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THE USE OF DIGITAL TOOLS FOR LEARNING BY NEUROTYPICAL AND NEURODIVERSE ANIMAL SCIENCE STUDENTS

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INTRODUCTION

Digital educational tools can have a positive impact on learning practices (Casey et al., 2015; Icard, 2014; Parwata & Sudiatmika, 2020) and can increase student agency in content, pace and level of engagement (Karich et al., 2014). The use of digital tools for managing personal life is ubiquitous, resulting in educators using digital platforms for teaching and to engage with students who have high levels of competency in navigating the digital space. Therefore, educators of the next generation of students in veterinary and animal science need to harness this proficiency for effective teaching and learning. This small study sought to determine which digital tools were used by animal science students and identify if there are tools that could be provided to assist students of varying abilities in their learning.

Within veterinary nursing education, how digital tools are being used for learning varies, although their use is becoming more widespread (Gledhill et al., 2017). Over one thousand students reported using their smartphones most often, and digital tools for communication and media, such as YouTube videos, to assist in their learning (Gledhill et al., 2017). However, YouTube videos can be inaccurate, thus students at Unitec are directed to online resources such as @Dove.org (atDove, n.d.) and an internally monitored communication system called Slack, Veterinary webinars, and to follow the pages of reputable relevant agencies such as the RNZSPCA, prompting the use of technology for learning. Engagement with learning is increased using gamification; animal science students reported enjoyment using Kahoot! for formative assessment, although there was no indication that it improved test scores (Cameron & Bizo, 2019).

The global pandemic saw compulsory reliance on digital tools for learning, instead of being in the classroom. Studies of tertiary students across the globe (for example, Aristovnik et al., 2020) and those of single universities (Mishra et al., 2020) or communities (Agarwal & Kaushik, 2020) report that students were generally satisfied with the 'new normal' using real-time video conferencing, such as ZOOM, to engage with lectures, and also using asynchronous methods such as written content, recorded lectures and communication via platforms such as Moodle. However, since the pandemic there has been a decline in student engagement and attendance across many tertiary educational providers (Wester et al., 2021), therefore, competence in using digital tools for learning remains an important remnant of the pandemic. This is evident in the use of platforms, for example educators directing students to content on Facebook and Twitter (Kimmons et al., 2021; Mei et al., 2019) but relies on the student's engagement to aid the learning process (Fossland et al., 2015).

Digital tool use in education can improve learning experiences for students who are neurodiverse (Horlin et al., 2023; Skelling, 2020). The widespread use of digital media, such as TikTok and Instagram, where anyone can connect and distribute information has increased awareness, acceptance and normalisation of neurodiversity

(Russell et al., 2022). For example; Aragon-Guevara et al. (2023) reported that of 133 videos with the hashtag #Autism, 27 percent were accurate, however, they were viewed 198.7 million times, and 'liked' by 25.2 million people. Anecdotally, enrollment at Unitec has increased since 2021 with 60 percent of students who registered for disability services listing 'neurodiversity' as a category for help; this increased to 71 percent in 2022 and 74 percent in 2023. Further, the use of note takers in class has decreased considerably (about 90 percent) with the use of note-taking software and the use of recorded lectures (D. Cavell, personal communication).

This study aimed to identify digital tools that could be provided to assist neurotypical and neurodivergent students by measuring which digital tools students use in their personal life and in their study. This goal was to assist educators in their utilisation of tools to enhance the learning experience for both neurotypical and neurodivergent students in the animal sciences field.

METHOD

Participants

Sixty-nine students enrolled in a variety of animal science courses at Unitec Institute of Technology, New Zealand, in Semesters 1 and 2 of 2023, participated in this study. Each belonged to one of five cohorts: Level 5 Bachelor of Applied Science (BASCI); Level 5 New Zealand Certificate in Animal Technology (NZCAT; first year); Level 6 BASCI, Level 6 Diploma in Veterinary Nursing (DVN, second year); and Level 7 Bachelor's in Veterinary Nursing (BVN; third year). The research was approved by the Unitec Human Ethics Committee Protocol 2018-1016.

Measures

Participants were asked to complete a 13-question multiple-choice questionnaire survey. They were asked to state their educational cohort and age, and to select whether they considered they might have or had a diagnosis of neurodivergence. There was no definition provided to ensure students did not feel excluded in completing the survey. The remaining questions required respondents to select tools they used in their personal life and in their studies. The list of tools was compiled by the authors and a member of the Learning and Achievement team (Figure 1). There was an opportunity for students to state tools they used but were not listed, detail tools that they did not use and why, and if there were tools that they would like to use for their learning in the future.

Digital Tool	Developer	Description
Chat bot GPT	OpenAI, Microsoft Corporation	Artificial Intelligence that provides text via prompts
CollaNote	Zauberberg Lab Limited Company	Notetaking App to PDF
Echo360	Echo360 Ltd	Lecture capture system
Excel	Microsoft Corporation	Spreadsheet editor: part of the Microsoft Office 365 suite
Facebook	Meta Platforms, Inc.	Social media and networking
Facebook messenger	Meta Platforms, Inc.	Communication chat service
Google docs	Google	Online multi-editor word processor
Google sheets	Google	Online multi-editor spreadsheet editor
Grammarly	Grammarly, Inc.	Cloud-based spelling and grammar reviewer
Instagram	Meta Platforms, Inc.	Social media for sharing content
Instagram messenger	Meta Platforms, Inc.	Communication chat service
Kahoot!	Kahoot AS	Online game-based learning platform
Keynote	Apple Inc.	Information presentation software for Mac
Mac 'Word'	Microsoft Corporation	Word processor; part of the Microsoft 365 Office suite
Moodle	Martin Dougiamas	Open-source learns management system
Outlook	Microsoft Corporation	Email exchange server software; part of the Microsoft 365 Office suite
Padlet	Padlet.com	Cloud-based collaborative web platform
Powerpoint	Microsoft Corporation	Information presentation software; part of the Microsoft 365 Office suite
Signal	Signal Messenger LLC	Communication chat service
Slack	Salesforce Inc.	Communication platform
Snapchat	Snap, Inc.	Multimedia instant messaging service
Socrative	Socrative.com	Online quiz platform
WhatsApp	Meta Platforms, Inc.	Communication chat service
Wikipedia	Larry Sanger and Jimmy Wales	Open-source content website
Word	Microsoft Corporation	Word processor; part of the Microsoft 365 suite
Youtube	Google	Online video sharing and social media platform
ZOOM	ZOOM.us	Online video communication platform

Figure 1. The digital tools mentioned in the survey and in this article. The developer and a brief description are included.

Procedure

The survey was conducted at the beginning of a teaching period and required approximately 10 minutes to complete. A PowerPoint slide provided details of the purpose of the survey and how to answer the questions. Participation in the study was voluntary which was indicated on the slide. If participants wished to not participate in the study, they were informed to fold their survey and pass it to the end of the row where it would be collected with the completed surveys.

Data analysis

Due to the small sample size, all responses for analysis were used (even if incomplete), and the number of responses for each question is provided in the text. Further, more than half of the students provided more than one answer to Question 6 so this data was not analysed. The survey data was compiled in Microsoft Excel® and descriptive statistics were conducted. For most questions, multiple answers were allowed therefore the percentages tabulated and graphed used the number of respondents within each category of neurodiversity as the denominator. Bar graphs were used to indicate the percentage of respondents within each neurodivergent category and the total number of respondents. To identify differences between the proportions of the different variables z-scores were calculated for variables that were dissimilar in the graphs to describe the relationship to the mean for that comparison of the groups of students; for example, if a comparison is significant it means that respondents used a particular digital tool significantly differently to the average of a comparison group. A basic theme analysis was conducted on the qualitative data.

Results

Demographics

Of the respondents, 53.7 percent (15/68) were enrolled in the first-year veterinary nursing course, 22.4 percent (15/68) enrolled in the Bachelor of Veterinary Nursing and 23.9 percent (16/68) enrolled in the Bachelor of Applied Science (Figure 2). Of these students over half (35/69, 55.6%) were in currently in a Level 5 course, 41.3 percent (26/69) in a Level 6 course and two students in a Level 7 course. Over half were between 18 and 23 years old (42/68, 61.7%). Most respondents reported to be of New Zealand or Pākehā ethnicity (27/64, 42.2%), or 'other' (30/64, 47.0%), with 10.9 percent being Māori students (7/64).

Nearly 20 percent of respondents (13/68, 19.1%) reported to be neurodivergent with 30.9 percent (21/68) reporting to be maybe neurodivergent. The Level 6 cohort consisted of the most neurodivergent students (7/13, 58.9%) with more Level 5 students self-reporting as maybe neurodivergent (12/21, 57.1%) and neurotypical students (19/34, 55.9%) than other levels.

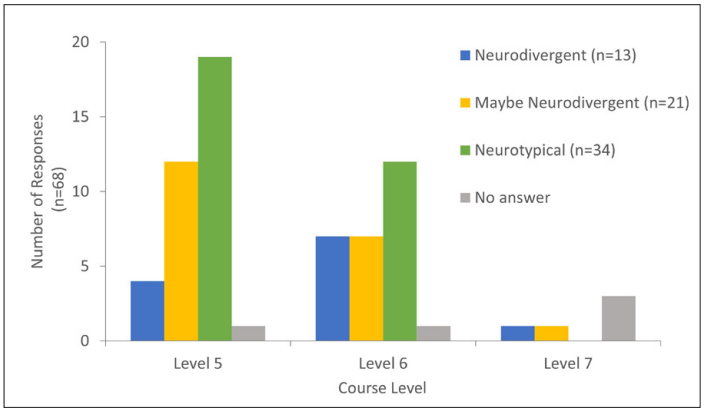

Figure 2. Distribution total responses of self-reported neurodiversity (n=63) across Level 5, 6 and 7.

Most students (40/68, 58.8%) used pen and paper to take notes in class and 36.8 percent (25/69) typed into a blank document ($z = 2.64$, $p = .0083$; Figure 3). Neurodivergent and maybe neurodivergent students reported using 'other' technology more than neurotypical students ($z = 2.31$, $p = < .05$. These included using notetaking apps such as OneNote or CollaNote and transferring written notes to digital after class.

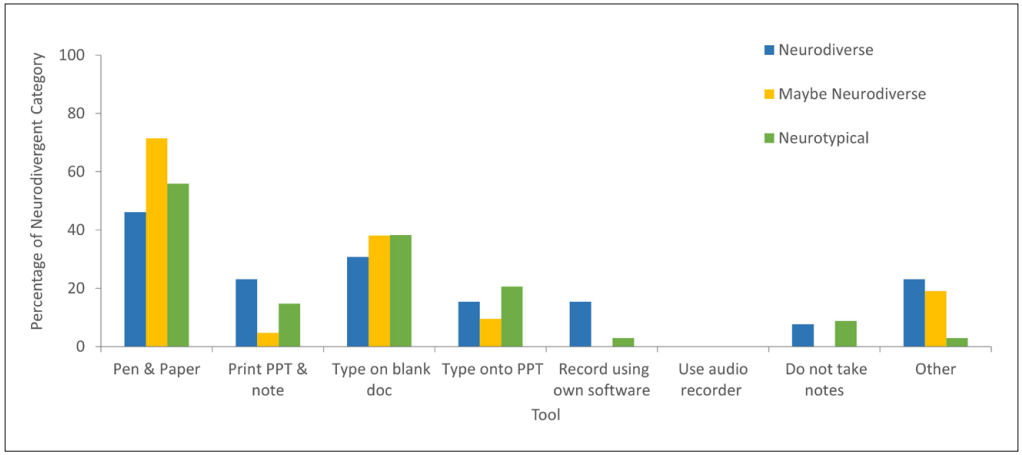

Figure 3. Percentage of respondents in each Neurodivergent category using different tools in class.

Smartphones were used by nearly all students in their personal life (56/69, 81.2%), but not for studying (21/69, 30.4%, $z = 3.14$, $p = .003$; Figure 4). Similar percentages of respondents used their iPad/tablet every day (11/69, 15.9%) and for study (10/69, 14.5%), and their own laptop everyday (48/69, 69.6%) and for study (53/69, 76.8%). More neurodivergent and maybe neurodivergent students used a desktop computer for everyday use (9/34; 26.5%, $z = 3.62$, $p < .05$) and for study (11/34; 32.3%, $z = 4.61$, $p < .05$) than neurotypical students for everyday use (6/34, 17.6%) and study (5/34, 14.7%).

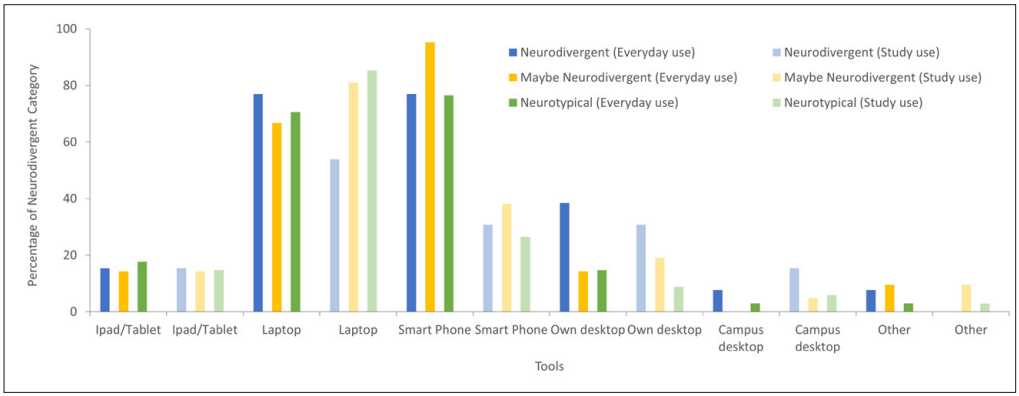

Figure 4. Percentage of respondents in each Neurodivergent category for everyday and study use of hardware.

Communication tools including Gmail (11/13, 84.6%, $z = 2.42$, $p < .05$), phone texting (10/13, 76.9%, $z = 3.57$, $p < .05$), Instagram messenger (6/13, 46.2%, $z = 2.21$, $p < .05$) and Instagram (6/13, 46.2%, $z = 2.79$, $p < .05$) were used by neurodivergent students for more everyday than for study (Figure 5). Maybe neurodivergent (between 10–15 out of 21) and neurotypical students (between 16–25/34) used WhatsApp, phone texting, Instagram ($z = 4.45$, $z < .05$), and Instagram messenger, Facebook, and Facebook messenger more every day by maybe neurodivergent (between 2–6/21) and neurotypical (between 4–7/34) than for study (all ps $< .05$). In comparison, tools such as Office 365 were used more frequently by those maybe neurodivergent (1/21, 3.2%) and neurotypical students (10/34, 29.4%) for study than every day ($z = -3.16$, $p < .05$) and neurotypical students (12/34, 38.2%) used Slack, an app monitored by the institution ($z = -2.63$, $p < .05$) in their study whereas neurodivergent students (3/13, 23.1%) did not.

Further, there were more neurotypical students using WhatsApp (16/34, 47.0%, $z = -2.00$, $p < .05$) and Facebook (18/34, 52.9%, $z = -2.34$, $p < .05$) every day than neurodivergent students using WhatsApp (2/13, 13.4%) and Facebook (9/13, 69.2%). Whereas more combined neurodivergent and maybe neurodivergent students used Facebook (4/34, 11.8%, $z = 2.06$, $p < .05$) in their study compared to neurotypical students (0/34); with neurotypical students preferring to use Outlook (13/34, 38.2% $z = -2.00$, $p < .05$) to communicate compared to combined neurodiverse and maybe neurodivergent (9/34, 26.5%) students.

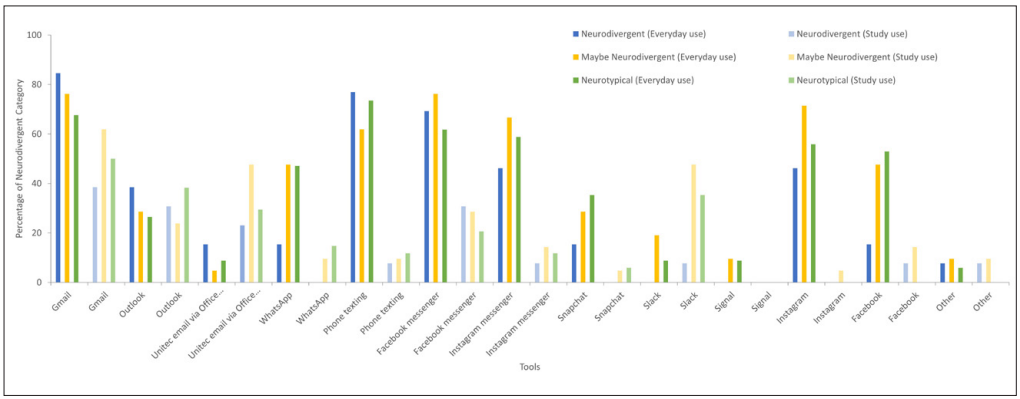

Figure 5. Percentage of respondents in each Neurodivergent category for everyday and study use of communication tools.

Neurodivergent students used learning tools including Kahoot! in class (10/13, 76.9%, z = -3.15, p < .05) and Moodle (11/13, 84.6%, z = -2.06, p < .05) for study rather than Kahoot! (2/13) and in everyday use (6/13, Figure 6). Maybe neurodivergent students and neurotypical students used Kahoot! in their own time (22/55), Kahoot! in class (45/55), Moodle (50/55), Echo (19/55), Zoom (25/55), and the library (43/55, 78.2%, all ps < .05) more for study than they did every day (max 28/55 for using Moodle). Padlet was used by maybe neurodivergent students (7/21, 33.3%) for their study more than neurodivergent and maybe neurodivergent in everyday use (0/21, z = -3.00, p < .05). For neurodivergent students, YouTube was used more for everyday use (12/13, 92.3%) compared to for study (7/13, 53.9%, 53.9%, z = 2.21, p < .05). Whereas for maybe neurodivergent and neurotypical students, YouTube was used a similar amount for everyday (30/55, 55.5%) and study use (32/55, 58.2%).

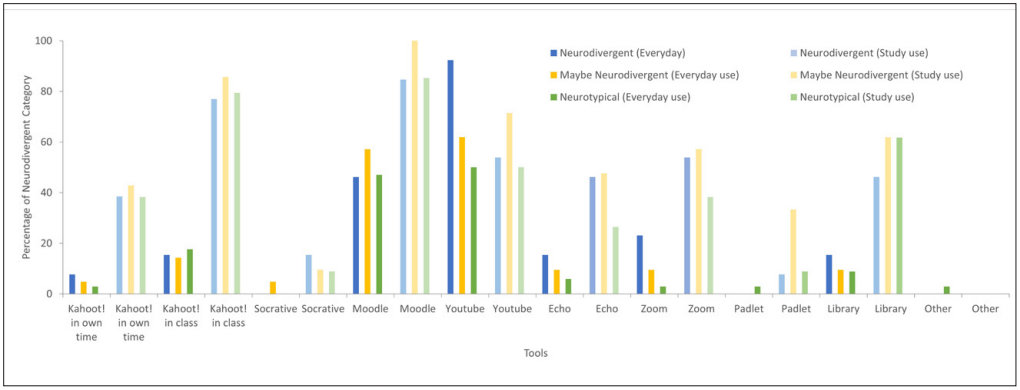

Figure 6. Percentage of respondents in each Neurodivergent category for everyday and study use of learning tools.

Grammarly was a tool used by nearly half of all types of students every day (31/68, 45.6%) and for study (28/68, 41.2%). Neurodivergent students used Grammarly more for everyday use (7/13, 58.3%) compared to for study (4/13, 30.8%) and maybe neurodivergent (14/21, 66.7%) and neurotypical students (20/34, 58.8%) used Grammarly more for study rather than everyday use (24/55, 43.6%), but this was not significant. Furthermore, all students used Grammarly (31/68, 45.6%) over ChatGPT (5/68, 7.4%) every day compared to using Grammerly (48/68, 70.1%) and ChatGPT (11/68, 16.2%) in their study (all ps < .05, except for neurodivergent students in their study).

More neurodivergent students used Google docs (6/13, 46.2%) compared to neurotypical students every day (4/31, 12.9%, z = 2.58, p < .05). Neurotypical students preferred to use the Office365 version of word processing (15/34, 44.1%,) to the Google option (4/34, 11.4%, z = 3.00, p < .05) every day and in their study with 91.2% of students (31/34) preferring to use Word to Google docs (16/34, 47.1%, z = 3.56, p < .05). Combining neurodivergent and maybe neurodivergent students showed a greater number of students used Google docs (15/34, 44.1%) every day compared to in their study (4/34, 11.7%, z = 2.97, p < .05), and Google sheets everyday (7/34, 20.5%) compared to study (1/34, 2.9%, z = 2.26, p < .05). Maybe neurodivergent students used Word (18/21, 85.7%) in their study more than every day (7/21, 33.3%, z = -3.46, p < .05) and used Powerpoint for study (19/21, 90.5%) more than every day (5/21, 23.8%, z = -4.37, p < .05).

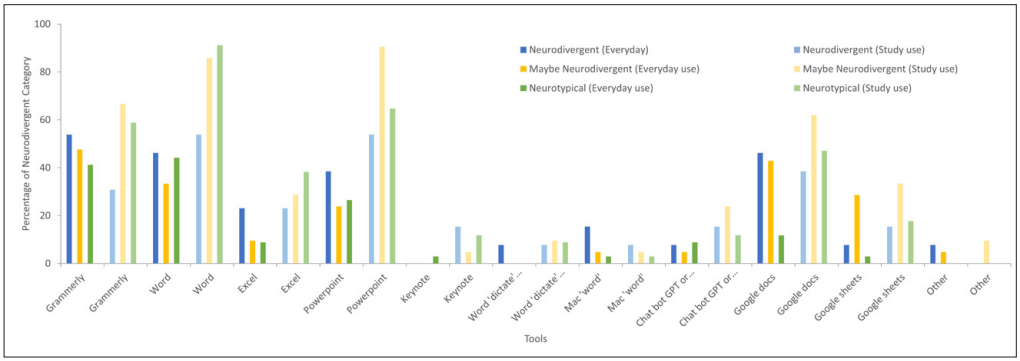

Figure 7. Percentage of respondents in each Neurodivergent category for everyday and study use of software.

Most students used APA referencing guides (58/69, 84.1%), peer reviewed articles (53/69, 76.8%) and journal databases (47/69, 68.1%; Figure 8). There were minimal differences in the percentage of students across neurodivergent categories using all tools.

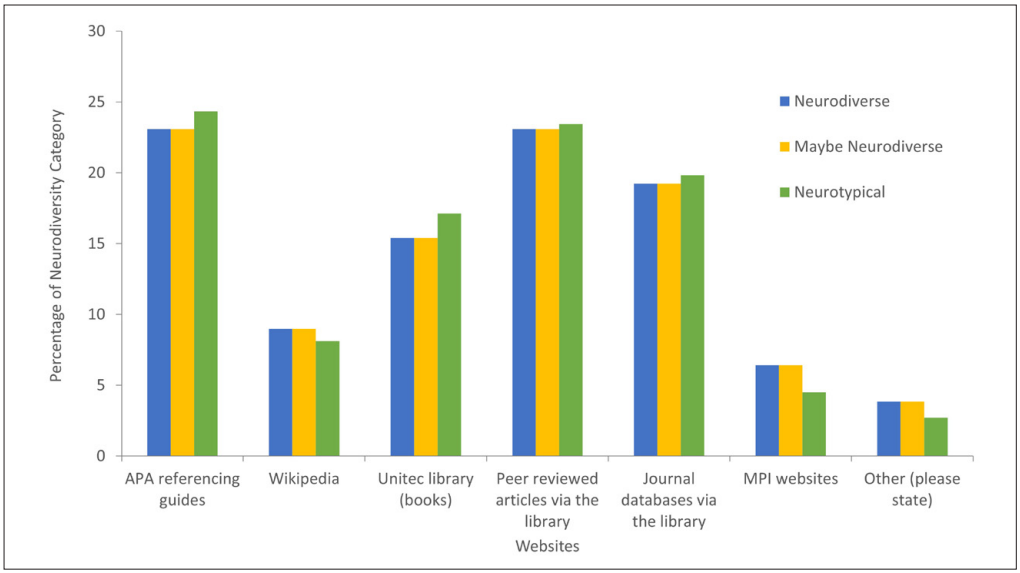

Figure 8. Percentage of respondents in each Neurodiversity category for everyday and study use of internet-based tools.

Half of all students (n = 35) provided specific feedback on their use of digital tools. A third (n = 20) across all neurodivergent categories reported a willingness to learn how to use digital technologies (for example, Word, Excel, Grammarly, Powerpoint, APA referencing and the library resources) but only if it was required. Across all students there were reports of not knowing tools (for example, Signal and Socrative), not liking new tools, or reporting that they were difficult, unreliable, old or unhelpful. Specifically, six neurodivergent students (out of 12) reported not wanting to use AI, Kahoot! and not wanting to use a computer in class. Maybe neurodivergent students (45%, 9/20) reported positive use of an alternative such as Google docs; and did not like unreliable (Wikipedia) or confusing (online APA referencing guides) tools. Neurotypical students (51.6%, 16/31) reported to not like Moodle, Excel or Word, or the library.

DISCUSSION

This study aimed to explore the digital tool use of animal science students in their personal and academic lives at Unitec. The objective was to fill a knowledge gap that could aid educators in leveraging students' digital competency for effective teaching and learning in the animal studies courses.

This study showed use of hardware tools iPads/tablets, laptops, and own desktops for personal and academic use by all students, however, smartphone usage showed significantly higher use in personal compared to that in study. The ubiquitous use of smartphones could be harnessed by educators to increase communication efficacy between students and teachers (Gledhill et al., 2017), via the availability of resources designed for education, such as Moodle® Blackboard® or Google® Classroom, being accessible through platforms that allow mobile-learning through smartphone apps (see for example, Naveed et al., 2023), decreasing the chance of missing important information. The challenge would be to ensure the user interface is intuitive and simple to achieve engagement (Miya & Govender, 2022).

The survey showed greater engagement in social media platforms Instagram and Facebook in personal use compared to academic use, typically accessed by smartphones. Neurodivergent students used Facebook for study more than neurotypical students. Research has indicated that utilising platforms for social media has a significant impact on student engagement, collaborative learning, and knowledge-sharing behaviour (Ansari & Khan, 2020); thus to harness this connection, educators could 'promote' or engage with their students in this way by posting their own work, or pointing their students directly to accurate and relevant posts via hashtags or group mentions.

The findings of the study suggest that digital tools are likely to play a crucial role in supporting neurodivergent students. Neurodivergent students indicated a willingness to learn to use digital tools if they were required for their learning, such as Grammarly. For example, neurotypical students used Outlook (a platform that can use multiple exchanges in one app) and used the institution-monitored communication tool, Slack; however, neurodivergent students did not. It would be interesting to delve deeper into the division in tool use. It could be due to existing usage of communication tools being easier than adjusting to using new technology in addition to challenges within the tertiary system, or because the implementation or interface of Outlook or Slack is not as 'neurodivergent-friendly' as what a student might currently use. Further, neurodivergent students also tended to use desktop computers both at home and on campus but used Google docs, available online anywhere, over that of the downloadable Office365 suite used by neurotypical students. Neurotypical students used more transitive devices such as laptops and tablets and wanted to learn about new tools. This is interesting because it aligns with reports that neurodivergent people are less adaptive to changing situations, thus, using a desktop inherently involves a consistent environment in which to study (Mirfin-Veitch et al., 2020). We could recommend, based on the results of our study, that educators need to be mindful when writing their teaching plans that neurodivergent students might struggle with bringing a range of different devices to their classes. Even inadvertently, expecting students to use devices on a whim might present barriers to students in their engagement and learning of the material. Presenting options for students to engage with the information during class and their independent study within a particular course or module will provide a consistent set of expectations for learning using a small range of technology rather than expecting students to be able to shift attention quickly and adjust to a new task.

Our results indicate that neurodiverse students use a wide range of platforms, phone apps and technologies in their personal life such as YouTube, TikTok, and Instagram. Neurotypical and maybe neurodivergent students use YouTube every day and in study, however, neurodivergent students use it predominantly for everyday use and not for study. Considering this usage, educators could use these existing connections to content in a multi-modal teaching approach. This has been reported as beneficial to neurodivergent students due to its ability to allow students to self-regulate and choose the model of teaching that works for them, for example, watching videos at home when classrooms are over-simulating (Horlin et al., 2023; Skelling, 2020). The authors highlight the importance of the over-educator's role in guiding students on platforms to ensure the information is current,

relevant, and accurate, and also teling students why the tool is beneficial (and necessary) and is worth the effort. For example, educators could explicitly direct students to specific quizzes for a specific test (Socrative) or create a specific page on social media for their students where videos can be shared by the class and checked by the educator for accuracy. Further, as students in the survey indicated wanting to learn how to use software, such as Grammarly, and recent advances in AI, teachers should offer guided instruction for these tools (though in moderation to mitigate overwhelming students).

Educators should continue to implement multi-modal teaching strategies that work for all learners. However, considering the increase in neurodiversity diagnoses (Russell et al., 2022; Sarrett, 2016), it is important that digital tool use is presented in a way that will allows neurodiverse students to excel without also creating challenges to students using technologies. This could be achieved by teaching students to use technology, encouraging educators to be organised and forewarn students of expectations for digital tool use in class, and limiting the use of different digital tools within a class to a few. This will allow all students the opportunity to engage and succeed which is presenting as an issue for graduates.

People who experience adversities, such as living a neurotypical world as neurodiverse, can have greater empathy for others and animals leading them to want to work with populations requiring greater compassion and understanding (Kimber et al., 2023). As an industry, we need to hold on to these individuals. This means supporting neurodiverse people already in the industry but also students during their education. In a 2019 survey by Diversity Works New Zealand, 30 percent of neurodiverse respondents felt their neurodiversity had impacted their career progression with people with autism experiencing difficulties during the hiring process (Davies et al., 2023). As educators of the future veterinary nurses and animal scientists, we need to ensure that neurodiverse students have the opportunity to succeed in their learning by mindfully exercising the use of digital tools, which they have shown competence and preference in using, in order to ensure they have the best chance of success after their study.

There were limitations to the study in the structure of the survey; firstly, the survey was not 'neurodivergent friendly' because students did not follow the instruction for Q6 which asked students to select what they do 'the most' indicating that they select one answer. This needed to be clearer as students selected multiple answers. Secondly, asking students to identify as neurodiverse may have influenced the number of students that selected this option, but may also have highlighted that there are more students unsure of their learning needs. This indicates that a conversation is required to ensure students are aware of the pathways to find help within the institution and that they have the right to communicate what they need to their educators.

In conclusion, this study serves as a starting point for understanding the dynamic relationship between students, digital tools, and learning experiences in the field of animal science. It highlights the importance of teaching students to use technology, encouraging educators to be aware of their students' needs especially as they progress through the levels, and planning teaching around the use of a considered range of digital tools using a multi-modal design. This needs to be a guided approach by the educator to ensure learning directives are effective, safe and achievable without digital barriers for individuals suited to working with animals.

ACKNOWLEDGEMENTS

Thank you to Associate Professor Nigel Adams for his assistance with the human ethics proposal and Ruth Laing for assisting with the list of digital tools available to Unitec students. We also appreciate the time taken by the students to complete the survey and will share our findings with the School of Environmental and Animal Sciences.

Chloe McMenamin is an emerging researcher with an interest in supporting veterinary students in achieving their fullest in their educational journeys. With over a decade of experience in the veterinary industry, Chloe has experience in a variety of veterinary nursing and animal health roles. Currently, a lecturer in applied animal health at Unitec, Chloe's passion for supporting students particularly those with neurodiversity stems from their own struggles in education. Chloe believes that exploring ways to support neurodiverse ākonga in education, will not only support student neurodiverse students but all students.

Kristie Cameron has a PhD and studies animal behaviour and welfare and is an Associate Professor at Unitec. Kristie is an active researcher and is the chair of the Unitec Early Career Researcher forum and the Co-chair of the Royal Society Te Apārangi Early Career Researcher committee.

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