	Desired resources/support		"No support was really provided. Things like provision of headset and microphone would have been useful"; "More training and resources for effective video recordings would be useful"
	Noted challenges		"Because everyone was stretched to capacity, getting support for anything was somewhat difficult."; "Minimal support provided … the sheer amount of work in work load"; "so a lot of staff ended up having to find other (more effective ways) to create lectures/run sessions"; “we do not have adequate technology to deliver online content to large cohorts”

Appendix

The seven open-ended questions posed to participants on the survey included:

1) What teaching methods did you favor for teaching statistics? Did these methods change drastically for online learning?

2) Do you feel your institution and department provided enough support to transition to online learning? If yes, please describe how support was provided. If no, please describe what support systems would be beneficial.

3) What, if any, specific challenges did you encounter teaching statistics/research methods relative to teaching other online courses?

4) Did you observe any positive impacts on your students during online teaching? If yes, please elaborate.

5) Did you observe any negative impacts on your students during online teaching? If yes, please elaborate.

6) Would you continue teaching statistics/research methods online when COVID-19 restrictions are lifted? Why or why not?

7) Is there anything else you wish to share about your experiences teaching statistics/research methods online?