PROCEEDINGS

Rangahau Horonuku Hou

New Research Landscapes

UNITEC /MIT RESEARCH SYMPOSIUM 2021

December 6 and 7

Unitec | Te Pūkenga

Manukau Institute of Technology | Te Pūkenga

ePress Research with impact

Unitec | Te Pūkenga

ISBN 978-1-99-118340-8

Proceedings: Rangahau Horonuku Hou – New Research Landscapes, Unitec/MIT Research Symposium 2021, December 6 and 7

Rangahau Horonuku Hou – New Research Landscapes, Unitec/MIT Research Symposium 2021 was jointly hosted by Unitec and MIT, Te Pūkenga, and was held online on December 6 and 7, 2021. All papers published in these proceedings have been double-blind peer-reviewed by two referees. The papers in this publication comprise the proceedings of Rangahau Horonuku Hou – New Research Landscapes, Unitec/MIT Research Symposium 2021. They reflect the authors' opinions and their inclusion in this publication does not necessarily constitute endorsement by the editors, ePress, Unitec, Te Pūkenga, and MIT, Te Pūkenga.

Editors: Evangelia Papoutsaki and Marie Shannon

https://doi.org/10.34074/proc.2206

This publication may be cited as: Papoutsaki, E., & Shannon, M. (Eds.). (2022). *Proceedings: Rangahau Horonuku Hou – New Research Landscapes, Unitec/MIT Research Symposium 2021, December 6 and 7*. Auckland: ePress, Unitec, Te Pūkenga. https://doi.org/10.34074/proc.2206

Cover design: Penny Thomson

An ePress publication

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ISBN 978-1-99-118340-8

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https://doi.org/10.34074/proc.2206001

We are pleased to present the proceedings of Rangahau Horonuku Hou – New Research Landscapes, an online research symposium collaboratively organised by Unitec and Manukau Institute of Technology in December 2021. Although face-to-face interactions are usually considered preferable, shifting to an online symposium during the Covid-19 pandemic facilitated a high degree of engagement from Institutes of Technology and Polytechnics across the mōtu, and enabled greater ease of attendance and programme navigation for participants. Unitec's blended online and face-to-face 2020 symposium received 21 presentations from outside Unitec; this collaborative symposium received 65, including those from MIT. Along with the highly successful national ITP symposium hosted by Weltec/Whitireia and Open Polytechnic, this testifies to an increasing trend toward research collaboration across the sector. This is particularly encouraging as we enter into the final stages of integration and the full formation of Te Pūkenga, at the time of writing.

The Māori and Pacific research streams were richly populated with a wide array of topics. It was pleasing to see that the Research with Impact award was won by a Kaupapa Māori research project, Ka Pu te Tuha, Ka Hao te Rangatahi – When the Old Net Is Cast Aside, the New Net Goes Fishing. This research was presented by Dr Tepora Emery, with researchers and research partners from Ngāti Pikiao including Mamaeroa Merito, Waitiahoaho Emery, Auroa Rikiti, Takiri te Ata Raerino and Freddy-Ray Collier.

The research presented in these proceedings includes topics as diverse as the use of chatbots to enhance customer satisfaction through to assessment practices in early-childhood education field placements. Online teaching and education responses to Covid-19 were the most consistent themes, unsurprisingly perhaps, given the pandemic was in full swing at the time of the symposium.

We are thrilled that Unitec ePress can give researchers the opportunity to publish full, peer-reviewed papers emerging from oral presentations at the symposium, providing enduring access to the findings for the sector and the world at large.

Ngā mihi mahana ki a koutou.

ONLINE FROM MONDAY: LECTURERS' EXPERIENCES OF THE RAPID TRANSITION TO ONLINE LEARNING DELIVERY FOLLOWING THE FIRST NATIONAL EMERGENCY RESPONSE TO COVID-19

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https://doi.org/10.34074/proc.2206002

Teaching and Learning

This publication may be cited as:

Heath, S., Perry, A., Kabbar, E., and Palfreyman, S. (2022). Online from Monday: Lecturers' Experiences of the Rapid Transition to Online Learning Delivery Following the First National Emergency Response to Covid-19. In E. Papoutsaki and M. Shannon (Eds.), *Proceedings: Rangahau Horonuku Hou – New Research Landscapes, Unitec/MIT Research Symposium 2021, December 6 and 7* (pp. 6–20). Auckland: ePress, Unitec, Te Pūkenga. https://doi.org/10.34074/proc.2206002

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ISBN 978-1-99-118340-8

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Research with impact
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ABSTRACT

Aotearoa New Zealand's health response during the first wave of the Covid-19 pandemic significantly impacted the tertiary education sector. Lecturers at tertiary institutions were required to make a rapid transition from familiar in-person teaching to teaching online as they navigated and responded to these unexpected and unplanned changes. The purpose of this paper is to present the results of a descriptive survey of tertiary-sector lecturers (n = 56) across five disciplines following Aotearoa New Zealand's first lockdown in March 2020. The study aimed to describe how the Covid-19 pandemic impacted teaching practice in one Aotearoa New Zealand polytechnic. It documented the impact of unexpected transition from in-person to online teaching from the lecturers' perspectives. An anonymous online survey was available for three weeks. It asked lecturers to identify their level of concern about online course delivery pre and post the initial lockdown event, and to comment on the challenges the lockdown presented. Participants were also asked to identify opportunities and benefits from their experience. Descriptive statistics are provided to show frequencies and to summarise information about the participants. Statistical analyses were conducted using IBM SPSS Version 25 software using Levene's Test for Equality of Variances and t-test. Qualitative analysis of the lecturers' free-text responses was undertaken using Braun and Clarke's (2006) general inductive approach. Analysis showed lecturers were initially concerned about the rapid shift to emergency remote teaching (ERT). Challenges reported included internet access and other technology-related issues, as well as curtailment of laboratory, simulated and experiential learning opportunities especially important in vocational education. This once-in-a-career opportunity provided lecturers with prolonged exposure to teaching remotely and enabled discovery and creativity which could be integrated immediately to support student learning and be used to shape future responses to adverse circumstances.

KEYWORDS

Online learning, vocational education, Covid-19 pandemic, emergency remote teaching

BACKGROUND

The confirmation of a novel coronavirus (SARS-CoV-2) by the World Health Organization (WHO) in January 2020 heralded the onset of the Covid-19 global pandemic and some of the most significant reactive changes ever made to the education sector (Ministry of Education, 2020). Aotearoa New Zealand was affected by the reach of the pandemic and the changes it forced. Despite the low morbidity of Covid-19 enabled by a managed border and a "Go hard, go early" preliminary response by the Prime Minister (Ardern, 2020a), there was still considerable disruption. Education responses to the health crisis impacted students and tertiary education programmes globally; The United Nations Educational, Scientific and Cultural Organisation (UNESCO) reported that the education of over 90% of the world's entire student body was affected (UNESCO, 2020). On 25 March 2020, in Aotearoa New Zealand, a national state of emergency was declared signalling the onset of a national Level 4 lockdown (Ardern, 2020b). Tertiary teaching and learning were summarily transitioned to online delivery.

LITERATURE REVIEW

Online learning has certainly been a pedagogy embraced by tertiary education providers. Even before the 2020 global pandemic, there was increasing interest in the use of online and blended teaching methods in higher education programmes (Kong & Song, 2014; Zimlich, 2015; Bhakta & Dutta, 2016). Tracing its origins back to correspondence and distance education, Sun and Chen (2016) documented the development of online learning supported by emerging digital technologies. The use of synchronous and asynchronous learning events, the availability of email, online messaging and conferencing, collaboration via Google Docs, and the use of Facebook, Twitter, TikTok, etc., have widely supported the development of online learning environments across disciplines (Sun & Chen, 2016; McCutcheon et al., 2014; Astle et al., 2020). Furthermore, the benefits of modern online learning identified by McDonald et al. (2017) suggest that its value lies in increased cost-effectiveness, accessibility and flexibility afforded to learners. Indeed, such characteristics of online learning products can cater to a wide range of students across many disciplines (Kebritchi et al., 2017). These factors also ensure that adoption of the pedagogy supports the development of learner self-direction and self-efficacy in learning (Dhawan, 2020). In vocational education, these are desirable attributes of a work-ready graduate (Godber & Atkins, 2021). However, despite the benefits for both students and institutions in the application of online learning strategies, successful resource development is not without the need for considerable investment and planning (Petrie et al., 2020).

McDonald et al. (2017) articulate the length of time and complexity of the planning process for transitioning from an in-person to an online course in health-professional education. In their study, through an inclusive and consultative process led by a steering group, the curriculum was mapped and sequenced, assessments were reviewed and consistency in the production of online course artefacts and content was also established. In nursing, Astle et al. (2020) also report the lengthy implementation timeline involved in online curriculum development. Other commentators provide the view that content cannot simply be copied from an in-person to an online setting without sufficient consideration (Koehler et al., 2004), and Li and Irby (2008) document the challenges involved in generating new materials in translation from in-person classes to an online setting. Furthermore, Yue et al. (2013) caution that teachers should understand what the use of technology adds to the learning activity, since poorly selected and adopted multimedia can be detrimental to learning.

In their systematic review of the literature on online learning, Kebritchi et al. (2017) add to the work of Yue et al. (2013) when they outline several more content- and teacher-related concerns. Online learning needs to account for the integration of the content between learners and instructors (Kebritchi et al., 2017, Bhakta & Dutta, 2016). This means that online programme delivery needs to account for content, pedagogy *and* technology. Here, online learning is often favoured where content is declarative (facts and principles) rather than teaching 'soft' interpersonal or practical skills (Callister & Love, 2016; Astle et al., 2020; McCutcheon et al., 2014). For the vocational education sector, course content is markedly skewed to 'soft,' practically based skills with institutions contributing significantly to developing a 'work-ready' graduate profile for apprenticeships and 'hands-on' employment (Cox & Prestridge, 2020). Effectively replicating in-person, practical teaching as an online experience is challenging, and may go some way to explain the perception that it has a limited place in vocational education (Johnson et al., 2020). However, other teacher factors are also indicated as being important to the adoption of online delivery.

Lowenthal et al. (2019) report that a teacher's self-perception of their ability to use online learning likely indicates the extent to which it would be used. Here, it is noted in the literature that professional development can assist the development of positive teacher self-perception, confidence and familiarity in using online-delivery teaching strategies. However, Kebritchi et al. (2017) found there was a lack of professional development available, concluding that this continued to contribute to the limited use or exploration of online delivery. Yet, in the pandemic situation, there was little opportunity for planning, professional development or preparation as the emergency, not the pedagogy, was paramount. As a matter of pedagogical concern, therefore, more accuracy in the definition of the transition to online learning is essential.

Bates (2020) and Scherman (2020) respectively define e-learning as an intentional form of distance education, with deliberate and purposeful advanced planning of the teaching and learning encounter. Obviously, the transition to

online modalities in the pandemic was not part of any planned process (Murgatrotd, 2020). Therefore, the rapid and unplanned transition from in-person to online delivery does not adequately express or represent the pedagogical integrity specific to e-learning; the use of Zoom online video conferencing software, or 'Zooming,' is equally not e-learning (Bates, 2020). Instead, the phrase 'emergency remote teaching' has been coined as a way of expressing the educational response to crisis or unexpected disruption such as the Covid-19 pandemic. For this research the definition provided by Hodges et al. (2020) is used to define emergency remote teaching (ERT):

> A temporary shift of instructional delivery to an alternate delivery model due to crisis circumstances [which] involves the use of fully remote teaching solutions for instruction or education that would otherwise be delivered face-to-face or as blended or hybrid courses and that will return to that format once the crisis or emergency has abated. (Para. 13)

From the perspective of the Aotearoa New Zealand institution featured in this study, ERT, rather than e-learning or online learning, best describes the teaching and learning practices implemented following lockdown restrictions in response to the global pandemic. In pivoting to ERT, short lead times before beginning online classes were common (Howe et al., 2021; Webb, 2021; Jelinska & Paradowski, 2021). While some lecturers had the benefit of previous experience of other online teaching pre-pandemic, it was also important to consider that even experienced lecturers become novices during ERT situations since the expectations of the role of the online lecturer are different (Howe et al., 2020; Redmond, 2011).

Using Hodges et al.'s (2020) definition of ERT, the perspectives of lecturers at one tertiary education institution in Aotearoa New Zealand who made the rapid transition from in-person to ERT were surveyed for this study. The institution has a focus on vocational and practical learning experiences. There were five disciplines represented in this study, including Healthcare and Social Practice, Community Studies, Building and Construction, Computing and Bridgepoint Education. Participants were familiar with Moodle, the learning management system (LMS) utilised by the institution to support curation and storage of supportive digital resources for students for each of their courses. However, using the LMS as an adjunct to in-person delivery reflects a different intention to online learning and should not be taken to imply participants were experienced users of online pedagogies.

RESEARCH DESIGN

Sensitive to the need to balance any potential intrusiveness of the research amidst the many competing personal and professional demands during the initial 2020 Covid-19 emergency response, the study design was carefully considered. To this end, the team used a descriptive survey with open and closed responses via online delivery. This approach supported lecturers to respond if they wished, and allowed the team to canvas a range of perspectives in a short time-frame. Furthermore, 'in-the-moment' research is supported internationally by Vindrola-Padros et al. (2020), who argue that the collection of data in real time maintains the immediacy of the participants' perspectives, which may be different from their retrospective recall of events. The use of open and closed questions within the survey enables researchers to obtain qualitative and quantitative data within one study. Here, the work of Coyle and Williams (2000) affirms the use of multiple methods in research, summarising that the use of qualitative and quantitative approaches to data collection is the only way to be certain of findings. Qualitative data pertains to non-numerical data and can be used to understand how an individual subjectively perceives and gives meaning to their experiences. In this type of study, a particular phenomenon can be described (Florczak, 2017). In contrast, quantitative data refers to numerical data used to describe, predict or control variables of interest. As the current study sought to describe how the Covid-19 pandemic impacted the teaching practice of tertiary teaching staff in an Aotearoa New Zealand polytechnic, a multiple methods approach was selected.

The objectives of the study were as follows:

- To document the impact of Covid-19 across a range of programmes offered at the home institution.
- To determine levels of lecturer concern before and after the switch to ERT.
- To document the challenges faced and opportunities that arose as a result of the switch.

- To identify strategies used in the moment to overcome challenges presented.
- To determine whether a phase two follow-up study would be viable.

Ethical approval was granted by the institution's Research Ethics Committee (UREC application number 2020-1024). Participants were a convenience sample of lecturers employed at one Aotearoa New Zealand tertiary institute during the first lockdown after the State of Emergency was declared (n = 56). In the five participating schools, 220 academic staff were employed and were eligible to respond.

Following informal pre-testing of the survey with non-participating lecturing staff, the survey link was emailed to all staff in contributing Schools via their School Research Lead. The email contained an introduction to the research, a survey link (Survey Monkey) and a Participant Information Sheet. Respondents were asked to provide personal details only if they would like to be contacted for any follow-up interviews if a phase two study was likely to be viable. There were 32 participants who indicated that they would like to be contacted for an interview. Confidentiality was assured, as only the principal investigator had access to the survey response data and these names were removed and stored separately before data analysis began. The survey was open for three weeks and email reminders were sent to lecturers one week before the survey closed. Consent was implied by the submission of the survey. To ensure reliability, 'online learning' was defined as ERT in the survey.

As the survey was descriptive, the statistical component was focused on reporting the participants' characteristics and responses. Demographic data was limited to years of teaching experience and school of employment. The level of concern of participants was captured using a five-point Likert Scale Levene's Test for Equality of Variances for small samples, and t-test was used to detect differences between the groups. No missing data were detected in the participants' responses; therefore, all responses were considered valid and were accepted for further analysis.

The qualitative data were analysed using Thomas' (2006) general inductive approach. The qualitative data-evaluation criteria adopted were credibility and internal validity. Together, these criteria aimed to ensure a degree of trustworthiness (Guba & Lincoln, 1994, cited in Bryman, 2008). In particular, a process of investigator triangulation was used. Triangulation is defined by Cresswell (2012) as "the process of corroborating evidence from different individuals … types of data … or methods of data collection" (p. 259). The authors independently reviewed the qualitative data and identified potential themes. They then reviewed the themes as a group, each defending their own conclusions and settling on the final themes by a process of discussion and consensus.

FINDINGS

There was a response rate of 25.45% (n = 56). The researchers acknowledge that a higher participation rate is preferred, but given the challenges lecturers faced at the time of the research, the response rate is adequate for this exploratory work. The following results are presented and discussed in three parts: (1) Participant characteristics; (2) challenges faced by teachers; and (3) the perceived outcomes of teaching and learning online.

Participant characteristics

Participants were mainly lecturers with 10 or more years' experience (n = 37, 66.1%) from five schools with a wide range of graduate profiles (n = 56, see Table 1). The majority of participants were either not at all familiar or slightly familiar with online teaching at the beginning of the Covid-19 emergency response (n = 33, 58.9%, see Table 2).

TABLE 1. SURVEY PARTICIPANTS AND TEACHING EXPERIENCE.

School		**Teaching experience**			
		10+ yrs	**6–10yrs**	**2–5 yrs**	**<2yrs**
Bridgepoint	7.1% (n = 4)	3		1	
Building Construction	17.9% (n = 10)	6	1	2	1
Community Studies	14.3% (n = 8)	4	3		1
Computing, Electrical and Applied Technology	39.3% (n = 22)	16	1	3	2
Healthcare and Social Practice	21.4% (n = 12)	8		1	3
Total	**56**	**37**	**5**	**7**	**7**

TABLE 2: SURVEY PARTICIPANTS AND FAMILIARITY WITH ONLINE TEACHING.

School		**Familiarity with online teaching**				
		Not	**Slightly**	**Somewhat**	**Moderate**	**Extremely**
Bridgepoint	7.1% (n = 4)	1	2	1		
Building Construction	17.9% (n = 10)	6	2	1	1	
Community Studies	14.3% (n = 8)	1	1	3	3	
Computing, Electrical & Applied Technology	39.3% (n = 22)	7	6	3	4	2
Healthcare and Social Practice	21.4% (n = 12)	4	3	2	3	
Total		**19**	**14**	**10**	**11**	**2**

Levene's Test for Equality of Variances and t-test were used to detect any group differences in the responses, based on lecturers' years of experience and familiarity with online delivery and their level of concern about moving teaching to online delivery. The statistical analysis was conducted using IBM SPSS Version 25 software. Levene's Test for Equality of Variances and t-test results indicate that there was no significant effect for the length of teaching experience and concern about using an online delivery mode (t = -.416, p = .679, see the full results in Tables 3a and 3b). Furthermore, the results also indicate no significant effect for familiarity with online teaching and level of concern about using an online delivery in this cohort (t = 1.854, p = .069, see the full results in Tables 4a and 4b).

TABLE 3A. LEVEL OF CONCERN BEFORE ERT DELIVERY AND TEACHING EXPERIENCE.

Level of concern before ERT delivery and teaching experience					
	Q: How many years of teaching experience do you have altogether?	n	Mean	Std. Deviation	Std. Error Mean
Q: Think about how you felt when you were first told you would need to deliver your course online because of the Covid-19 emergency response. What was your level of concern?	Less than 2 years	7	2.86	1.464	.553
	10 or more years	37	3.08	1.278	.210

TABLE 3B. INDEPENDENT SAMPLES TEST: LEVEL OF CONCERN BEFORE ERT DELIVERY AND TEACHING EXPERIENCE.

Independent Samples Test									
	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Equal variances assumed	.694	.410	-.416	42	.679	-.224	.538	-1.310	.862
Equal variances not assumed			-.378	7.827	.715	-.224	.592	-1.594	1.146

TABLE 4A. FAMILIARITY WITH ONLINE DELIVERY MODES AND LEVEL OF CONCERN.

Level of concern before ERT delivery and teaching experience					
	Q: How familiar were you with online teaching at the beginning of Covid-19 emergency response?	n	Mean	Std. Deviation	Std. Error Mean
Q: Think about how you felt when you were first told you would need to deliver your course online because of the Covid-19 emergency response. What was your level of concern?	Not familiar	33	3.24	1.300	.226
	Familiar	23	2.61	1.196	.249

TABLE 4B. INDEPENDENT SAMPLES TEST: FAMILIARITY WITH ONLINE DELIVERY MODES AND LEVEL OF CONCERN.

Independent Samples Test									
	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Equal variances assumed	.220	.641	1.854	54	.069	.634	.342	-.052	1.319
Equal variances not assumed			1.882	49.883	.066	.634	.337	-.043	1.310

The survey results suggest that the overall level of concern about ERT declined over the initial health response. The percentage of lecturers who were moderately or extremely concerned before online course delivery started, decreased from 12.5% (n = 7) and 26.8% (n = 15) to 10.7% (n = 6) and 7.1% (n = 4) respectively after online delivery started. At the same time, the percentage of participants who were not at all concerned or were slightly concerned increased from 16.1% (n = 9) and 21.4% (n = 12) before online course delivery started, to 21.4% (n = 12) and 41.1% (n = 23, see Figure 1) respectively after online delivery started.

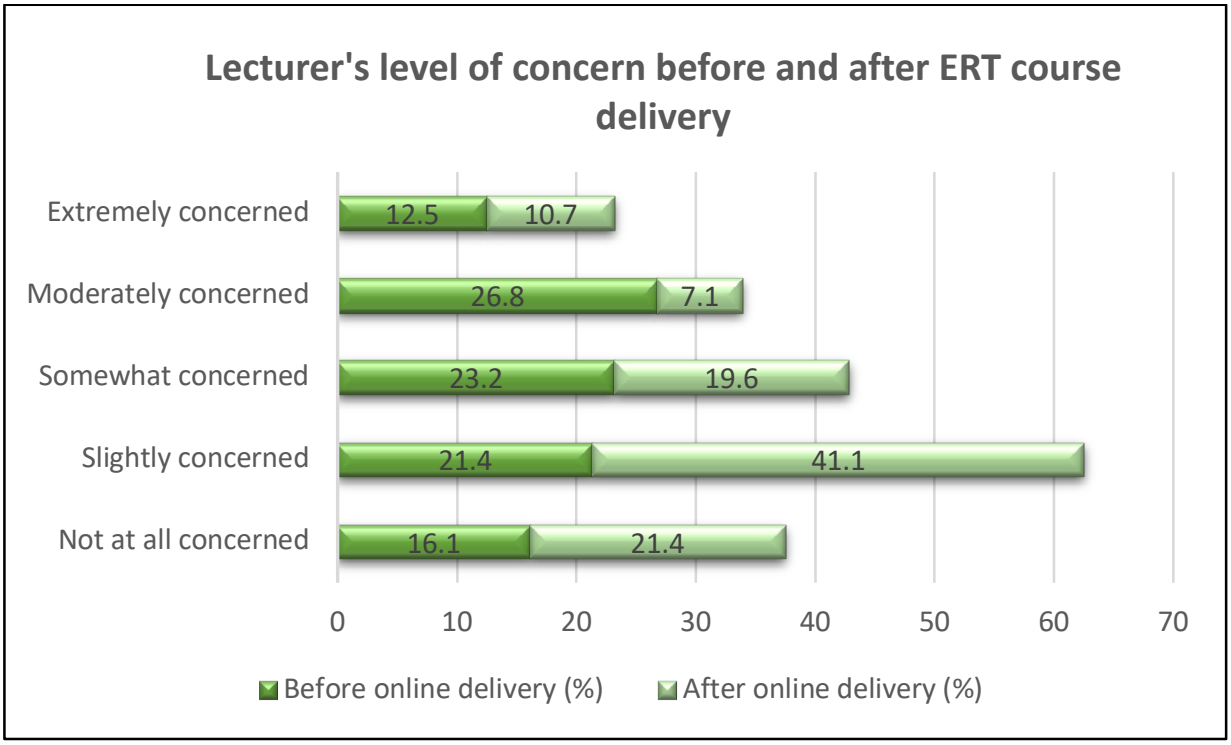

Figure 1. Graph to show lecturers' levels of concern before and after ERT course delivery.

Challenges faced by lecturers

Lecturers faced challenges in the transition to ERT. When asked about the source of these challenges, participants most frequently indicated student-focused challenges were their main concern (78.6%, n = 44), followed by technical issues (69.6%, n = 39), their own capability (41.1%, n = 23) and other stated issues (30.4%, n = 17). Additionally, participants were asked to provide an example of the challenge(s) they identified.

The student-focused challenges indicated by the participants demonstrated a broad area of concern. The most pressing issue reported related to students being challenged by the need to share a device with other family members and being able to find a suitable space within the household to study. Participant 42 (Computing) wrote:

> *Several students said that it was much harder to learn at home because there were so many other things happening compared when they come to [polytechnic], they come to study.*

Participant 24 (Building Construction) elaborated on what was occurring for some:

> *Trying to home school kids while studying, one laptop shared in a family, having to do extra shifts to support the family leaving no time for study, poor internet access due to location.*

Participant 30 (Community Studies) summarised:

> *It was difficult for some students to move to online because of either lack of device, poor internet or distractions in their living areas.*

One participant reported their students' attempts to learn using a smartphone. Supporting students' use of the software needed for ERT like Zoom, for example, and the specialist requirements of the students' chosen programme was mentioned by 23% (n = 13). Problems that arose were described by Participant 33 (Community Studies):

> *Student[s] could not hear properly on Zoom.*

Participant 4 (Building Construction) outlined:

> *I was more worried whether the students had access to adequate IT equipment and internet to allow them to participate through Zoom, and also machines that could run the specialist software.*

Other participants noted that student attendance rates declined, with absences explained by the need to manage the complexities of the home situation, where space, home schooling and parenting young children made attending difficult. Technical challenges for participants were related to internet availability, stability and use of the software provided for teaching and meeting. For another, computer glitches that were not easily fixed added frustration.

Reflecting on their own capability, participants centred on two concerns: self-perception and the effectiveness of their teaching. Participant 48 (Bridgepoint) described a lack of personal ability to use the technology effectively:

> *[Knowing] what would be [a] good teaching style to suit an online environment.*

Others (Bridgepoint, Healthcare and Social Practice) described how a lack of familiarity with the software impacted their ability to be creative and to develop interactive, student-focused learning. The online classroom felt different from an on-campus experience. Here, comparing online to the usual practices of effective teaching, staff missed the nuances of the classroom environment that would indicate a student was struggling to understand. Participant 13 (Healthcare and Social Practice) elaborated on this issue:

> *All I would be able to see was a wall of names. It was difficult to interact and to gauge whether students understood or were even interested.*

The ability to guide and direct the class was also different online. A new lecturer (Participant 1, Healthcare and Social Practice) wrote:

> *… being new, could I present my ideas and content effectively in a foreign medium?*

Above all was the challenge of adaptation; the need to transform teaching in such a significant way within such a short timeframe.

The strategies participants used to overcome these challenges varied. One third of the participants indicated that they sought help from colleagues (37.5%, n = 21); others sought help from the institute's academic services (30.4%, n = 17), such as the teacher-support service and information technology (IT) services (25.0%, n = 14). Participants stated they used other strategies such as personal research about techniques for online delivery (7.1%, n = 4).

The realities of emergency remote teaching

Participants were asked about the effects of ERT on courses, and any perceived opportunities or benefits from the move. Participants reflected that the major impact of ERT had been on content delivery. They explained about the difficulties found in teaching practical aspects of their courses. The inability to have laboratory or simulated experiences to support theoretical concepts was described by Participant 2 (Building Construction), who stated:

> *While theoretical drafting examples were given, it's not the lightbulb moment of combining the fieldwork and then creating a [model] representation.*

Where courses had a significant experiential component such as the development of interpersonal skills, participants saw how the convenience of in-person teaching and learning was impacted to the detriment of students' progress because it was difficult to replicate online. Participant 54 (Bridgepoint) shared:

> *I rewrote all my practical investigative group assessments, as students didn't necessarily have the resources to carry out these assessments, to become pretend contexts for individual engagement.*

The absence of practical learning changed the way participants adapted their chosen content; supporting and scaffolding students' own investigations and knowledge building was substituted for a more directive approach that could be accessed asynchronously. Other disciplines fared better, such as Healthcare and Social Practice, where staff using tutorially based approaches managed to navigate lockdown without any major adjustments to content or delivery, but missed the opportunity to do so in person.

Participants provided positive commentary on student engagement with their courses. The ability to be able to attend asynchronously worked well for students who were essential workers, and for those who were home schooling their children at the same time as studying themselves. Participants referred to their attendance and lack of assessment extension data to demonstrate there was improved engagement by some students. Rethinking delivery also brought new insights. Using flipped learning appeared to strengthen students' positive sense of achievement and promoted greater engagement. There were other observations brought about by ERT, including the explanation that for some students being on campus was the preferred way of learning (Participant 49, Computing). One area that provided many comments was the observed change in the lecturer–student relationship, reflected in the words of Participant 26 (Building Construction):

> *We all connected in a different way. We saw each other's homes and met family members, and recognised we were all in it together.*

Outcomes of emergency remote teaching

ERT gave participants permission to experiment and be creative. Throughout the initial lockdown, the participants had developed a wide range of teaching and learning strategies for use in the online environment. The impact of this experience on content delivery showed in the narratives about opportunities and benefits. They illustrated how much progress had been made towards increasing the learner-centredness of courses using asynchronous activities; the opportunities for students to ask questions using the 'chat' function, and to develop independent learning skills; and being able to cater to different learning needs. Participant 36 (Community Studies) stated:

> *I've now got a small bank of Moodle activities which can stretch those students who want more. And I've learned a lot more about better delivery techniques online.*

The use of technology brought the opportunity for students to demonstrate their learning in different ways, such as vlog assessments, and participants were open to considering various alternatives, including making assessment completely online. Benefits were seen in the potential to deliver courses using hybrid and blended delivery models. The flipped classroom approach using ECHO 360 also featured in commentary from both Computing and Building Construction. Participants considered that these forms of remote teaching and learning might also reduce the financial burden of travel for some students, as well as encouraging self-sufficiency in learning. For other participants, the ability to use lesson recordings as a review strategy provided the opportunity to 'play and pause' recorded technical explanations; this was highlighted by Participant 23 (Building and Construction) and Participant 35 (Community Studies), who also recognised the value of students being able to access material several times if needed to support learning key principles.

A stated objective of this study was to revisit willing participants once it was safe to return to campus. Indeed, more than half of the respondents answered the call to take part. However, when the study was launched we could not have envisaged the amount of time Tāmaki Makaurau Auckland would remain in lockdown and the necessity that would arise to continue to use online teaching and learning. Two years after the initial lockdown, we are only now starting to reach pre-pandemic levels of face-to-face on-campus classroom delivery. The potential to revisit the study two years on and the value of doing so remains under consideration.

DISCUSSION

The findings of this research project align with international research with respect to the challenges experienced by educators when required to urgently and unexpectedly transition from teaching in person to ERT (Houlden & Veletsianos, 2020). One significant challenge was the lack of pedagogical knowledge needed for teaching online, which was reflected in this present study and mirrored by international findings (Rapanta et al., 2020). The pedagogical advice within the literature to be cautious and deliberate about the introduction of online learning delivery (Johnson et al., 2020; Bates, 2020), was simply not possible when responding to a global pandemic. This study showed that lecturers developed confidence with the new delivery model over time, and that they became more confident and creative in their approach. Furthermore, some of the new ways of working they discovered were intended to be retained even once onsite learning had resumed.

Delivering the practical components of courses was indeed difficult. The absence of laboratory and simulated experience greatly impacted delivery of some courses in Building Construction, Bridgepoint, and Healthcare and Social Practice in particular. For Healthcare and Social Practice, it was the loss of 'soft' skills like interpersonal communication and for Building Construction the opportunity for depth of discussion. While there was evidence of great ingenuity in attempting to minimise the impact of these losses, there is reason to consider the potential for future disruption and the ways that these components can be covered, perhaps through flexibility in programming or extending timeframes. Solutions may come from the use of more blended or hybrid learning options. These types of design also offer greater opportunities for students with busy or complex lives to have greater engagement with vocational education. They may also add greater resilience to curricula, minimising the impact of the rapid educational change and alternative forms of temporary, instructional delivery as defined by Hodges et al. (2020).

The magnitude of the change that occurred across the sector with the implementation of the national State of Emergency in March 2020 cannot be underestimated. The once-in-a-career opportunity to explore a whole new mode of delivery for students has changed thinking and confidence, and has created an appetite to continue to look at new ways of ensuring that our programmes remain learner centred for the 21st century. Professional development will be essential to support the continued development of skills in the coming years. Preparedness for the personal and professional adversity described by Seaton et al. (2012) is no longer optional.

The practical nature and heavy reliance on 'soft skills' development in vocational education could indicate that online teaching and learning might be a threat to student success, especially over a prolonged period like that experienced in Tāmaki Makaurau Auckland. However, it is also possible that the disruption and consequences of being off campus might yet reveal how workforce preparation can be transformed. The creativity displayed by the participants in this Aotearoa New Zealand study has shown that there are many opportunities to rethink and redevelop teaching, learning and assessment strategies across disciplines. Learning remotely perhaps reflects more-contemporary workforce preparation.

Our new generation of students will be even more confident in their use of digital technologies on entry to vocational education, and will expect to use these not only to support their learning but as an adjunct to their career pathway. Since online learning expands the range and flexibility of available in-person teaching and learning strategies, there is the potential for vocational education to appeal to a broader range of learners. Furthermore, a more flexible approach could make enrolment into all programmes increasingly attractive to people from a wider range of socioeconomic backgrounds.

CONCLUSION

Within the tertiary sector, vocational education has a heavy reliance on in-person approaches to teaching and learning and, by design, practical, work-ready skills development. The primary repercussion of lockdown for the disciplines represented in this study has been the significant loss of that practical experience. However, hybrid delivery models could provide a solution and these deserve to be explored and developed further. Lecturers have shown that they are adaptive and creative, mastering and navigating the technology to suit learner needs.

Having demonstrated that online learning can work for some aspects of vocational education, there is a need to further develop lecturers' skill sets in preparing and managing online learning. Professional development will be a key feature of any move to do so but, armed with the level of creativity found in ERT content-delivery and assessment, solutions originating from lockdown can be further refined. It will certainly be possible to add value to future teaching and learning experiences in a student-focused way. The advantages and possibilities for students who are juggling personal responsibilities and want to engage with education are enormous with such models.

Living as we do across two major tectonic plates in this country, the vocational education sector would do well to heed warnings that the global pandemic is unlikely to be the last pandemic or natural disaster. For this reason, the sector must take the time to learn from these recent lockdown experiences, and to prepare for future emergencies that will inevitably impact on the delivery of teaching and learning, for the of benefit future learners.

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MAKING SENSE OF E-LEARNING PLATFORM DATA TO INFORM TEACHING AND LEARNING PRACTICE

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https://doi.org/10.34074/proc.2206003

Teaching and Learning

This publication may be cited as:

Meintjes, H., Zivaljevic, A., and Kumar, R. (2022). Making Sense of E-Learning Platform Data to Inform Teaching and Learning Practice. In E. Papoutsaki and M. Shannon (Eds.), *Proceedings: Rangahau Horonuku Hou – New Research Landscapes, Unitec/MIT Research Symposium 2021, December 6 and 7* (pp. 21–38). Auckland: ePress, Unitec, Te Pūkenga. https://doi.org/10.34074/proc.2206003

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ISBN 978-1-99-118340-8

ePress
Research with impact
Unitec
Te Pūkenga

ABSTRACT

Masses of data are gathered by learning platforms while students are interacting with them. The learning analytics and knowledge (LAK) and educational data mining (EDM) research communities analyse these data to extract useful information. This study aims to give an overview and possible explanations for the findings of these research communities regarding the relationships between student online interactions and success or failure in a course. The available EDM and LAK literature from 2010 onwards was reviewed. Significant direct and indirect relationships between success and a range of variables were reported. The characteristics of good teaching and learning, as identified by Cognitive Load Theory (CLT), Chickering and Gamson's Seven Principles for Good Practice in Undergraduate Education, and Anderson's Equivalence Theorem were then used as a framework to reflect on and attempt to explain the findings. For example, various studies found the number of logins to be negatively correlated with success. This may be an indication of poor study methods or a warning sign of a poorly designed site. Spending unexpectedly long periods on a task may indicate a poor match between the task's cognitive load and the student's level of readiness. Passively listening to recorded lectures as a study method is also linked to lower levels of success. These findings may inform the guidance given to students regarding studying successfully online and have some lessons for the design of online environments to promote successful learning. With the complementary use of EDM, LAK and pedagogical theory, the data generated by e-learning platforms provide useful pointers to improve online teaching and learning.

KEYWORDS

Learning analytics, learning analytics and knowledge, educational data mining, interactions, forecasting, e-learning, online behaviour, navigational pattern, risk prediction, good teaching practice, quality instruction, e-platforms

INTRODUCTION

The assumption of this study is that both student factors and the quality of the instruction that they receive are important in student achievement. The increase in the use of e-learning platforms in teaching and learning necessitates a reflection on what quality instruction is in an online environment. Even when attending face-to-face classroom sessions in physical learning spaces, the online components of blended delivery models are increasingly forming fundamental parts of courses. The advent of the Covid -19 pandemic pushed the boundaries further by necessitating the use of online classes.

This study aims to integrate the findings of the educational data mining (EDM) and learning analytics and knowledge (LAK, formerly learning analytics [LA]) research communities with the characteristics of quality instruction according to generally accepted pedagogical theories, namely, Cognitive Load Theory (CLT), Chickering and Gamson's Seven Principles for Good Practice in Undergraduate Education, and Anderson's Equivalence Theorem. It reviews the findings of numerous research studies (2010 onwards) reporting on possible relationships between student interactions with e-learning platforms and success or failure in courses.

Relevant literature from the LAK (LA) and EDM fields, e-learning and pedagogical theory is used to:

- Identify interactions that can serve as indicators of success or risk of failing.
- Explain the found interactions and educational outcomes in the light of generally accepted pedagogical principles of quality instruction.

Background information regarding data collection by e-platforms, the analysis thereof and some relevant pedagogical theories are discussed below.

BACKGROUND

E-learning platforms such as Blackboard, Moodle, Canvas, Sakai and Desire2Learn are systems that provide an "integrated set of interactive online services that provide teachers, learners, parents and others involved in education with information, tools, and resources to support and enhance educational delivery and management" (Hill, 2012, p. 1).

Different applications, such as learning management systems (LMSs, such as Canvas), learning content management systems (LCMSs, such as Moodle), virtual learning environments (VLEs, such as Blackboard) and course management systems (CMSs, such as Desire2Learn) are designed to facilitate e-learning by making content available while managing and tracking student progress and performance (Chang, 2019; Greenberg, 2013). Data about how frequently students log in and what they click on, when they study, how long they study and how well they learn are collected in the background while students interact with the online resources on these applications. The term 'e-learning platforms' is generally used in this article to refer to any of the afore-mentioned applications and systems.

Numerous research studies aimed at finding if and how the data around student use of e-learning platforms can be utilised to predict success and/or risk of failure were found, and will be reported in the section Findings from Research Communities.

In some studies, LAK and/or EDM researchers focus on the data generated by e-learning platforms only. Other studies combine the e-learning platform data with those gathered using other instruments, including written examination and/or test results, personality-, self-efficacy-, learning-style surveys, and questionnaires (Kotsiantis et al., 2013; Zha & Adams, 2015; Rienties et al., 2016; Jo et al., 2016; Monteiro & Leite, 2016).

Siemens and Baker (2012, pp. 1–2) describe LAK as an approach using "measurement, collection, analysis and reporting of data about learners and their context for purposes of understanding and optimising learning and the environments in which it occurs." The EDM research community looks for patterns in large educational data collections that are too voluminous to be analysed without computerised methods (Romero & Ventura, as cited in Papamitsiou & Economides, 2014).

These two research communities are complementary: LAK uses a holistic framework, whereas EDM adopts a "reductionist viewpoint by analyzing individual components, seeking for new patterns in data and modifying respective algorithms" (Siemens & Baker, 2012; Papamitsiou & Economides, 2014, p. 50).

The findings of both research communities can help teachers/designers to optimise, customise and diversify online learning environments. Teachers can gain a better understanding of the optimal pedagogical processes. Their understanding can be fed back to students and help to formulate recommendations for good practice in online studies.

PEDAGOGICAL THEORY: TEACHING AND LEARNING PRINCIPLES THAT CHARACTERISE QUALITY INSTRUCTION

The features of quality instruction as described by Anderson's Equivalency Theorem, CLT and Chickering and Gamson's Seven Principles for Good Practice in Undergraduate Education are described below.

Equivalency Theorem

Designers/teachers create learning environments where students interact with content, other students, and their teachers. A successful learning environment promotes a mix of these different interactions (Monteiro & Leite, 2016).

Anderson's (2003) Equivalency Theorem states that at least one of these interactions has to take place at a high level to ensure deep and meaningful learning. In a tutorial delivery mode with small classes, high levels of learning are achieved "through high levels of student–student and student–teacher interaction" (p. 4). In a lecture mode of delivery, both student–teacher and student–content interactions are at a medium level, with low levels of student–student interaction: a less than satisfactory situation. To improve the mix, an online high-level student–content interaction component (as possible in a blended environment) could be added.

Per definition, all interactions within a fully online course have to be addressed through online interactions (Kurt, 2018). Khan et al. (2017) state that the course features that would encourage online student–content interactions for undergraduates may be similar to those that actively engage students with the content in face-to-face courses, making the application of classic pedagogical theories in online environments valid. In their opinion, the big difference in pedagogy (between e-learning and face-to-face environments) lies in the methods that are used to encourage student–student and student–teacher communication and interaction.

Cognitive load theory

The aim of instructional design (Paas et al., 2003; Yen et al., 2015) is to keep the cognitive load of the resources within the student's Zone of Proximal Development (ZPD). The ZPD is defined as the zone "between the actual developmental level as determined by independent problem solving and the potential development as determined by problem solving under adult guidance or in collaboration with more capable peers" (Vygotsky, 1978, p 86). Keeping the resource demands within the ZPD (Figure 1) enables students to succeed through their own learning efforts. Little learning takes place if the cognitive load is too low (without some challenge) or too high and consequently overwhelming the student.

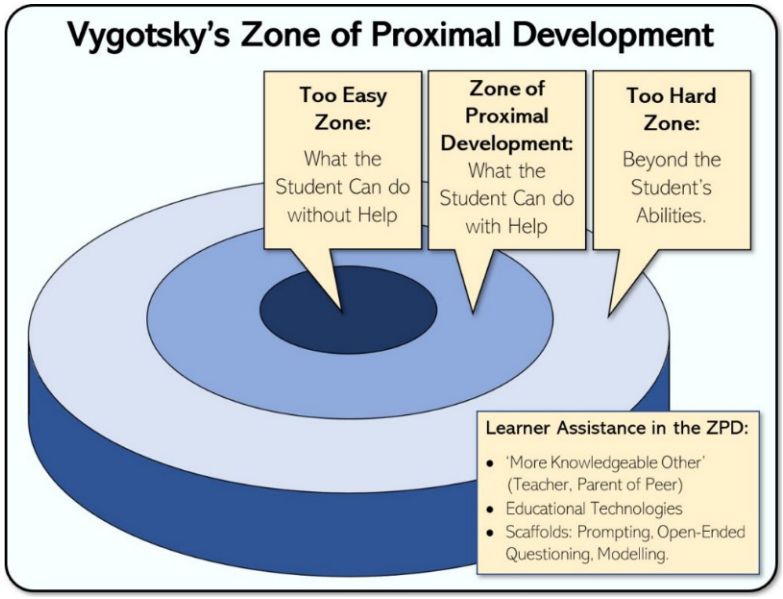

Figure 1. Vygotsky's Zone of Proximal Development (ZPD) (Drew, 2022).

Cognitive Load Theory identifies three types of cognitive load:

- Intrinsic cognitive load (ICL): a function of the inherent nature of the learning material and learners' prior knowledge. It can be assessed by content experts based on element interactivity, element complexity, the number of elements, the type of the content (procedures, concepts, facts, processes or principles), and the nature of the content (technical, theoretical, or practical).
- Extraneous cognitive load (ECL): determined by instructional design and the activities required of students.
- Germane cognitive load (GCL): the effort involved in relating prior knowledge to current instructional content to construct schemas stored in the long-term memory.

For the learning process to succeed, the global cognitive load (the sum of the three types [ICL + ECL + GCL]) should not exceed the student's cognitive resources (Yen et al., 2015; Pociask et al., 2013). As CLT provides a framework for analysing and evaluating learning and teaching resources (including online), it is a valuable tool for teachers/designers to optimise the learner experience and learning.

Principles of Good Practice

Chickering and Gamson's (1987) Seven Principles for Good Practice in Undergraduate Education is a summary of decades of research (Johnson, 2014). These principles form the basis of later guidelines, such as those from Ewell and Jones (1996), Macfadyen and Dawson (2012), Johnson (2014), Kontos (2015), and Crews and Wilkinson (2015). They link directly or indirectly with Anderson's (2003) Equivalency Theorem and CLT, as will be shown.

Quality instruction encourages active learning: it encourages learners to do things and think about what they are doing (Chickering & Gamson, 1999; Riley & Ward, 2017). Active learning represents high levels of student–content, student–student and student–teacher interaction (Anderson, 2003). It implies that students are engaged, motivated, participating (Salmon, 2013), self-directed, independent, taking responsibility for their learning with self-competence, have proficient reading and writing skills, time-management skills, and are inspired to learn (Kerr et al., 2006). Allen and Tanner (as cited in Khan et al., 2017) define active learning as "seeking new information, organizing it in a way that is meaningful, and having the chance to explain to others" (p. 108). Contrary to this, passive-recipient learning (such as simply listening to a lecture, representing low-level interaction), disregards the fact that students learn best when they get opportunities to use their skills. Assessments that require active demonstration of synthesis and application can play a role in promoting active learning (Ewell & Jones, 1996). Walsh et al. (2011) reiterate the aforementioned when describing an engaging pedagogical environment as one where learners "reflect on their own learning and become self-regulated and self-directed" (p. 3). Furthermore, Kintu et al. (2017) explain that self-regulation in learners, and intrinsic motivation that leads to persistence, are linked to knowledge construction.

In quality learning, the content is presented on suitable levels. This principle links directly with CLT and is under the control of the teacher/designer. To engage students and enable them to succeed through their efforts, Khan et al. (2017, p. 114), Kizilcec et al. (2013), and McLoughlin and Lee (2008) propose that course content must be simplified, follow micro-steps, and include cognitive tools (scaffolds) such as rubrics, carefully detailed guidelines, and examples to keep the cognitive load within the ZPD of the students by communicating clear expectations for student work. The content should augment thinking and cognition, and may include a wide variety of learner-generated resources accruing from students creating, sharing and revising ideas. Since student interests and levels of readiness differ, multiple means of instruction, engagement and assessment are needed for maximum engagement and learning. Audio, video, student group and individual work, reflections, demonstrations, presentations, diagrams, etc., should be included to make learning accessible for all students.

Good practice is also characterised by prompt and frequent feedback (Chickering & Gamson, 1999; Ewell & Jones, 1996) to students on their performance. Early assessment can provide teachers with indicators of students' readiness, and steps for remediation can be taken early. A quick turnaround of assessments is essential in

this regard. In an online environment, much of the teaching consists of providing meaningful, constructive, individualised and actionable input and feedback on student work (Poll et al., 2014). An important consideration for going online is the speedy automatic feedback that students can get, especially with objective-type questions (such as teaching basic facts and scenario-based questions). Feedback has the ability to help students learn from their mistakes, guide them to be independent, take responsibility for their learning and become self-directed. This improves the quality of instruction through promotion of student–content and teacher–student interactions (Anderson, 2003) and provides support to bring the task's cognitive load within the students' ZPD. E-learning platforms provide students with powerful tools for self-study in their own time and in their own way. Newer developments include customised feedback models that automatically recommend the most relevant, suitable and personalised remedial sections in textbooks, in response to knowledge deficiencies exposed by online assessment outcomes (Thaker et al., 2020). These tools open up the scope of how further and deeper independent learning could be promoted by online platforms.

Quality instruction encourages student–student co-operation (Ewell & Jones, 1996; Chickering & Gamson, 1999). It provides opportunities for teamwork, which provides multiple feedback opportunities and increases involvement while modelling the world of work, where teamwork is often the norm. Kintu et al. (2017) found that face-to-face support is a predictor of learner satisfaction, and that social support among the learners predicts knowledge construction. An environment with a high degree of interactivity among learners (Anderson's [2003] student–student interaction), collaborative learning and interactive content is further ideal to engage disengaged students (Walsh et al., 2011). The ideal learning environment promotes different interactions between people, such as co-participation, communication and sharing (Monteiro & Leite, 2016). McLoughlin and Lee (2008) emphasise that students should be offered multiple opportunities for open, social, peer-to-peer and multi-faceted forms of communication with a network of peers and communities that then serve as their support. In an online environment, deliberately building a community through asynchronous and synchronous collaboration tools (forums, blogs, wikis, online discussions, student-led discussions, and small-group activities that could be followed up by large-group activities) is recommended to give students a sense of belonging, and for the exchange of ideas and information (Poll et al., 2014). Video-conferencing tools also make provision for group interaction in break-out rooms. Khan et al. (2017) state that engaging students in an online environment may be a challenge even for experienced online instructors. They advise against relying on physical, face-to-face interactions alone for student interaction in blended courses. Social aspects should be explicitly built into the online parts to increase engagement and motivation, deepen learning, make learning coherent and encourage students to interact with the online content.

Adequate time on task needs to be planned and communicated. Learning involves interacting with content and others, and these interactions need time. Research confirms that efficient learning requires a considerable investment in time, and being prepared to invest that time is important. Communication about expectations of how time should be utilised in a course can influence the learning quality significantly (Ewell & Jones, 1996). For example, the time expected to be spent after school hours (self-directed study) is usually part of the required study time in blended courses.

Out-of-class contact with teachers is important in engaging students (Ewell & Jones, 1996; Chickering & Gamson, 1999; McLoughlin & Lee, 2008; Walsh et al., 2011) and should be facilitated. Researchers agree on encouraging student–teacher contact (Equivalency Theorem's student–teacher interaction): Ewell and Jones (1996) explain that "contact between faculty and students is strongly associated with both program completion and effective learning" (p. 22). Students see teachers that they engage with as role models. This contact encourages them to think about their values and plans. To facilitate contact between students and teachers in an online course, Poll et al. (2014) stipulate that course information "should include instructor contact information and availability, course communication instructions and guidelines (like instructor email or message guidelines), and set appropriate standards for instructor responsiveness and availability (like response time, assignment feedback)" (p. 61).

The three pedagogical theories were used to create one simple framework (Figure 2) in which all the overlapping features are combined. Equivalency Theorem, CLT and the Seven Principles for Good Practice are described in

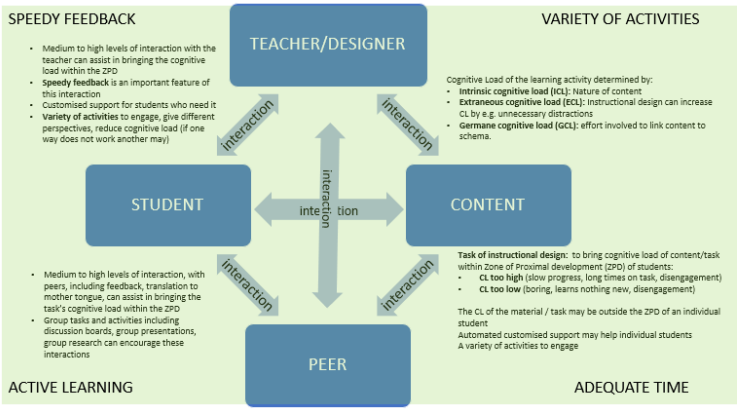

Figure 2. A framework based on Anderson's (2003) Equivalency Theorem combined with CLT (Paas et al., 2003) and the Seven Principles for Good Practice in Undergraduate Education (Chickering & Gamson, 1999).

terms of Anderson's three types of interactions (student–student, student–teacher and student–content). The three interactions are included in the Seven Principles for Good Practice – the remaining principles are characteristics that these three interactions should meet: the criteria of adequate time, active involvement, using a variety of activities to actively engage and support, and speedy feedback (Chickering & Gamson, 1999).

Cognitive Load Theory relates to all of these, since keeping the content within the student's zone of proximal development is fundamental in making the interactions successful and active learning possible. It provides the reason for adequate time, a variety of activities and timely feedback.

Looking at interactions includes looking at student–student, student–teacher/designer and student–content interactions, measurement of and platforms for interactions, and encouragement of interactions and co-operation.

Active learning includes encouraging active use of resources such as recorded lectures, a variety of types of tasks (multiple means of instruction) and suitable levels of the activities to keep the cognitive load within the ZPD. (There is the possibility that online activity types may be seen as active learning when they are not, and that the level of student–content interactions [Equivalency Theorem] or poorly designed online environments may increase the cognitive load without increasing active-learning opportunities).

Feedback includes the timing, frequency and the nature of the feedback.

Adequate time includes the communication of time demands, the consideration of timing, types of tasks, the cognitive load of the tasks and the avoidance of distracting time-consuming features.

METHOD

This study aims to identify from the literature the online behaviours and interactions that can serve as indicators of success or risk of failing, and then to evaluate these indicators using generally accepted pedagogical principles of quality instruction (as discussed above).

Relevant articles were found through online searches on Databases (including Ebscohost, ERIC, Psychinfo, IEEE Xplore, www.irrodl.org, ejournals.bc.edu, doaj.org, Google Scholar, Jstor and Researchgate), and using keywords on their own and in combination. The keywords related to learning analytics (LA), learning analytics and knowledge (LAK), educational data mining (EDM), interactions, forecasting, e-learning, online behaviour, navigational pattern, risk prediction, good teaching practice, quality instruction.

Systematic literature studies served as examples of appropriate research methodology, and sources of relevant literature in the LAK and EDM fields and relationships between online behaviour and study success. These systematic studies include:

- Sergis and Sampson (in Peña-Ayala, 2017), who tabulated and cited 54 studies published between 2005 and 2016 in the emerging research field of teaching and learning analytics (TLA), and looked at aims and statistical methods used.
- Avella et al. (2016), who describe the concept of LA, its data sources, its aims, its techniques and uses.
- Papamitsiou and Economides (2014), who compared studies on the use of LA and EDM from 2008 to 2014. They found that these studies aimed at student–student behaviour modelling, prediction of performance, increasing self-reflection and self-awareness, prediction of dropout and retention, improving feedback and assessment services, and recommendation of resources.

Classic works on pedagogics between 1978 and 2020 were included. Learning analytics, EDM and e-learning research reported in the years between 2010 and 2020 were used. Zotero was used to collect and cite suitable articles and to compile the reference list.

The studies' main ideas were paraphrased, they were sorted into tables, and categorised under headings as they emerged. For example, the found articles reported a number of significant positive/negative or no relationships (used as the largest category for classification). Small categories such as 'total study time', 'timing of access' and 'time on task' emerged under positive/negative relationships, and were then combined to form larger categories such as time factors. No judgements were made. Research findings are reported as they were found, and are listed in the following section.

FINDINGS FROM RESEARCH COMMUNITIES

A wide variety of studies on this topic were found. They range from systematic overviews to investigations of the effects of single behavioural aspects. Some researchers, such as Conijn et al. (2017), found there is not much value in using LMS data for the purpose of early intervention. Strang (2016, p. 280) found "very little correlation between student online practices" and the academic outcomes, which he explains as being due to the small sample of students used in his study and the nature of the course. Other researchers found positive and also negative correlations between online interaction and behavioural factors and student success. These factors are listed and briefly described below.

Online environment/interaction/behavioural factors linked to success or failure

Student activity

High and specific activity. Kotsiantis et al. (2013) found that high student activity (total number of actions) and viewing specific sections (access to the forum, user view, assignment view, and glossary view) were associated with excellent grades. Lack of interest in viewing assignments was associated with fail grades. Bainbridge et al. (2018) found that the "relative number of forum posts and amount of content read" (p. 256) are factors linked to success. Macfadyen and Dawson (2012) found a significant correlation between student learning outcomes (final grade) and the use of engagement tools (discussions, mail, use of LMS-based course content materials, and visits to the My Grades tool).

Total number of logins/total hits/clicking. Bainbridge et al. (2018) found that students that "show high relative levels of reading forums and opening online sessions multiple times" (p. 256) have a greater likelihood of performing poorly. The number of total login/total hits, therefore did not predict success (Firat, 2016). Rienties et al. (2016) found a weak positive relationship between clicking and academic performance, explaining around 10% of the variation.

Time investment and management

Time on task. Successful students invest sufficient amounts of time on tasks and actively participate in the learning process (Jo et al., 2016). Also, Keskin et al. 2016) and Firat (2016) found that more time spent on the LMS is linked to success. Kovanovic et al. (2015) linked time on task (seen as an estimate of the amount of effort a student puts in) as a predictor of success.

Timing of access. Baker et al. (2015) found that early and continuous accessing of resources throughout the early weeks of the course are linked to success. As expected, not engaging indicates risk. Cluster analysis of all available data showed high academic performance was positively associated with early submission of intra-semester assessment tasks. Agnihotri et al. (2020), Levy and Ramim (2012), and Colthorpe et al. (2015) all report a strong correlation between procrastination and poorer chances of success. However, Hunt-Isaak et al. (2020) found recent participation to be a more relevant predictor of ultimate success than past participation.

Regularity of study. The regularity of learning has a significant effect on learners' performance (Jo et al., 2016). Logging "into the LMS more steadily from the beginning of a class to the end" correlates with better performance (Jo et al., 2015). They explain that this "involves neither temporal access at a certain point nor merely one long time visit, but rather conscious learning with awareness over a relatively long term" p. 222).

Navigational patterns

Keskin et al. (2016) used interaction themes such as homepage, content and discussion. They found no difference in the navigational patterns followed by successful and unsuccessful students, but they found that successful students spent more time on each login.

Interacting with staff and other students

Live interactive environments versus lecture recordings. Colthorpe et al. (2015) found a negative correlation between performance and using lecture recording review as a learning strategy. Li et al. (2020) conclude that live interactive environments with teachers teaching the materials and prompting and questioning students are associated with a far lower drop-out rate than environments using solely recordings.

Student–student interaction in forums and discussions. Kotsiantis et al. (2013) and Bainbridge et al. (2018) found participation in forums was linked to success. Macfadyen and Dawson, (2012) describe a correlation between participation in discussions (student–student interaction) and achievement of learning outcomes.

Student–teacher email interaction. Macfadyen and Dawson (2012) observe a positive correlation between email (student–teacher interaction) and students achieving the learning outcomes.

Assessment results and feedback

Success in formative or previous assessments. According to Baker et al. (2015), good performance in formative activities is linked to success in the course. Rienties et al. (2016) report a positive link between final results and performance during continuous assessments. Romero et al., Romero-Zaldivar et al. and Shih et al. (cited in Papamitsiou & Economides, 2014) identify the number of quizzes passed as an important predictor of success.

Responsive feedback on assessments. Automated relevant, suitable, and personalised recommended remedial sections in textbooks in response to knowledge deficiencies as exposed by online assessment outcomes are linked to positive outcomes (Thaker et al., 2020).

Studies about online behaviours resulting from 'other factors'

'Other factors' describe studies where data, obtained through LMSs, are combined with data obtained by instruments that are not part of the e-learning platforms (surveys, previous assessment results, questionnaires and psychological instruments, or administrative data).

Access and attitude related to learning technologies. Ellis et al. (2013) and Monteiro and Leite (2016) found significant relationships between academic achievement, positive attitudes to learning technologies and valuing ongoing formative assessment. They explain that to benefit from e-learning, students should view the online resources as essential and valuable. A low access frequency and the perception of the LMS system as difficult to use are related to low performance (Kotsiantis et al., 2013), so fail grades can be predicted by the lack of a computer at home and low self-efficacy. Zha and Adams (2015) conclude that a student's perceived proficiency in using the LMS significantly affected their interaction with the content.

Student background and psychological factors. In the German context, research by Berens et al. (2019) found that administrative data (biographical data) strongly predict student success or failure. The use of student background data in predicting at-risk students in the American context is evident in the work of Pelaez et al. (2019). These findings imply (although not stated), that the student's background may determine their online behaviour leading to success or failure. This is a strong possibility in the light of the findings of the role of psychological factors. Jo et al. (2016) attribute online behavioural patterns to underlying psychological factors. Self-regulatory ability and time-management strategies drive regular login activity, which results in high performance. They used SEM modelling to analyse their data, and confidently conclude that a student's self-regulation abilities could be deduced from their online log variables alone without using any other instruments.

Rienties et al. (2016) found that learners' activities during continuous assessments (behaviour) and "learning motivations and emotions" (attitudes) (p. 2) explain up to 50% of the variance in performance. Bainbridge et al. (2018) identified that the biggest predictors of risk include a low "previous cumulative GPA and partial grades in the course" (p. 257).

RESULTS

The findings from the LAK (LA) and EDM research communities as given above will be discussed here in the light of the characteristics of quality instruction, as described by the chosen three pedagogical theories. The characteristics of the three theories are combined to focus on interactions and co-operation, active learning, feedback and adequate time, as explained at the end of the background section.

Interaction and co-operation among students, between students and teachers/designers, and students and content are key features of all quality instruction whether face to face or online (Anderson, 2003; Chickering & Gamson, 1999; Ewell & Jones, 1996). E-learning platforms offer a variety of interaction and co-operation tools. These involve the use of online forums, blogs, wikis, synchronous or asynchronous online discussions, student-led discussions and small-group activities, which could be followed up by large-group activities.

Both students and staff (teachers) are active on e-learning platforms: teacher–student interactions occur mostly through announcements, online discussions, emails and online conferences. There are ways in which researchers can analyse social interactions in online discussion forums and on social media, using qualitative methods and interaction analysis combined with learning analytics (Gunawardena et al., 2016). Hernández-García et al. (2016), using Gelphi as a social-network learning-analytics tool, analysed data generated by the messages sent and received in an e-learning platform. They report that this type of analysis can help instructors to identify lurkers, who are following the course without actively participating in it, and students who are active readers but are not performing well. It can further provide insight on which users are contributing the most valuable and interesting content.

Interaction between the teachers/designers and the users of e-learning platform resources through the use of interviews, surveys and feedback is described by Ain et al. (2016) and Berridge et al. (2012). This allows the designers to find out what the user wants in the website, update the interface, and perform iterations and validations. In this way, the user's mental model and designer perception are optimally aligned.

But student–teacher and student–student interactions can also happen outside these platforms on social media, chat rooms and in communities. Platforms designed for social interactions like Facebook, Adobe Connect, Sococo, Skype, Google Hangouts, Zoom, Microsoft Teams, Google team drives, etc., could be used for communicating with students. Data about these interactions would therefore not be captured by the e-learning platforms.

The term 'active learning' describes the type of learning where there is a search for new information, that information is organised in meaningful ways and explained to others *(*Allen & Tanner, cited in Khan et al., 2017). Walsh et al. (2011, p. 3) define the aim of active learning as allowing students an opportunity to "reflect on their own learning and become self-regulated and self-directed." Active learning can therefore be related to students being successful in a course by managing to learn from the formative or previous assessments, as reported by Romero-Zaldivar et al. (cited in Papamitsiou & Economides, 2014), Baker et al. (2015) and Rienties et al. (2016).

Colthorpe et al. (2015) found a negative correlation between performance, the use of reviewing of lecture recordings as a learning strategy, and accessing the online lecture recordings. This confirms that listening to a lecture (Anderson, 2003), whether it is online or face to face, is still passive learning. In a face-to-face lecture the teacher will ask questions, leading to medium levels of student–teacher and student–content interaction with low levels of student–student interaction. In a recorded lecture the student–teacher interactions also become low unless other engagement tools, such as worksheets, quizzes, or discussions, are used. This may also explain the finding of Bainbridge et al. (2018), Firat (2016) and Strang (2016), that the number of total logins/total hits/opening sessions was either inversely related to success or not at all related. Passively listening to a lecture or clicking casually through a module could demonstrate what Ellis et al. (2017) describe as "fragmented conception of learning" leading to a surface learning, as opposed to "cohesive and integrated conceptions of learning" (p. 159) leading to deep approaches to learning.

The findings above contradict the results of Jo et al. (2016), who found the frequency of logins to be a predictor of success. One may assume that logins/total hits, although easily measurable, are complex and multidimensional, as they have different aims, such as logging in to study actively, to skim read, or to passively stare at resources. If logins/total hits mean students are logging in in quick succession to different areas/courses, or for short periods at a time, this would reflect that students are just opening links without meaningful interaction; seeing a lot and staying busy, but without absorbing much or linking it to their prior knowledge to construct schema. Even though the student seems to be active, this behavioural pattern does not represent active learning – an essential feature in quality courses (Chickering & Gamson, 1999; Ewell & Jones, 1996) – nor does it represent a high level of student–content interaction (Anderson, 2003). Since there is practically no engagement, the cognitive load is irrelevant, or may be perceived to be too high or too low (Paas et al., 2003).

Another possible deduction of the negative correlation between the number of logins/total hits/opening sessions and results (Bainbridge et al., 2018; Firat, 2016, p. 85) is that poor instructional design may unintentionally increase the extraneous cognitive load (ECL) (Yen et al., 2015; Pociask et al., 2013). The design of some course pages may encourage clicking by perhaps including distracting elements such as "irrelevant images, illogical learning paths or outbound links that lead the user away from the course" (Hetsevich, 2009, p. 3). These features may shorten the time on task and may inhibit students' prospects of high levels of interaction, success and deep learning. Some students may be more prone to distraction than others. Niemi (2018, p. 82) states that detailed data about "students clicking through irrelevant content or inappropriate activities" may be worthless in explaining the optimum ways of online interaction. Ideal interactions to track would be those with "research-tested, learning- and motivation-focused content and activities."

Meaningful, constructive, individualised and actionable feedback and input help students to learn in a timely way from their mistakes in procedures, thinking and understanding (Poll & Weller, 2014). The link between success in

formative or previous assessments (Baker et al., 2015; Bainbridge et al., 2018; Shih et al., cited in Papamitsiou & Economides, 2014) may be related to the feedback that they receive immediately and frequently from the system. The positive effect of appropriate, relevant feedback is emphasised by the work of Thaker et al. (2020) on responsive online feedback using the TextRec + DynRemRec student model to refer students to textbook sections to correct the specific deficiencies exposed in the assessment.

But feedback can go much further and achieve much more than simply giving information on how assessments have gone. Feedback on their learning processes can make students more aware of how they can improve their interactions and their learning techniques. Enhancing student feedback by using results from LAK and EDM is a strategy already being used by some institutions. At the Open University in the UK, data obtained from e-learning platforms form part of an integrated plan for student support; for example, Analytics4Action (Rienties et al., 2016). Bainbridge et al. (2018) discuss a model (with an 80% success rate in predicting at-risk students) for tracking and feeding back to students to alter their behaviour, and mention other models, such as the Marist College OAAI project and the Purdue University Course Signals (explained by Baker et al., 2015), that have a predictive value between 44% and 80% depending on the variables.

Adequate time is a requirement in quality instruction, and correlates with the research findings that successful students spend more time online (Bainbridge et al., 2018; Kovanovic et al., 2015; Firat 2016; Jo et al., 2016; Keskin et al., 2016; Kotsiantis et al., 2013). Three factors are involved: total login time, login frequency and login regularity. Learners are more successful if they show high ability to prioritise tasks, are aware of their tasks, check their tasks regularly, and spend their time evenly rather than procrastinate and cram (Jo et al., 2016).

All activities do not give an equal return on the time spent on them. Park (2017) reports that for the same time spent on the task, design/development-based learning activities may involve deeper learning than discussion-based learning activities. This highlights the importance of setting up e-learning course pages for supporting success without increasing the cognitive load through unnecessary and time-consuming features.

The timing of access seems to be a factor in predicting success: early access and getting a head start in the early weeks of a course is linked to success (Baker et al., 2015; Levy & Ramim, 2012), as is the early submission of assignments (Colthorpe et al., 2015). This supports the advice of Poll et al. (2014) that students must be given time to prepare for the course by posting the syllabus and making the course available – as well as communicating the dates and times of synchronous activities in advance – at least a week before it is due to begin to enable students to plan time for adequate interaction.

Content with a high cognitive load will take a longer time to process. Therefore, very long browsing times may be warning signs that the material's cognitive load exceeds the students' cognitive resources (such as the working memory with its limited capacity), that students may have less prior knowledge than anticipated, that students lack the cognitive skills to construct schemas of storage in their long- term memories for retention, or that the instructional design unnecessarily introduces extraneous cognitive load that hinders instead of promotes learning processes (Yen et al., 2015; Pociask et al., 2013).

POTENTIAL CURRENT AND FUTURE USES OF THE RESULTS OF LAK AND EDM FOR ACADEMICS

Exciting research themes using the results from LAK and EDM include:

- Prediction models tracking and feeding back to students to optimise their interactions and behaviour (Bainbridge et al., 2018; Rienties et al., 2016).
- Creating students' awareness of the learning methods that they use and in doing so contribute to metacognition and self-directed learning (Marzouk et al., 2016).
- Adaptive and responsive models intervening in a timely way to adjust the cognitive level and channel students towards work that has a higher or lower cognitive level, or enabling tools (Yen et al., 2015).

- Appropriate and relevant feedback given in response to answers in assessments (Thaker et al., 2020). (Some researchers, such as Friesen [2013], however, see this automation of learning as a threat to self-monitoring and self-regulation by the learner.)
- Enhanced and personalised learning interventions that can be constructed based on students' behaviours if more accurate prediction models are available. According to Jo et al. (2016), individual learners' psychological factors such as self-efficacy can be explored based solely on their login patterns (including login frequency, login time, and regularity of login interval) without the use of any other external instruments.
- Experience sampling method (ESM) to supplement web log analysis (WLA) can be used to collect data on learners' emotion and cognitive involvement in different learning tasks (Park, in Hokanson et al., 2015).
- Combining educational data mining (EDM) with multimodal learning analytics, which gather and analyse multiple sources of data (video, logs, text, artefacts, audio, gestures, biosensors) to examine learning (Blikstein & Worsley, 2016).
- Combining EDM with social-network learning-analytics tools to model interactions on forums, discussions and social media (Gunawardena et al., 2016).
- Graphical user interfaces (GUI) (such as SLAM-KIT) simplify researchers' journeys through complex learning environments by revealing basic features and visualising their statistical characteristics (Noroozi et al., 2019).

Potential future research

For teachers/designers, the application of CLT specifically in the design and development of online activities offers an exciting field of research. Open-ended questionnaires, interviews and focus groups could be used to gain an understanding of how certain resource design features can enhance or inhibit student experience. Measurable attributes that hinder or promote learning speed and depth can be analysed with the available learning analytics. The model in Figure 2 can serve as a framework to analyse and evaluate online resources as well as serve as a checklist when designing resources.

CONCLUSION

There are some contradictory findings in the researched literature regarding online behaviour and interactions that can serve as indicators of success or risk of failing. While some researchers report no behavioural patterns linked to success in courses, others found evidence that students' success or failure depends on whether students interact long enough with the content, perform well in formative activities and interact in a manner that fosters deep learning. Others found a combination of factors (such as time spent interacting with the course materials and regularity of login intervals combined with the number of logins) gave a better prediction of success.

It can be concluded that information compiled using LAK and EDM has the potential for teachers to track their students' progress, and for course designers to improve their designs. It seems useful to identify and act on alarming patterns of behaviour (such as inactivity, irregularity of logins, continuously logging in, late logins, and poor results in formative assessments). These research fields offer possibilities to enable teachers and designers to customise materials for specific student needs, build scaffolds where certain behaviours are observed, and, combined with additional instruments, determine the attitudes and biases of students to address issues that may inhibit progress. These tools can be utilised to give feedback to students about their learning processes and time management, and to teachers/designers to optimise the interface.

An important aspect touched on in this study is how certain page features could distract or focus students' attention, and lead to superficial or deep learning: this is something that the designer can control. Studying login and click behaviour (frequency, intervals between, duration, time on task and clicking sequences) could help designers to better understand the strengths and weaknesses of different page layouts and compositions.

Pedagogical theory could provide useful backgrounds for analyses of data from LAK and EDM. It can contribute to understanding how to apply the insights gained from these analyses and make them useful in optimising courses and interfaces. Anderson's Equivalency Theorem urges the course designer to aim for an optimal mix of interactions in the online environment with at least high levels of student–content interaction. The generally accepted pedagogical principles of quality instruction can all be achieved in an online environment. Cognitive load theory warns that students spending long periods on tasks without success and/or tackling further tasks, can serve as warning signs of a mismatch between the readiness of students for the demands of the task, insufficient support or distracting features of the online environment. Application of other principles, such as collaboration and the use of cognitive tools, can help to draw students into deeper engagement with the course. Ultimately, the test for the contribution of LAK and EDM research is in the prospective long-term impact that they may have on student pedagogical practice (Gašević et al., 2015).

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RECONCEPTUALISING THE ASSESSMENT PRACTICES WITHIN EARLY CHILDHOOD FIELD PLACEMENTS: USING COLLABORATIVE REFLECTIVE CONVERSATIONS TO MENTOR STUDENT TEACHERS ON PRACTICUM

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https://doi.org/10.34074/proc.2206004

Teaching and Learning

This publication may be cited as:

Perry, J., and Probine, S. (2022). Reconceptualising the Assessment Practices Within Early Childhood Field Placements: Using Collaborative Reflective Conversations to Mentor Student Teachers on Practicum. In E. Papoutsaki and M. Shannon (Eds.), *Proceedings: Rangahau Horonuku Hou – New Research Landscapes, Unitec/MIT Research Symposium 2021, December 6 and 7* (pp. 39–51). Auckland: ePress, Unitec, Te Pūkenga. https://doi.org/10.34074/proc.2206004

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ABSTRACT

The practicum components in early childhood field-based programmes form a core part of achieving praxis, or the balance between theory and practice, which is interwoven with values, beliefs and experiences that form a teacher identity. The practicum assessment involves achieving competency against a set of discipline-based criteria during a period of observation by an external, registered teacher. This paper reports on responses to the national Covid-19 lockdown restrictions, under which the requirements of the traditional practicum could not be met and an alternative version of the assessment had to be developed. The methodology for this project was constructivist grounded theory coupled with a socio-constructivist ethos. The method of data collection was an anonymous survey of students, lecturers and centre-based teachers. The findings indicate an unexpected growth in student empowerment in discussing their own practice.

KEYWORDS

Early childhood education, practicum assessment, collaborative reflective conversation

INTRODUCTION

Learning to teach involves the development of both practical and theoretical skills. Thus, a crucial aspect of initial teacher-education programmes are the periods students spend working with children and teachers in the context of an operating early childhood setting. These periods are variously called teaching practice, teaching placement or practicum. Aspden and McLachlan (2017) suggest that "Practicum is generally accepted to be one of the most critical components of effective teacher education programmes" (p. 21). White et al. (2016) believe this is because practicum provides "opportunities for preservice student teachers to apply their recently acquired pedagogical knowledge to the field, and offers significant insight into the professional world into which they will eventually become a member" (p. 282).

The practicum, then, not only offers a chance to apply theoretical knowledge learned in the classroom to situations in the field but it is also an assessment of the growth and understanding inherent in the student teacher's practice. Essentially, practicum measures how well they have changed experience into knowledge that can be drawn upon in the future in similar circumstances. A key vehicle through which this happens is reflective practice, in which the student looks back at episodes in practice when they may have been challenged, when their values and beliefs at the time prevented them from responding appropriately or they were encountering something they were simply unfamiliar with. Making sense of what happened by unpacking perspectives, assumptions and beliefs empowers the student to move forward in their practice.

In 2020, the practicum placements for the initial early childhood teacher-education programmes at Manukau Institute of Technology (MIT) were called into question during the first national lockdown response to the Covid-19 pandemic. In late March, the Level 4 restrictions then in place meant that movement was severely limited and early childhood centres were closed. It was almost the end of the semester (June) when centres began to reopen to dedicated 'bubbles' of ten children and teachers. This meant that students who were part of the usual workforce at the centre could also return. However, the Visiting Lecturers (VLs), who would normally be visiting multiple centres to assess the students, were seen as at risk of spreading infection and were therefore barred from physically going

to the centres. Therefore, the issue became how to assess the students who were at the centres on practicum in a way that maintained the core elements of the process.

To maintain the practicum's important role in the programmes, the early childhood team had to rethink the structure of practicum to meet the new restrictions. The plan was to replace the single observation of a student's practice and triadic assessment visit by the VL with three 'virtual' visits. Two would be between the VL and the student, in which they would reflect together on the student's growing understanding of each of the practicum criteria. In these visits, the goals for the student to work on throughout the following week could be set. To support students with this unfamiliar situation, a reflective framework was developed for students to document their thoughts about the individual practicum criteria. In this, the student would focus on three topics: first, what they already knew about the criteria; second, examples from their own practice that illustrated how they met the criteria; and third, how their work on the particular criteria might have changed them as a teacher. The students then referred to this framework when they met with their VL each week online to engage in conversations about their practice.

For the final assessment visit, the VL, who could not visit in person, this time visited 'virtually' with the student and the Associate Teacher (AT). In this meeting, the student was charged with explaining why they thought they had met each of the criteria and the AT was asked to triangulate the evidence and add more examples if needed. This was an important shift in the three roles, as the VL and AT adopted a listening/guiding/questioning role while the student explained their thinking and laid out evidence for meeting each criterion as they led the conversation. The role of assessor of the student's practice remained with the VL and AT; however, their professional interpretation of the observation now sat alongside what the student offered as evidence from their own bank of knowledge of practice.

Once all the different practica had been completed, the researchers conducted a small-scale qualitative research project in order to examine what could be learned from this event, and to ascertain whether shifts should be made in how future practica were assessed. This paper explores how these events and the teaching team's responses informed a reconceptualised approach to practicum as part of the later redevelopment of the Bachelor of Education (Early Childhood Teaching) at Manukau Institute of Technology (MIT). This redevelopment responded to the requirements for initial teacher education providers developed by the Teaching Council of Aotearoa New Zealand (2019). It also included the development of a set of key teaching tasks, in which students are now required to demonstrate competency by the conclusion of the programme. This article begins with a review of the literature, examining definitions, challenges, purpose and differing approaches to practicum. The methodical framework and methods are then introduced before outlining the findings, which include deep learning, a shift in power dynamics and the evolution of a new role for the visiting lecturer. The paper concludes with a discussion about the implications of these findings and describes how these informed the redevelopment of the practicum component in the new iteration of the Bachelor of Education (Early Childhood Teaching) at MIT.

LITERATURE REVIEW

Practicum – Definitions and potential challenges

The assessment of practicum is competency-based, meaning that a student's practice is observed and judged by an experienced assessor against a set of pre-defined criteria. The method of assessment varies across initial teacher education programmes. However, a commonality is that students spend a number of weeks in an early childhood setting, where they contribute as a member of the teaching team and engage in regular reflective conversations with their AT. Near the conclusion of the placement, their VL observes their practice and then a conversation takes place between the VL, AT and student, known as the 'triadic.' It is at this meeting that it is decided whether the student has sufficiently demonstrated their ability to meet each of the assessment of practice criteria.

While the intent of this approach is to empower all three parties to play equal roles, an issue can arise when the interplay of the complex system of relationships and variables that can occur in each unique placement means that this is not the case. Zhang et al. (2015), for instance, challenge the method of formal observation, arguing this is a positivist approach that contradicts the sociocultural theories that underpin early childhood teaching in Aotearoa New Zealand (Ministry of Education, 2017). Further, Ortlipp (2009) and Gibbons et al. (2018) question the minimal time a VL spends observing and discussing the student's practice. In fact, in many cases a student may not have met their VL prior to their assessment of practice. In response, Gibbons et al. (2018) argue that greater flexibility is needed in how practicum is approached, to allow a professional relationship between the student and VL to develop.

McConnell (2011) asserts that inconsistencies can occur in the professional knowledge and experience of both the AT and VL. In the practicum period, it is the AT who guides the student throughout the practical and critical reflective processes, and both supports the student in this and articulates their own decisions about the student's practice. Indeed, Ortlipp (2009) argues that the AT's role is particularly important, as it is they who are working in the field and have current professional knowledge and experience. However, whatever the ability and experience of the VL and AT, it is likely they will still be viewed by the student as the holders of knowledge. This may then result in the student deliberately positioning themselves in a passive role due to the pressure to ultimately pass their assessment of practice (Gibbons et al., 2018). Aspden (2017) asserts that a contributing factor could be a lack of understanding about how students can demonstrate that they meet the criteria. She argues for alternative approaches that better "prepare and support the participants" (p. 140) and which address the subjective nature of practicum assessment. McConnell (2011) supports this view, arguing that "it is not sufficient for teachers to be embedded in a teaching community only. They must be supported in critical inquiry" (p. 69).

The importance of learning the skills to turn experience into practical knowledge

A key part of the process of developing practical knowledge must be the development of reflective skills that do more than just describe a situation from practice. At the core of reflective practice lies the ability to turn experience into pedagogical knowledge and to develop strategies to be able to draw upon in similar situations in the future (Loizou, 2011). Bullock (2012) describes this as having "an epistemology of experiential knowledge" rather than "an epistemology of propositional knowledge" (p. 145). McFarland et al. (2009) assert that there are two critical practices that students must learn to engage in if they are to develop their professional knowledge. These are reflective practice and evaluation. Reflective practice is described by O'Connor and Diggins (2002) as "a cycle that involves stopping to consider practices and the reasons for them, thinking critically about alternative perspectives and changing practices based on new understandings" (p. 16), whereas evaluation is considered "an ongoing process involving self-questioning through which educators review the value or effectiveness of a particular practice" (McFarland et al., 2009, p. 506). These skills can be intentionally taught in the classroom and can be assessed through the summative tasks attached to the practicum. Opportunities to practice these skills in the context of the classroom prior to the practicum are important, as Pretorius and Ford (2016, p. 242) argue that "intentional and facilitated discussions of reflective experiences with peers and staff often encourage students to better reflect on their own thoughts and understanding." Experiences on practicum, when coupled with summative assessment work that requires students to reflect on teaching events as well as self-evaluate their practice – for example, through goal setting – are therefore key skills that students need to develop, in order to develop their professional and practical knowledge of teaching.

The transformative nature of collaborative reflection and engagement in learning

Reflective practice is traditionally seen as a solitary process for individuals in which events are revisited for their meaning and relevance to practice (Schön, 1987). In practicum, students are charged with untangling the complex, multifaceted nature of events that take place in teaching environments. In this intricate maze, where no two situations are alike, being able to create professional knowledge through critical self-reflection on the possible meaning of each event is crucial. Coombes and Downie (2014) argue that this process allows student teachers to

"construct their own professional knowledge, to negotiate and shape the curriculum, and make links with theory" (p. 22). Ma (2013) suggests that, in this process, interaction and collaboration with others can be critical in creating "new understandings and interpretations" from experiences and encounters. Although agreeing, Barbour (2013) qualifies the importance of collaboration with others as only useful if the importance in the event is pointed out and its value for practice assessed. Finally, Foong et al. (2018) highlight the importance of context for making sense of events, drawing on the multiple perspectives and different lenses that collaboration with others can bring.

Interestingly, this use of collaborative practices to create knowledge shifts reflective practice to reside within a sociocultural paradigm, where once the individual was left alone to consider their own practice. Creating reflective practice as a web of social interaction with a range of knowledgeable others offers a much wider range of perspectives and ideas to the teacher (Clàra et al., 2019).

THE PROJECT

As with many research projects, the important impact of the changes occurring through the 'virtual' practicum was something we began to notice as it took place. Therefore, with ethical approval gained in May 2020, the researchers embarked on a project to explore as much of the new approach as possible. Using a constructivist grounded methodological approach, the researchers sent out an anonymous survey to capture the responses of the students, Visiting Lecturers and Associate Teachers in regards to this different approach. Two questions were asked:

- What are your thoughts about the practicum you have just completed?
- Did you find the reflective framework useful in your learning? How and why?

The survey was sent to 103 degree (BEd [ECT]), 53 diploma and 27 certificate students. The survey was also sent to 11 Visiting Lecturers and 80 Associate Teachers. Responses were received from 81 students (44.26%), eight Visiting Lecturers (72.72%) and 18 Associate Teachers (22.5%). Responses received were organised by thematic analysis. This type of analysis involves reading and rereading the documentation, searching for similarities that can be organised into initial themes. These could be further refined as the analysis progressed (Terry & Hayfield, 2021).

LIMITATIONS

A limitation of this study was that the importance of this event became apparent while it was occurring. This meant that perspectives of participants could not be obtained prior to the practicum, and that ethical permission to seek feedback after the event was sought relatively quickly in order to remain relevant to participants. This resulted in the survey being sent to all cohorts of students and did not ask which year of study each student was undertaking. A further limitation is that the data was only collected at the conclusion of one semester; however, this study has now informed a longitudinal study that examines the impact of the changes made to practicum as a result of this research as the new iteration of the BEd (ECT) is taught for the first time.

FINDINGS

The overall findings indicate three themes. These include: deeper learning; different power dynamics within the triadic relationship of the practicum; and the different role of the VL, who initially took on a mentorship role, before becoming an assessor. All of these findings led to the further empowerment of the student to deeply engage in creating professional knowledge through collaborative interaction with others. It was clear that the new approach in empowering the students to explain how they felt they had met the criteria for the practicum resulted in a noticeable growth in students' confidence and in their own sense of their practice, which meant they were better equipped to set new goals and ask questions of themselves in order to develop their own practice.

Deep learning

The core value of practicum is the opportunity to learn from experience in the field and from interactions with the learning community of the early childhood centre. The two meetings with the VL prior to the triadic empowered the students to unpack the examples they were considering for each of the criteria. In doing so, they were able to challenge themselves to see more of the values, beliefs, perspectives and assumptions that underpinned their responses in each situation. In this research, a number of the responses to the survey from students, VLs and ATs all commented on the depth of the learning the students had experienced:

> *It was really challenging, but I learned a lot from it, and I'm starting to build up my confidence.* (Student)

> *It was very good, as I had to really think for myself and be accountable for my learning.* (Student)

> *It was exciting to hear them talk about their professional growth, deepening understanding of their practice and growing confidence over the three weeks.* (VL)

> *I like the idea that I wasn't telling them about their practice just asking questions that provoked thinking.* (VL)

> *I think sometimes it's good to see and hear the student in action.* (AT)

Changes in the power dynamic of the triadic meeting

The assessment of practice in a practicum placement ends with a discussion between the student, AT and VL known as the triadic. In previous triadics, the VL and AT often began by telling the student how they thought the student had met the criteria of the practicum. This was a judgement based on the professional knowledge of the VL and AT and drawn from their experiences. In the new situation, the dynamic was upturned and the student explained, based on their own knowledge, how they had met the criteria. This enabled them to draw on and showcase what they knew. For example, one student wrote:

> *In previous years, we would just be told how our VL thought we met the criteria but never really had to justify our practice for ourselves. Through having to do this, I believe I gained a better understanding of the criteria and how I personally show this in my practice.* (Student)

And a VL commented:

> *I thought the students contributed more to the discussions than what I have experienced in the Centre. They really had to think about how they met the criteria … and to explain what they understood about each criterion as well. This made them think about what they had learned through the semester.* (VL)

Change in the role of the VL

By making the changes to the practicum to respond to the restrictions of the pandemic, the role of the VL focused less immediately on the assessment. Instead, the VL balanced the roles of facilitator, guide and knowledgeable other in a collaborative reflective process. This ongoing engagement over the three weeks of the practicum not only deepened the relationship between the student and VL, but also opened another source of perspectives and ideas on each critical incident of practice for the student. The regular meetings between students and VLs created a space for mentorship, not just assessment. It gave the opportunities for a relationship to form and for authentic and reflective conversations about practice to take place:

> *I enjoyed practicum this semester. I found it very helpful to have the weekly online meetings with my VL. This meant that when I got to my final triadic, I felt prepared.* (Student)

> *… it was nice to have extra guidance available towards being reflective in our practice and experiences.* (Student)

It was also great to be able to revisit and draw together threads of stories that continued to be built and revisited over the three weeks. (VL)

They had shared that they had been having catch-ups with their VL each week so that was really good too. (AT)

DISCUSSION

Deep learning and a sense of agency in the practicum process

The findings in this project clearly show that change in the roles within the practicum meant the student could showcase not only how they had met the criteria of the practicum but their growing skills and knowledge over time (Han et al., 2020). The development of this professional knowledge through allowing students to access a range of different perspectives in the three weeks of the practicum added educational value to the process for the student. Araújo and Antunes (2021) discuss "the need to consider students' power and agency, and their opportunity to make decisions when choosing the instruments to assess the progress and the exit performances of candidate teachers" (p. 270).

The mentor role for the VL meant any issues could potentially be ironed out before the triadic happened, which meant the student was more confident in talking about their teaching and had time to draw together tangible examples from their practice. Being able to do this with a level of confidence and success meant, as Johnson et al. (2017) point out, that students were experiencing growing satisfaction in developing more understanding of their practice. This was evident in the responses to the survey.

This new approach positioned the student firmly at the centre of their assessment of practice, and collaborative reflection became a key tool to support them to engage with and gather multiple perspectives to better understand each socially and culturally situated event (Kim et al., 2013). Positioning the student in a stronger role, however, required the student, the VL and the AT to reframe their own images of the desired teacher in practicum, as well as the traditional observation protocols that had been part of their previous assessment of practice experiences. In the future, this repositioning must sit alongside the view of the student's own practice and developing teacher identity, and supply an image that is personal and contextualised and not generic. These changes thus enabled a move from what Al-Malki and Weir (2014) called "a compliant student-trainee" towards someone "professionally qualified to teach and classroom ready" (p. 442).

Changes in the power dynamic of the triadic meeting and importance of collaborative reflection

Traditionally, the assessment of practice has relied on the experience and knowledge of the VL and AT in terms of how students have met the practicum criteria. In this new approach to the assessment, a guided reflective process enabled the student to take the central role and ownership of explaining how they met the criteria, rather than this being explained by the VL and AT. This collaborative process of reflection is described by Kim and Lee (2002) when they suggest that "the collaborative learning situation can provide a social context in which learners can reflect on their ideas or thoughts more effectively than in an individual reflection setting, by providing cognitive conflict or the help of capable peers and teachers" (p. 379).

This engagement in a collaborative process is an important addition to the role of the VL, and with it comes the possibility of more-established relationships and clearer understanding of questions that the student may need to reflect further on before the triadic meeting happens. The earlier exploration of aspects of their practice helps them to be better prepared for the discussion. In this situation, the student is supported through a co-constructed process of creating professional knowledge of their practice by a collaborator in the reflective process. Kim and Lee (2002) point out that this process can include "the social aspect of learner–learner interaction" (p. 375). Radovic et

al. (2021) suggest that this gives the student a broader impression of the event they are reflecting on, as this social process brings further knowledge from different settings to bear on the tensions experienced in different events.

Implications for the role of the VL and classroom lecturer

These findings suggest that there is potential for the development of more aligned co-constructive approaches to this area of field-based programmes. This project has not sought to dispense with the actual assessment competency as the focus of each practicum placement because maintaining a particular level of quality for new members of the profession is crucial. However, adapting the process to a more supportive, collaborative approach in the early stages of the practicum and empowering the student to know much more clearly about their own practice can only strengthen their ability to develop quality practices and to meet the specific criteria for each practicum. Christiansen et al. (2014) point out that "While a student may be assessed by individual teacher educators, who bring their own notions of the desired teacher to the fore, it is the formal observation protocol and its criteria which transmit the institutionalised expectations" (p. 439).

In this project, the change in the roles in the triadic saw the emergence of a much more authentic assessment (Araújo & Antunes, 2021). The student was supported to think about their own practice, what they had learned and what goals they wanted to set next. This is a critical finding, as supporting students to develop the skills to reflect on and set goals will enable them to take control of their own practice in the future, and to continue working to improve and refine aspects of their practice. Thus, they will establish themselves as work-ready, knowledgeable and confident teachers by the end of their studies. Chen and Russell (2019) focus on opportunities for students to reflect throughout their practicum placements, arguing that "It is through reflection that students construct meaning from their experiences, bridge practice and theory, and become aware of how they learn in real-life situations" (p. 60). Foong et al. (2018), however, highlight that collective reflection is a "social process influenced by context and conditions" (p. 43), and it is the multiple perspectives of such collaboration and shared sense-making that deepen the learning for the student teacher.

Changes to practicum components of the Bachelor of Education (Early Childhood Teaching) Programme

During the period in which this research took place, the early childhood team at MIT were in the process of redeveloping the Bachelor of Education (Early Childhood Teaching) programme, a project that concluded with the accreditation of the new programme in June 2021. This redevelopment was particularly important in that it responded to the Teaching Council of Aotearoa New Zealand's requirements for initial teacher education providers (2019). Of particular relevance to the practicum component of this programme was the requirement that a set of key teaching tasks (KTTs) be developed. The Council define KTTs as "clearly defined discrete tasks aligned to the standards. They are observable and measurable and describe actions that derive from the integration of knowledge, understanding and behaviour" (Teaching Council of Aotearoa New Zealand, 2019, p. 36). The KTTs developed for this programme have hence become the practice-assessment criteria for all degree practica.

The findings of this research have directly informed the new programme. These findings fall into three main areas: first, the structure of the practicum itself; second, the structure of the assessments that are part of or impacted by the practicum; third, the role of the class teacher leading up to the practicum (and also what it all means for the students).

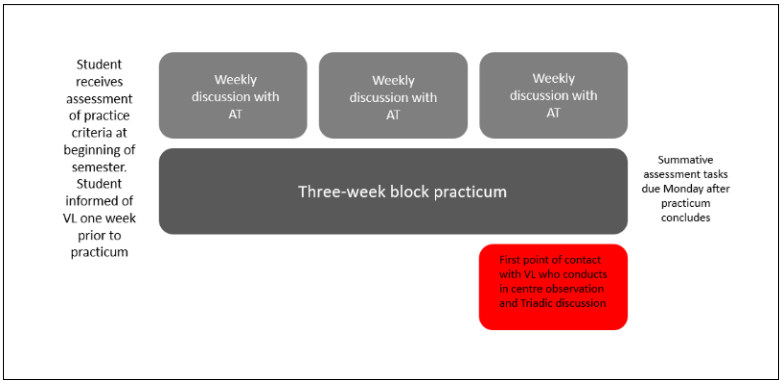

Figure 1. Previous structure of the practicum.

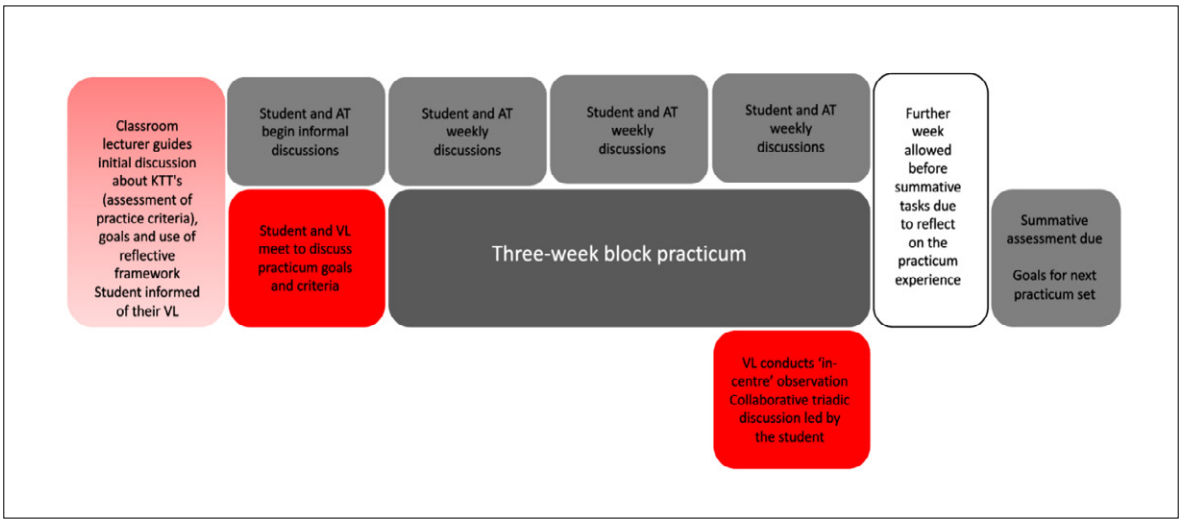

Figure 2. Reconceptualised model of practicum.

The structure of the practicum

First, as a result of the changes made because of the pandemic, the structure of practicum has changed irreversibly for the MIT students, VLs and ATs. Figure 1 outlines how practicum was previously structured. In the reconceptualised model (Figure 2), a greater emphasis is placed on collaborative reflection and relationships. The students are now very aware of their own learning and knowledge, and how that has affected their confidence and understanding of what they can do. Within the new "democratic relationships" (Dayan, 2008, p. 153) of the triadic, they are able to use their own professional knowledge to judge themselves against the criteria (Ortlipp, 2009). In this way, they are able to look at their own practice reflectively to form stronger understanding of what is now needed as well as the extent of their "socialis[ation] into emergent professional identities" (Andrew & Razoumova, 2017, p. 176).

The addition of a reflective framework (Figure 3), to support collaborative reflection and professional knowledge building, also is an important addition to this process. This deliberate framework enables the students to provide evidence of professional knowledge growth from both theory and practice, and build it into further professional knowledge through the additional focus on how they have changed as a result of what has happened. The use of collaborative reflection helps to develop a shared language rather than a dependency on a master narrative, so that learning is individualised and contextual (Bullock, 2012), reframed within the co-constructed conversation with the VL.

Professional Inquiry Six: The Professional Teacher Assessment of Practice Framework

Teaching Standard	Key Teaching Task practice criteria	*What do I know that relates to this criterion? (knowledge, theory and what quality practice looks like)*	*What are some examples (stories) that I could talk about that demonstrate that I do this in practice?*	*What have I learned about myself and my role as a teacher that relates to this criterion during this teaching practice?*
Te Tiriti o Waitangi Partnership:	Integrates into everyday practice and curriculum design opportunities to affirm Māori language, culture and knowledge			
	Uses Te Reo Māori respectfully and consistently in everyday practice			
	Role models and advocates respect of tikanga Māori in everyday practice			
Professional Learning:	When faced with a teaching situation that didn't go as well as expected, inquires and critically reflects on own practice and seeks multiple perspectives to find alternative ways of responding			
	Models professional spoken and written communication in English			
	Sets personal and professional goals, seeking opportunities to refine practice in collaboration with others in the learning community, using key early childhood documents and current research and literature			

Figure 3. A section of the assessment of practice framework for Professional Inquiry Six.

The structure of the assessments

Second, the assessments that are part of or impacted by the practicum have also evolved to better take advantage of the ongoing learning and the stronger reflective approaches. Assessments within the time of the practicum now focus more strongly on changing challenging events and dilemmas into professional knowledge, and rethinking earlier ones to build further from new knowledge recently developed.

Assessments that are impacted by the learning from the practicum placement include refocusing on the student's philosophy at the end of each practicum to add new knowledge to what has already been developed. Based on a critical review of this new knowledge, goals for both practice and the next practicum are set at the end of the last to enable the student to focus attention on further growth.

The role of the class teacher

Third, the time in the classroom before and after the practicum affords the classroom teacher time to both prepare the student by using the reflective framework to unpack examples from practice and also to slot new theoretical learning into practice events, drawing in the KTTs and the Standards and Code of the Teaching Council of Aotearoa New Zealand (2017) (See Figure 2). Placing further emphasis on unpacking the assessment of practice criteria prior to practicum also creates further opportunities for collaborative reflection and discussion, both with the classroom lecturer and amongst the student's peers.

Importantly, the VL can develop an approach to the collaborative interaction that gives the student time to process, times when silence can enable further thinking, and through questioning and role-modelling critical reflection for the student. They can introduce assumptions, help to define dilemmas and play 'devil's advocate' in the student's thinking (Clàra et al., 2019).

These changes aim to nurture deeper learning for the student. They shift away from the assessment of students' practice being judged through the lens of one person's professional experience (the VL), to an approach that

focuses on the student maintaining ownership of their practice and the VL becoming a co-constructor of knowledge rather than the more knowledgeable other, thus leading to an empowered agentic student.

CONCLUSION

When collaboration and co-construction become the key focus of the development of professional knowledge, "The teacher [supervisor] is no longer the one-who-teaches, but the one who is himself taught in dialogue with the students, which, in turn, while being taught, also teach" (Freire, 1970, p. 61). In this new approach, the VL's role of mentor and assessor, together with the classroom teacher's focus on unpacking multiple examples of practice, supports and guides the student teacher to better understand the development of professional knowledge. The process of change brought about by our response to the strictures of the pandemic has left the teaching team at MIT with the core image of the student not as completely reliant on the interpretations of practice of the VL and AT but able to articulate what they know based on their own experiences of working in the field. A second phase of this research has now begun, in which, alongside the gathering of students', ATs' and VLs' perspectives of this reconceptualised approach, the VLs will now interrogate more deeply their roles in supporting students to take a central role in the development of their professional knowledge and practice.

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INQUIRING ABOUT CULTURAL COMPONENTS OF EARLY CHILDHOOD EDUCATION

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https://doi.org/10.34074/proc.2206005

Teaching and Learning

This publication may be cited as:

Afrin, T. (2022). Inquiring About Cultural Components of Early Childhood Education. In E. Papoutsaki and M. Shannon (Eds.), *Proceedings: Rangahau Horonuku Hou – New Research Landscapes, Unitec/MIT Research Symposium 2021, December 6 and 7* (pp. 52–62). Auckland: ePress, Unitec, Te Pūkenga. https://doi.org/10.34074/proc.2206005

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ISBN 978-1-99-118340-8

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ABSTRACT

Culture and diversity are familiar yet challenging concepts for early childhood kaiako (teachers). This is a background paper to stimulate thoughts and queries around cultural components in early childhood environments. The author presents findings from a completed research that supports culturally responsive practices within the early childhood teacher education context. The completed research applies a Teaching as Inquiry model to formulate queries for the lecturers. The author then proposes a future research project within the early childhood education context to explore the components of culture. Under a sociocultural research framework, the proposed research aims to collect data from a range of early childhood settings in Tāmaki Makaurau Auckland. Convenience sampling will be used to select willing centres from the initial teacher education (ITE) providers' database. With the collected data, the proposed study is aimed at enabling participants to develop a reusable reflection model for early childhood kaiako who seek to embrace culturally relevant pedagogy. In support of the proposal, the author theoretically applies a Teaching as Inquiry model to selected questions for reflection listed in Te Whāriki, the early childhood curriculum. The discussion may extract thoughts to help kaiako to formulate focus queries, learning queries and teaching queries within the early childhood education environment.

KEYWORDS

Culture, cultural responsiveness, early childhood teacher education, reflection and reflective practice, Te Whāriki

INTRODUCTION

This paper is a proposal to study early childhood education (ECE) services in terms of understanding their own ways of valuing culture. The expected outcome is to develop a reusable reflection model with queries that are deemed important to current practice and result in changes in thoughts and in actions. The Teaching Council sets standards of practice that all registered teachers in Aotearoa New Zealand should adhere to, and Professional Learning is one of the six standards that asks teachers to have ongoing reflective queries (Ministry of Education, 2017). This resonates with the idea that teaching cannot be based on theories and research alone, as the understanding of these has to be filtered through every teacher (Hedges, 2012). One of the other standards, Learning-focused Culture, suggests that kaiako should manage the education setting in a way that ensures every learner's physical, social, emotional and cultural safety. Cultural Safety can be linked to valuing cultural identities (Durie, 2003). Another standard, Design for Learning, also suggests to value learners as rich cultural capital and therefore to provide culturally responsive learning contexts. Culturally responsive pedagogy is more than the practice of teachers that encompasses continuous growth of knowledge about the culture of the student groups within the authentic contexts. While that could be appreciated as culturally relevant pedagogy aiming for better achievements for all, culturally responsive pedagogy asks teachers to use cultural knowledge with the purpose of supporting students, but also for altering social inequality and promoting social justice through education (Lynch & Rata, 2018). Within the same document of code and standards for teachers, the council also discusses commitment to the profession, to the learners, to the families and whānau, and to society and the community. Every teacher should have a commitment to all learners that encourages respect for their diversity, heritage, language, culture and identity. Reflection on these commitments and standards can question the early childhood teachers in their day-to-day

practice, and thereby help them to develop to be more effective in implementing the curriculum. The practice of reflection may or may not lead to a culturally responsive pedagogy but will initiate a journey towards culturally relevant pedagogy.

Culturally responsive pedagogy is also discussed in relation to tuākana–tēina relationships within the context of early childhood (Rameka & Glasgow, 2017). Understanding the origin of a cultural practice such as tuakana–teina (the supportive relationship between an older and a younger person) emerging from communal child-rearing practices opens up a door to integrate cultural knowledge into teaching. Similarly, reflection can initiate from seeking the origin of cultural practices of the diverse whānau and families with whom kaiako work. The early childhood education curriculum, Te Whāriki (a Māori word, or kupu, that means the woven mat) (Ministry of Education, 2017), lists reflection as one of the 15 responsibilities of a kaiako, stating that people working in an early childhood setting should be "thoughtful and reflective about what they do, using evidence, critical inquiry and problem solving to shape their practice" (Ministry of Education, 2017, p. 48). However, with the professional growth of kaiako, reflection becomes integral in many ways to carrying out all other responsibilities. The idea of the proposed study comes from a completed research project by the author on cultural components of early childhood teacher education programmes (Afrin, 2017).

SNAPSHOTS OF THE COMPLETED RESEARCH

The completed research mentioned above had the objective of finding out the cultural components of early childhood teacher education programmes, and to see how these components impact the student teachers in their learning, and how these components impact the teaching of the lecturers. The study, therefore, was based on early childhood teacher education programmes involving initial teacher education (ITE) providers. At the time of the research (2014–17), 33 ITE providers were listed as offering qualifications leading to teacher registration (Ministry of Education, 2014; 2017). There were two factors to consider while approaching the providers with the invitation to participate. The first one was that these providers were from the Tāmaki Makaurau Auckland region. The second consideration was that these the providers were from different categories of tertiary education organisations (TEOs): private training establishments (PTEs), polytechnics, universities and wānanga. The first consideration of limiting the providers to the Tāmaki Makaurau Auckland region was in line with convenience sampling (Lavrakas, 2008). There were eight TEOs (in 2014) in Tāmaki Makaurau Auckland that offered early childhood education (ECE) programmes at the time of the study. Except for one, due to ethical considerations, all the other seven TEOs were sent a request to participate in this research. Initial communications (by email) were made to already-known contact persons or the programme leaders of ECE at different TEOs, as informed by webpage searches and phone calls. Among these seven TEOs, only three responded. The three TEOs who became the participants in this research were from only two of the categories noted above: one participating TEO was a university and the other two TEOs were polytechnics.

Under the sociocultural theoretical framework, the researcher then involved these three TEOs in a qualitative research project in which the intention was to derive rich and informed data from a smaller sample of participants (Ingleby, 2012). Twenty-eight lecturers and student teachers participated in the completed study. Interviews (Kvale & Brinkmann, 2015; Opie, 1999) and focus-group discussions (FGDs) (Krueger, 2009; Morgan, 1997) were the research tools for this study. There were no predetermined responses (Howard, 2011) for FGDs or interviews. The interviews were for 30–45 minutes duration each and FGDs were for 45–50 minutes. They took place in unused classrooms in different TEOs, as indicated by the initial contact persons of the relevant TEOs. In the data collection, both interviews and FGDs were found to be appropriate, as participants shared a wide range of data.

The researcher used the four steps of data collection, data reduction, data organisation and data interpretation, as suggested by Davidson and Tolich (2003). Data collection was conducted in face-to-face encounters where the responses were audio-recorded with participants' consent. At the data-reduction stage, some topics were found to be irrelevant to the research topic, such as reference to books or own research, knowledge content related to home-based and centre-based early childhood settings, participants' experiences of other jobs, or comparisons between TEOs. While data reduction was going on, the researcher simultaneously organised the data. Quotes that could

explain a particular theme more accurately were kept. Data interpretation was the last step, in which the researcher discovered patterns and regularities in the expected and unexpected findings. At the data interpretation step, the researcher formed arguments using similar and contrasting data under each theme.

To analyse qualitative data is quite a complex task (Edwards, 2010). Thematic coding was applied and an assortment of critical themes emerged from the repeated data (Patton, 2015). These include biculturalism, multiculturalism, professional identity, female dominance, nuance of technology, and comfort zone for individuals. Each of these themes prompts questions and debates. Participants suggested biculturalism was a well-practiced component, yet there were misconceptions that bicultural practice is only relevant to Māori children.

Multiculturalism was found to be another component specific to the context of Tāmaki Makaurau Auckland. Participants suggested that increased in-depth knowledge about diversity could broaden future employment contexts for the student teachers. Participants were proud of the fact that they were either teachers or teachers in training, and their own professional growth was often incorporated in the classroom kōrero (discussion). Some components of culture such as childcare, shopping and household responsibilities were also identified by the participants due to the dominance of women studying early childhood education. Technology was identified, too, not only as a tool for ako (teaching), but also as a way of changing classroom culture. Lastly, participants suggested creating a comfort zone for individuals where they felt safe to share stories from their own cultures. An existing model for reflection, Teaching as Inquiry (Aitken & Sinnema, 2008), was applied to the discussion under these concepts. The Teaching as Inquiry model has three types of queries that were utilised. Focus queries urge the lecturers to ask questions, such as: what is important to teach? Teaching queries create curiosity about which way to present the concept to the learners. Learning queries ask whether the teaching–learning of the chosen concept has brought any outcomes for society and the community. An example of using the model in terms of biculturalism is discussed to follow.

Biculturalism in Aotearoa New Zealand does not imply individual's own culture or identity but refers to the commitment to Te Tiriti o Waitangi (The Treaty of Waitangi) (Orange, 2013). Therefore, there is a discussion as to whether the appropriate term to use in education is Tiriti-based practice rather bicultural practice (Jenkin, 2017). However, for this paper, bicultural practice is used throughout to refer to the committed practice of kaiako to promote tikanga practices of tangata whenua. The term 'biculturalism' acknowledges Te Tiriti o Waitangi as Aotearoa New Zealand's founding document, signed in 1840 by the representatives of Māori and the Crown. Te Whāriki confirms that central to this relationship between Māori and the Crown lies the spirit of partnership, and the obligations for participation and protection. Te Whāriki also draws attention to the welcoming of immigrants in Aotearoa New Zealand in the context of Tiriti-based partnership (Ministry of Education, 2017). The findings of the research show participants having a flawed understanding that the relevance of biculturalism is limited to a child or families from Māori ethnicities. With the application of the Teaching as Inquiry model, a focus query for lecturers is to find out what the learners already know and feel about Te Tiriti o Waitangi. Teaching queries include how to use the knowledge and attitudes to motivate learners to create a commitment towards bicultural practice. The learning queries are to ask questions such as to where and to what extent the learners are able to take the refined knowledge, skills and attitude in terms of bicultural practice.

PROPOSED RESEARCH HIGHLIGHTS

The proposed research is to create similar opportunities for early childhood educators working in early childhood services. Te Whāriki is a curriculum document that emphasises learning processes rather than knowledge outcomes (Soler & Miller, 2003). Learning from each other, learning from tamariki (children), and learning from whānau (family) is a process encouraged within the early childhood community. Te Whāriki indicates the teaching and learning practices in Aotearoa New Zealand to be reflective of ako (a Māori kupu, or word, which means to learn and to teach) (Pere, 1994), as seen in the use of the word 'ako' or 'akoranga' (the place of learning) in all four of its principles.

The following table shows the use of 'ako' and 'akoranga' in the principles of Te Whāriki (Ministry of Education, 2017, pp. 21–23).

TABLE 1: THE CONCEPT OF AKO WITHIN TE WHĀRIKI PRINCIPLES.

Principles	Explanation in te reo Māori	Explanation in English
Ngā hononga / Relationships	Mā roto i ngā piringa, i ngā whakahaere i waenganui o te mokopuna me te katoa, e whakatō te kaha ki roto i te mokopuna ki te ako.	Children learn through responsive and reciprocal relationships with people, places and things.
Whakamana / Empowerment	Mā te whāriki o te kōhanga reo e whakatō te kaha ki roto i te mokopuna, ki te ako, kia pakari ai tana tipu.	The early childhood curriculum empowers the child to learn and grow.
Whānau tangata / Family and community	Me whiri mai te whānau, te hapū, te iwi, me tauiwi, me ō rātou wāhi nohonga, ki roto i te whāriki o te kōhanga reo, hei āwhina, hei tautoko i te akoranga, i te whakatipuranga o te mokopuna.	The wider world of family and community is an integral part of the early childhood curriculum.
Kotahitanga / Holistic development	Mā te whāriki o te kōhanga reo e whakaata te kotahitanga o ngā whakahaere katoa mō te ako a te mokopuna, mō te tipu o te mokopuna.	The early childhood curriculum reflects the holistic way children learn and grow.

RESEARCH QUESTIONS WITHIN THE PROPOSED FRAMEWORK

To create a meaningful, documented place of ako, early childhood kaiako reflect on their practice. The proposed study is to create a model that the participants can fill and re-fill using queries. The research questions can be very similar to the completed research, but within the context of early childhood education:

- What are the cultural components acknowledged, incorporated and celebrated in the early childhood education services?
- What impact do these components have on tamariki in terms of learning?
- What impact do these components have on kaiako in terms of reflective practice?

METHODS AND METHODOLOGIES WITHIN THE PROPOSED FRAMEWORK

Sociocultural theoretical framework will be applicable to this research. The sociocultural theory of development was pioneered by Russian psychologist Lev Vygotsky (Ball, 2012). His theory explains how we learn from the context of the submerged knowledge of our culture from birth or even from before birth (Vygotsky, 1986), which he describes as 'cultural mediating.' In the context of adult teaching and learning, Vygotsky's sociocultural theory of human development suggests that people construct knowledge through experiential learning (Fry et al., 2009; Vygotsky, 1986). Experiential learning refers to the learning that happens from experience. The reflections of kaiako are thus dependent on experiencing first. Sociocultural theories are extended to ecology in Bronfenbrenner's (1979) theory. Bronfenbrenner, in his ecological theory of development, identifies several systems, such as the microsystem, mesosystem, exo-system and macro-system (Bronfenbrenner, 1995). Individuals exist in relation to these systems at varying proximities. Each of these systems influences one's life either directly or contextually. Bronfenbrenner (2005) extended his theory to become a bioecological theory of human development. In the bioecological theory, Bronfenbrenner adds that the complex intertwined systems around individuals can produce different results due to the biological make-up of an individual over time. To use this umbrella of sociocultural or bio-ecological circumstances can be relevant, as learning from others within several interchangeable contexts is intended when inquiring into cultural components.

The samples will be from the early childhood centres that are listed in the ITE provider's database. The author may invite several ITE providers to join in. Depending on the number of providers who become involved, the number of early childhood settings can be decided. At the current stage, the proposed study could involve the early childhood services from Unitec's database. Under a qualitative research framework, five to ten services might be chosen to share their day-to-day stories, from a range of settings. In Aotearoa New Zealand, the range of diverse settings that are teacher led includes community and privately-owned centres, kindergartens, Montessori schools, Steiner

schools, Te Kohanga Reo and Pasifika language nests. The research participants could be tamariki, early childhood kaiako, centre managers and parents. Convenience sampling might be used as per availability of the participants. Interviews with centre managers might reveal the sector expectations. At least two parents from each centre could also be invited to join a group discussion to understand their perspectives of cultural growth of their own tamariki. A rich discussion can result in queries that are deeper in meanings and more relevant to the early childhood kaiako. From each centre, an observation/discussion with at least two tamariki groups could be conducted to understand the use of cultural components by tamariki. Three kaiako from each centre could also be interviewed to find out the spontaneous and attempted components of culture being used in early childhood pedagogy. Interviews (Kvale & Brinkmann, 2015; Opie, 1999) and FGDs (Krueger, 2009; Morgan, 1997) are likely to be appropriate research tools for this study. There will be no pre-determined responses (Howard, 2011) for FGDs or interviews. The interviews would be of approximately 30 minutes duration each and FGDs could be for 45–50 minutes each. They will take place at the premises of participating early childhood services. Thematic coding can also be applied in the proposed research. Ethics approval will need to be obtained for the study.

CURRICULUM-BASED DISCUSSION

While the data is not available to discuss further, an analysis of reflective questions indicated in Te Whāriki is examined here with the purpose of finding contextual ways to relfect. Te Whāriki has indicted five areas, or strands, under which tamariki learning can be identified and promoted. These areas are: Mana Atua or Wellbeing, Mana Whenua or Belonging, Mana Reo or Communication, Mana Tangata or Contribution, and Mana Aotūroa or Exploration (Ministry of Education, 2017, pp. 24–25). Reflective questions for kaiako are suggested under each of these strands. In total, there are 59 questions to stimulate thought, as indicated in the following table.

TABLE 2: TE WHĀRIKI STRANDS AND QUESTIONS FOR REFLECTION.

Strand	Number of questions for reflection
Mana Atua / Wellbeing	12
Mana Whenua / Belonging	11
Mana Tangata / Contribution	12
Mana Reo / Communication	12
Mana Aotūroa / Exploration	12

In this article, two questions from each strand, a total of ten questions, are selected to be discussed.

Example questions for Mana Atua or Wellbeing:

- In what ways might kaiako work to ensure that feeding, toileting and nappy-changing practices are familiar to children?
- What cultural considerations are/should be taken account of when promoting children's health and wellbeing? (Ministry of Education, 2017, p. 30)

These questions create opportunities for kaiako to notice the components of culture in practice. Feeding, for example, can be reflective of differences in families and their ethnic groups. The common items in a lunch box can be a source of ako, not only for tamariki, but also for kaiako. The concept of karakia kai (a blessing said or sung before eating), hāngi (a traditional Māori method of cooking) and kūmara as a traditional food item in Aotearoa are components of culture, as the services are located in Aotearoa New Zealand where Te Tiriti o Waitangi is seen as a foundation document (Orange, 2013). Religious requirements around food intake are another element that is commonly documented in ECE services. The Māori model of health and wellbeing, Te Whare Tapa Whā (Durie, 1998), captures emotional, spiritual, physical and whānau health to be the four important aspects. This model has

universal relevance and shares similar cultural values of many cultures around the world. Considerations as such can be linked to the celebrations of religious and cultural festivals in the early childhood services.

Example questions for Mana Whenua or Belonging:

- How do kaiako learn about the languages and cultures of all families, and in what ways are these affirmed in the [early childhood] setting?
- How might kaiako help children and families learn more about the local area? (Ministry of Education, 2017, p. 35)

These questions may refer to the use of community languages with the support of whānau. However, in many cases the parents of tamariki in early childhood education settings are working (Kamerman, 2006). It might take extra efforts for teachers to capture funds of knowledge from busy parents who notice and appreciate tamariki in their own culture. If possible, kaiako can work together with whānau to plan experiences acknowledging their language and culture. Greetings and displays might represent and affirm these. The reflection here can also reveal components from community resources, such as visits to parks, zoos and museums. Further, centres often invite people from the local area who represent a career, such as the Police and the Fire Safety Department.

Example questions for Mana Tangata or Contribution:

- Do all children experience fair and equitable access to, and participation in, play and learning opportunities?
- What do kaiako do when children are excluded by others? (Ministry of Education, 2017, p. 40)

These questions will allow the teachers to see the stereotypes that are commonly present in society (Rubin et al., 1998). Teachers, while planning for experiences, can reflect on how the materials to be provided, stories to be told and strategies to be used can include a range of voices and perspectives that challenge the ones that are frequently available. Teachers can also ask themselves whether they are contributing to empowering Māori and Pasifika learners. Reflection on these questions may also lead to thoughts on supporting tamariki with additional needs.

Example questions for Mana Reo or Communication:

- In what ways and to what extent do kaiako identify and respond to children's non-verbal communication?
- In what ways is te reo Māori used and encouraged in this setting as a living language? (Ministry of Education, 2017, p. 40)

Reflection on these questions may lead to ways of communication that are commonly used for infants. Sign language, as one of the official languages of Aotearoa, can be given importance. Bicultural practices, including the use of te reo Māori both in displays and in interactions, could be examined. It has been questioned that other languages are used more from a tokenistic approach in the sector (Jenkin, 2017). This claim can also be scrutinised locally. How much of the local history of the location of the centre is incorporated in planned teaching–learning experiences can be considered by the kaiako.

Example questions for Mana Aotūroa or Exploration:

- In what ways might kaiako show children that their play and imagination are valued?
- What domain knowledge would help kaiako to recognise, respond to and extend children's generation and refinement of working theories? (Ministry of Education, 2017, p. 50)

Reflection on these questions might introduce challenges in presenting play in the form of learning to families, as some might see play as a waste of time. Families who might value structured learning need to be considered, and can cause dilemmas for teachers. Connecting with children can also require the use of components from contemporary media for children. Increased use of technology within the ecological systems of children can be an area of reflection on the changes in the ways we live (Johnson, 2010). Bronfenbrenner (1979) describes the

ecological systems that children are immersed in. The microsystem is the child's closest system, in which they spend a significant amount of time and create crucial relationships. Examples of the microsystem can be the home as well as early childhood services. Increased use of technology in both microsystems is usually noticeable. This might influence the factors that are part of the macrosystem, which is the outermost layer surrounding the child, including subtle but important processes such as politics and cultural values. The systems within the macrosystem are the mesosystem (relationship between two microsystems) and exo-systems (systems that have indirect influence). Reflective queries can be made to see how this generation of children is adopting and using technology and media knowledge to develop working theories.

CONCLUSION

Within the very busy environment of early childhood education, teachers are likely to be engaged with reflection in action (a type of reflection that happens when you are on the floor with tamariki) (Schön, 1983, as cited in Golubich, 1997). However, reflection *on* action (a type of reflection that happens more formally after the event has occurred) can also reveal information and methods that are useful in the lives of tamariki. Both retrospective and prospective approaches (Hayes, 2010) can be valuable, formulating future queries directed by past experiences of teaching and learning.

The proposed study might introduce ideas that are useful within the early childhood context of Aotearoa New Zealand. The findings of the proposed research will provide the sector with sets of examples of conducted reflections that reveal focus query, teaching query and learning query on the components identified by the local teams. Another idea to consider (as indicated by one of the participants in the 2021 Unitec/MIT Research Symposium) is to conduct comparative studies with other countries; for example, a study with the Bangaladeshi early childhood community. It might be interesting to do so, as in Bangladesh children are quite oppressed by adult superiority, especially in terms of independent decision-making (Mohajan, 2014). This idea was raised because both the author and the other symposium participant are from Bangladesh.

If implemented within the context of Aotearoa New Zealand, the findings will be helpful for early childhood teachers to stimulate reflective thinking. They will also interest people working in schools to understand the process of transition. Educators, lecturers and kaiako of any field of education who would like to think more about culture within their profession will be informed by this study. This study can also add to the knowledge of early childhood centre supervisors, managers and teachers. Researchers whose research interests involve culture in education, professional growth and/or reflective practices will be interested in the findings of this study. Limitations of the study might be that, if conducted in Tāmaki Makaurau Auckland, the findings might be less relevant to services that are located in other centres and regions, due to differing diversity within different geographical locations in Aotearoa New Zealand.

Inquiring about components of culture in early childhood services can open the gate to explicit knowledge for teachers (Hedges, 2012). In this shifting world where teaching is imbued with uncertainty, unpredictability and even anxiety, it is worth getting to know the context better and more deeply (Hansen, 1997). A simple definition of reflection is to "stop, think and change," so that educators are able to reconsider their actions to improve future practices (O'Connor & Diggins, 2002, p. 9). However, a more complex explanation might be more useful, knowing that many aspects of sociocultural perspectives are invisible and intangible, and critical reflection is needed for the exploration of culture and its components (Sanchez & Thorp, 2008). In the area of reflection, the following quote may be old, but it is worth mentioning here: "If the artist does not perfect a new vision in his process of doing, he acts mechanically and repeats some old model fixed like a blueprint in his mind" (Dewey, 1934, p. 50). A fixed blueprint in the mind of the kaiako cannot lead to successful teaching and learning for tamariki (children). In a rapidly changing society, it is important for kaiako to look at practices and rethink their actions (Sinnema & Aitken, 2012). Reflection helps kaiako to grow, be resilient, be more positive, and focus on solutions rather than problems. It also emphasises professional criticism rather than environmental criticism (Leroux & Thèorêt, 2014). The proposed

study may open doors for early childhood kaiako to reflect on concepts that are otherwise ignored. The study may also motivate the participants to knock on doors that are difficult to open.

ACKNOWLEDGEMENT

I would like to acknowledge Dr Chris Jenkin, Senior Lecturer at Auckland University of Technology, for all her support with research, learning and teaching.

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RECONCEPTUALISING TERTIARY CONTEMPORARY MUSIC PERFORMANCE ASSESSMENT

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https://doi.org/10.34074/proc.2206006

Teaching and Learning

This publication may be cited as:

Orange, C. (2022). Reconceptualising Tertiary Contemporary Music Performance Assessment. In E. Papoutsaki and M. Shannon (eds.), *Proceedings: Rangahau Horonuku Hou – New Research Landscapes, Unitec/MIT Research Symposium 2021, December 6 and 7*, (pp. 63–84). Auckland: ePress, Unitec, Te Pūkenga. https://doi.org/10.34074/proc.2206006

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ISBN 978-1-99-118340-8

ABSTRACT

Contemporary music performances are typically assessed by criteria such as Musicianship, Accuracy, Technique, Professionalism and Contribution. These measures continue to be used despite low discrimination between them and specific items on the assessment schedules (Thompson & Williamon, 2003). In addition, there is a lack of objective evidence that assessment is truly comprehensive. Greater transparency in domain definition and comprehensiveness may aid understanding of the rubric, and lead to better assessment. This study investigated whether popular-music performance assessment criteria are supported by a multidimensional scaling analysis (MDS). What might an MDS analysis contribute to confidence in the validity of these common measures of music performance? Performance students and tutors at an Aotearoa New Zealand tertiary music institute participated in focus-group sessions where they answered structured questionnaires. These provided descriptors of musical efforts that contribute to successful music shows. These descriptors of performance were then mapped using a mixed-method process with concept mapping (Coxon, 1999; Trochim & Kane, 2005), and card sorting via novel use of web-based user experience (UX) platform OptimalSort (Paea & Baird, 2018). The MDS analysis of the descriptor item set, and comparison of emergent clusters with typical rubric, revealed alternative constructs underlying the language of music performance assessment. Results suggest that the incumbent measures confound important dimensions. The importance of collaborative interaction in the development of musical skill is suggested by our analysis, and this is supported by findings in the literature (Green, 2008; Schiavio et al., 2020). The more comprehensive and detailed description of music performance constructs provided by this MDS approach may illuminate music performance studies and lead to greater understanding of how assessment may best benefit learning.

INTRODUCTION

This article will briefly examine some of the assumptions inherent in assessing music performance, look at the way assessment is integrated in contemporary learning pedagogy, and outline some of the dilemmas that face tutors given the nature of music itself. The aim here is to better understand the conceptualisation of music performance and the constructs that define its conceptual domain. I will then highlight the issues around lack of domain definition. The research approach taken in this study and the methods used to explore the domain will then be described, and results presented and discussed.

Assumptions around musical quality judgement

While quality judgements of musical performances have ecological validity, since it is almost impossible not to judge a music performance, assessment in an educational setting is a complex exercise and is based on a number of assumptions: that evaluation of a performance is objectively meaningful in terms of the properties of that performance, and the listener's awareness of those properties (Thompson & Williamon, 2003). In addition, it assumes that experienced or acculturated listeners can identify qualities of the performance, and, familiar with this style, will tend to agree about the relative merits of several performances within that style. In an educational setting, quality judgements play a crucial role in quantifying the difference between performances and conveying information about those performances to the performers. Thompson and Williamon (2003) examined the use of assessment schedules taken from educational contexts in the empirical judgement of performance quality. Agreement between judges was low – around 0.53 – and correlations between items on the assessment scheme were strong enough to question the discriminative validity of the global constructs used (p. 33).

Implementing assessment

Performance assessment is one of the most common forms of assessment in music. Summative performance assessments are typically used in a large part (25%) of final grading (Harrison et al., 2013; Denis, 2017). Students at tertiary contemporary music schools may direct efforts at improving their performances, informed by their perception of which strategies are most successful. Tutors assessing performances face a complex task where good understanding of the influences on learning, and confidence in the assessment measures, are essential for curriculum to be relevant in creating learning. Given that assessors have been found to prioritise different constructs, Thompson et al. (1998) suggest that the criteria must be context specific and updated to accommodate the music performed, the instruments used, and the social and institutional setting. To have confidence in performance assessment measures, the rubric must comprehensively address the domain of learning. This study employed a grounded theory approach to research students' and tutors' perceptions of successful strategies in contemporary music performance, and, in reconceptualising assessment, illuminate the complexity of music learning and teaching. How tutors acquire good understanding of their students' perceptions so they may implement assessments that support learning, however, is a complex process.

Problematic aspects of contemporary music performance assessment

Assessing music performance is full of "opposing binaries or dilemmas that teachers must negotiate and reconcile as they facilitate music learning" (DeLuca & Bolden, 2014, p. 70).

- Contemporary music performance is collaborative and creative. Schools will typically try to replicate real-world concert environments for performances. Judging learning when presented in a live band performance, especially regarding improvisation, is problematic. In addition, because contemporary songwriting and composition are typically collaborative activities, at least in popular music, judging contribution to original material, in a live concert, is especially challenging.
- Knowing how much facility is due to learning at school as distinct from prior learning and informal learning is important but complex.
- Acknowledging and reconciling the contrasting aspects – technical proficiency and musical expressivity – is essential but demanding (DeLuca & Bolden, 2014).
- Music performance also occurs under more diverse circumstances than many art forms and learning outcomes extend over a much longer time period than most contemporary academic assessment schedules allow, given the necessarily longer interactions between teacher and student (Green & Walmsley, 2006).
- Standardisation of music tests is problematic for many reasons: the diversity of genre; the difficulty in assessing complex expressive elements; and the fact that the value of music for many practitioners is intrinsic.
- Students entering Aotearoa New Zealand tertiary music schools have come from high school learning environments that, since the 1990s, have prioritised STEM subjects (science, technology, engineering and mathematics) over the humanities. The education system has been commodified with a push for 'performativity' (Ball, 2003). When performances, including collaborative ones, serve as measures of productivity or output, opportunity for genuine collaboration is diminished. The affordances of Unit Standards, which in Music Performance were written in "favour of group responsibilities and attending group rehearsals to foster a sense of belonging," and where "the standard was less about the mechanics of music," have been undermined to a large degree (T. Thwaites, personal communication, October 7, 2022).

Initial surveys suggested that students prioritised collegial and collaborative efforts, for example, establishing ground rules, or tikanga, leading to stronger team culture, or whanaungatanga (Melhuish, 2020). They saw the importance of leadership and spending time building rapport and "identifying the value of sharing so as to end up with a result greater than the sum of the parts, and a sense of camaraderie" (p. 82). While these are somewhat acknowledged in the assessment rubric (see Figure 1), the extent to which students engage in and rely on

collectivist values to further music learning is an area of interest. This is, of course, especially salient in our Aotearoa New Zealand context.

EVALUATING ASSESSMENT

Content representation in assessment

Rubrics, checklists, rating scales and portfolios, peer and self-reflection and written reflection are all common means to organise and assess music performance. Rubrics and ratings checklists "use descriptors of performance domain criteria (e.g., tone, balance, rhythm, etc.) to provide an isolated domain-specific rating or overall total for a holistic performance score" (Denis, 2017, p. 5). These global measures are summations of ratings on specific performance characteristics: e.g., for accuracy, pitch, intonation, timing, rhythm, articulation (for example, see Figure 1).

Concern around validity

Content validity is commonly examined in relation to inferences made from the scores: the relevance of each test item to its stated objective or to all the objectives measured by the test. Once established, however, the criteria for assessment tend to be used many times, with many students, and the descriptive language runs the risk of losing meaning and perhaps merely underscoring the (implicit or explicit) learning-culture bias of the institution.

Domain definition

Even after content representation is established, and inferences made from the scores are scrutinised, there remains inherent bias since, typically, any scrutiny of the original test developers' prior definition of the domain to be assessed will not have been addressed (Sereci, 1998). In summary, without examining the adequacy of domain definition, there is no unbiased evaluation of any test.

Performance assessment criteria

The rubric or rating scales presented in Figure 1 are used in this study.

Breakdown of MARKING RUBRIC – Performance assessments to be marked on the following:

INDIVIDUAL CRITERIA
(Apply an individual mark to each member of the band/act)

Accuracy and Musicianship /10

- Timing, notes, pitch
- Parts developed (for original material including sounds)
- Interpretation, feel, dynamics (cover material parts learnt including sounds – if applicable)

Professionalism and Contribution /10

- Attendance – rehearsals, workshops, gig and review
- Attitude and communication
- Participation and engagement (bringing songs, suggesting arrangements and ideas, being an active part of musical discussions)

Performer Stagecraft /10

- Visual aspects and audience appeal and engagement

ARTIST CRITERIA
(Apply an overall mark to all members of band/act)

Performance /10

- Original songs and song choices. Did band/artist meet the performance assessment objectives? (These will be specified on the assessment coversheet, e.g. – One new original, two covers, etc.)
- Cohesions. Did the band/artist look and sound like a band/artist – well-rehearsed, prepared, confident?
- Performance, including the intros/endings and set development. (Could the band play an entire song, did the performance flow? Gaps between songs, etc.)

Figure 1. Example: Global measures and specific characteristics of performance for both individual and band performance aspects assessed in a band concert. (Creative contribution is typically assessed separately from on-the-night performance but may be incorporated into a performance marking schedule as is the case presented here).

Overview of research approach and methodology

The primary objective of this study was to explore the descriptive language of music performance assessment, and interrogate the domain comprehensiveness of the incumbent global measures. There is potential for creating assessment tools that better assess student achievement at this vocation. Taking a step back from the composite global constructs, then, this study applied sorting techniques and MDS to music performance success-attribution items to create a multidimensional representation of the domain, reveal underlying dimensions, and facilitate examination of the descriptive language of music performance assessment.

Attributions for success (items) were elicited from both popular music performance students and music education professionals. It was anticipated that tutors were used to identifying 'markers' of successful strategies in performance and would contribute these, whereas the students would be more likely to describe specific efforts. By including both participant groups, a broad range of specific efforts towards performance success was collated, which met the first objective of this study. Sorting techniques and MDS were applied to create an inter-item semantic-like map using a pattern-investigation approach with a heuristic design.

This map facilitated the unravelling of objective dimensions in perception underlying the performance domain, and permitted examination of the descriptive language of music performance assessment. Construct validity and comprehensiveness of the incumbent global measures was examined and interrogated at an item level. New constructs and emergent dimensional structure were examined and re-interpreted by this researcher, music tutors and music educators, and compared to a sample rubric for music performance at tertiary level.

LIMITATIONS

This study is the initial stage in a two-part project to map the tertiary contemporary music performance assessment environment and clarify the theoretical underpinnings of music performance assessment criteria. This study did not examine predictive validation. Further research will involve profiling tutor assessment of student performances to expose themes and clarify the robustness of the emergent constructs. Research into cognitive profiles of gifted children and musical talent development have found heterogeneity in individual profiles (Da Costa & Lubart, 2016). However, analysis at the level of group differences is not undertaken in the present investigation. Instead, construct validity of the incumbent measures' dimensional consistency will be examined and assessed at an item level. The descriptor set may be broad enough to be useful in researching other genres of music learning, for example 'classical' music, since descriptors from a range of contemporary assessment sites were included. Items were sourced from both the contemporary pop-music performance rubric (Figure 1) and the rubric for jazz competitions, and symphony and chamber music competitions, as well as instrumental tuition. Indications from the literature, however, are that educational assessment varies widely with delivery context (Leong, 2014).

SIGNIFICANCE OF THIS STUDY

As far as is known, no attempt has been made to analyse the language of music performance criteria as a coherent domain, examinable in terms of its structure of judged similarity. Convergence with findings in the literature on musical skill learning and tutor attribution are anticipated (Schiavio et al., 2020). Once emergent constructs are shown to be robust, the comprehensiveness and validity of current criteria may be challenged, or new, more robust dimensions may be suggested. This may facilitate reconceptualisation of contemporary music assessment.

METHODOLOGY

This section will describe the two main research objectives and studies, and the research methodologies adopted. Description of the participants follows, and the creation of stimuli (statements, descriptors). Research procedures are described, with justification for methodologies and discussion of their limitations. Finally, the analytic strategies are described.

The primary objective of this study was to examine the adequacy of domain definition in assessment of tertiary contemporary music performance, and to better understand criteria. By exploring the descriptive language of music performance assessment and examining the relationships between the constructs that emerged, comprehensiveness in the assessment criteria of contemporary music performance was to be made transparent. To this end, a systematic structure for representing judgement of performance was needed. Extant criteria are ubiquitous in institution-based music performance education, and many studies have examined the relationship between rubric and the behaviours that assessment claims to measure. This study however, takes a step back from the incumbent rubric, to remap the domain from an item level.

The assumption is that combining estimates of similarity overlap of meaning – semantic similarity – from several participants can result in more reliable organising than one researcher's own individual judgement. (Bimler & Kirkland, 2002). The emergent relationships between the ideas are assumed to relate to actual probability of co-occurrence. Concept mapping has been widely used in healthcare contexts. Trochim and Kane (2005) list many instances where this methodology has been applied to develop conceptual frameworks for complex constructs – including, for example: coping, depression, anxiety, a theory of care, quality of life and quality of care, end-of-life care, and tobacco-industry efforts to undermine public health.

Innovations in mapping, including novel approaches to sorting, and use of the resulting map for exploring profiles, were developed by Massey University, Aotearoa New Zealand, researchers Kirkland, Bimler and colleagues (Bimler & Kirkland, 1998, 2001; Kirkland et al., 2004; Marshall et al., 2002). These have been applied in research, and include studies examining construct validity of attachment styles (Bimler & Kirkland, 2002), truancy styles (Bimler & Kirkland, 2001), teachers' emotional skills (Harvey et al., 2012), and by this author to explore dimensions underlying an emotional and behavioural problems checklist (Orange, 2005).

LIMITATIONS OF THE METHODOLOGY

It was hypothesised that data from all respondents – student, tutor and specialist – would be amenable to analysis at the low-dimension item level and that an MDS analysis would reveal alternative dimensions underlying the domain that may converge with findings in contemporary studies of music performance. There was no guarantee, however, that interpretable dimensions would be recovered, given the novel application of this method to the domain.

Rating data indicating the perceived importance of items was not solicited. However, further study will be undertaken using the resultant map to summarise patterns in tutor assessment collected via Q-sorting (Block, 1961; Bimler & Kirkland, 2002), and verify whether tutors access the same cognitive organisation.

OBJECTIVES

This study had two main objectives:

- Objective One was to develop a pool of descriptors capturing student and tutor perceptions of efforts that lead to successful performances. The development of these measures is described to follow in Study 1.
- Objective Two was an analysis of the descriptors aimed at identifying and validating possible latent structure. Latent coherence or dimensional consistency may be revealed by creating an inter-item semantic-like map. The map-construction phase and analysis is detailed in Study 2.

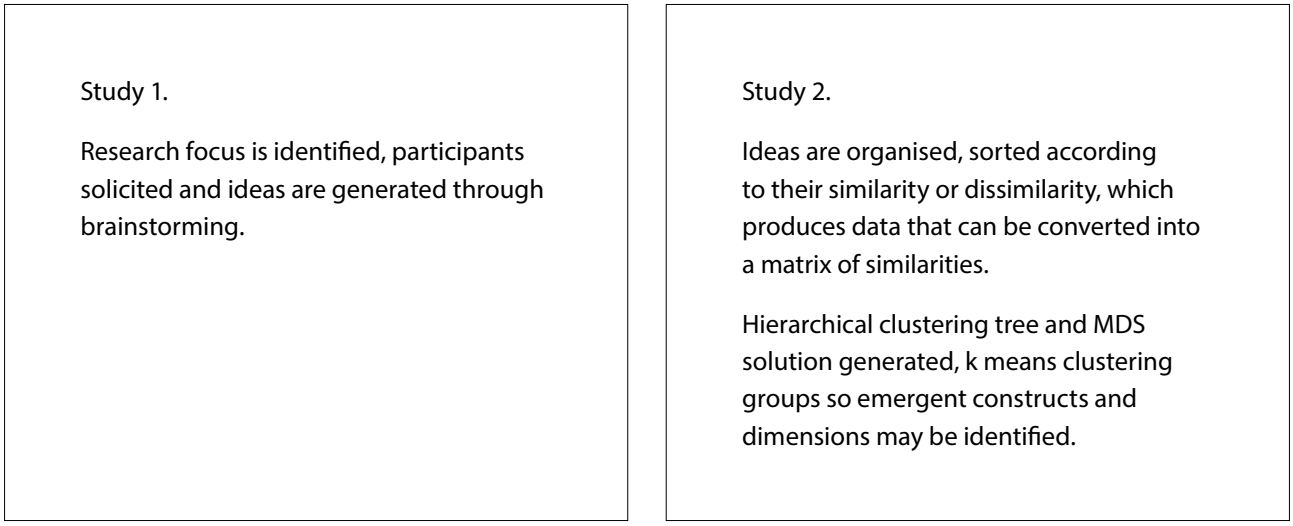


Figure 2. Methods summary.

This map will then be used as a tool in future research to summarise patterns in tutors' individual assessment data. These summaries may be checked against current criteria for validation of the emergent structure. Comparative validity checking between assessment on the one hand, and graduate profiles on the other may then lead to better understanding of pathways in music performance education

RESEARCH APPROACH

This study draws on a research methodology called 'structured conceptualisation' (Trochim & Linton, 1986; Trochim & Kane, 2005), which is analogous to mind mapping, but in this case is a structured group 'concept mapping,' Concept mapping is a method of visualising how a group thinks about a particular issue (Goldman & Kane, 2014). This type of concept mapping is a mixed-methods participatory-group idea-mapping methodology. Different group processes are utilised: brainstorming and free sorting (Coxon, 1999), and these are integrated with, and analysed by, MDS (Kruskal, 1982) and hierarchical clustering (Trochim & Kane, 2005).

In a typical concept mapping, the research focus is identified, participants solicited and ideas are generated through brainstorming. These ideas are organised – sorted – and sometimes rated against variables of interest. Sorting ideas according to their similarity (free or open sorting) produces data which can be analysed statistically (MDS) and ideas represented spatially as maps. Both Study 1 and Study 2 used a web-based user experience platform, OptimalSort (Paea & Baird, 2018), to collect and process data.

Multidimensional scaling (MDS) (Coxon, 1982; Kruskal, 1982) can express similarity judgements through spatial representation. By organising these judgements into clusters, MDS creates an empirical framework for representing participants' perceptions, and thus contribute to the goals of this study.

A hierarchical-clustering tree (a dendrogram) was created that showed the structure within the similarity matrix. The dendrogram was used to decide the optimal number of clusters, and k-means clustering was used to arrange the points in the MDS solution in that number of clusters. K-means clustering is an iterative process, which needs a starting point, provided by the dendrogram.

Interpretation of clusters and dimensions was aided in OptimalSort by 3D cluster view, which shows the similarity between descriptors as a three-dimensional spatial relationship. Each point represents an individual descriptor. A small group of tutors examined the resulting groups of descriptors and individually labelled the themes. These were then compared with the global measures in the original rubric.

STUDY 1

Participants

A convenience sample of tertiary-level contemporary music performance students and tutors was identified, and brainstorming focus-group sessions initiated. The student informants were at Stage 1 of a music degree at an Aotearoa New Zealand polytechnic located in Tāmaki Makaurau Auckland, but also included some recently graduated students. The tutor participants were all staff at the same institution, but also included staff at a remote delivery in another centre, as well as music educators in the community who were not staff. Māori and Pasifika make up more than 35–40% of the student population at this polytechnic and were represented thus in the demographic of our participants.

Group focus sessions: Student focus-group

A focus session with 17 Stage 1 performance students was held during a performance workshop, where students answered a structured questionnaire intended to elicit statements describing performance objectives. The focus was on individual and band efforts to improve performances, and they were asked to recall aspects they were working on before the previous performance and efforts they were working on currently for the upcoming show. The focus question put to the students was: "What do you expect to see in individual playing preparation and in actual performance that contributes to successful music shows?" They were also canvassed as to aspects they thought were missing but should be included in the Performance Assessment, and those that they thought might be given too much attention by the assessment and tutors. In addition, students were asked to unpack the global measures in their current performance assessment rubric (Figure 1).

Group focus sessions: Tutor focus-group

In a focus group of six tutors currently teaching on performance papers, participants were asked to think about the last performance they assessed and write down aspects of the performances they commented on in their feedback (verbal and written). They were also asked to identify which global constructs (e.g., accuracy, professionalism, musicianship, etc.) and which specific constructs (pitch, rhythm, visual appeal, original song, etc.) they found most challenging to assess and why. This is in addition to unpacking the current rubric for performance assessment (see Figure 1).

RESULTS AND DISCUSSION

Student focus-group

Students contributed items that referenced performance preparation, e.g., *"Discussed and practiced bvs [backing vocals] harmony"* and *"Developing set choreography in the front line"*; as well as on-the-night strategies and competencies, e.g., *"Responded appropriately to cues and communicated song to audience"*. The initial responses also featured collaborative processes. Many of the items contributed by students referenced group work of a collaborative nature, e.g., *"Worked together on choosing songs"* and *"Everyone played in time to establish the right groove"*.

Tutor focus-group

Tutor descriptors also referenced performance preparation elements: *"Well-familiarised with material so ready to perform"* and *"Chose song that was suitable for the singer/band"*. The tutor focus-group sessions garnered descriptions that referenced more 'markers' of development.

Tutors will generally have worked with the students in rehearsal and will have some insight into how much work the band has put into a particular musical element when they assess them in performance. Formative tasks are typically set and feedback is given after the performances and in reviews. Hence, tutor items referenced many onstage performance elements, such as *"Made eye contact with audience"* and *"Beginnings and endings were tight"*.

Participants contributed a wide range of 130 descriptors that included rehearsal processes, technical skill development, stage presence, audience-communication focus and inclusive, collaborative processes.

Tutor questionnaire

Tutors reported difficulty assessing some elements when embedded in group performances. Hearing individual contributions in the band context and assessing original songs played as part of the performance were most challenging. In addition, some responses suggested very divergent issue for different tutors. For example, professionalism was at once reported to be *"usually easier to assess"* in group performances, and most challenging to measure. Judging how much prior learning has been brought into the formal assessment was confirmed to be an issue. Connection to the audience was also highlighted as an element needing more detailed criteria. Stagecraft was highlighted as another area of skill not well-integrated into the delivery and difficult to assess.

Performance assessment criteria from a range of contemporary music pedagogies was surveyed in the literature and included if missing from responses. From 130 written responses, the author identified themes and eliminated redundancies – or reduced a number of synonymous items to a single one that conveyed the common theme.

The author took care to include items describing both student–student and student–tutor relationships, given findings in the literature that highlight the importance of peer collaborative and inclusive interaction: *79. Recognised playing limitations and asked for advice for specific need* and *27. Attended all rehearsals, workshops, performances and reviews*.

The list was reduced to 110 descriptor items.

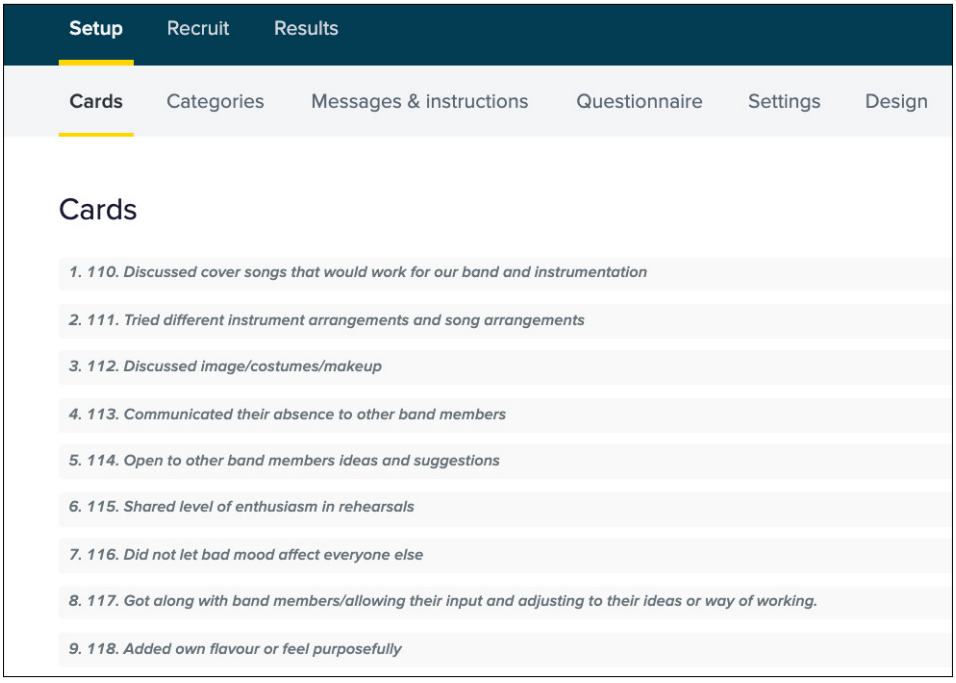


Figure 3. A sample of the 110 items in the final list in OptimalSort.

STUDY 2

Eliciting similarity data and analysis

Free sorting (Coxon, 1999) or open sorting was used to elicit judgements of semantic similarity from the descriptor set. The goal is to elicit from the participants as much information about the perceived similarities or dissimilarities in a way that is not too taxing on them but is reliable and can be achieved relatively quickly and can be pooled across participants. An open card-sort asks participants to sort and categorise content into their own categories and label those categories (Spencer, 2009). Novel use of web-based user experience (UX) platform OW (Paea & Baird, 2018) meant online sorting could take place during the Covid-19 lockdowns in Tāmaki Makaurau Auckland in 2021, and removed the necessity to print cards, and hold physical sorting sessions. In OptimalSort all items are entered and become a numbered virtual list of cards that can be dragged one at a time into a sorting area, grouped according to semantic similarity, and each group categorised with a label. This ease of access comes with some disadvantages, however. Moderating the sorts in person, which can give the researcher information about how decisions have been made, is not practicable online.

Stimuli

The 110 descriptors were entered into OptimalSort for sorting online and the same convenience samples were approached for similarity sorting (see Figure 3).

Participants

About half the sorters were students and half tutors, and some music educators in the research community also engaged in the sorting process. Coxon (1999) has found that 30 is the ideal number of sorters to produce stable map structures. Eighty-three sorts were attempted but only 33 were accepted as suitable. Twenty-seven full sorts were completed plus six partial sorts.

RESULTS AND DISCUSSION

OptimalSort converts the data to a matrix of similarities, which shows the relationships between descriptors based on how many – or what percentage of – sorters place the two cards into the same category. Clusters of cards appear on the matrix in the same shade of blue when they are strongly related to each other. OptimalSort was successful in identifying where descriptors were perceived as similar, showing clear bunching of items.

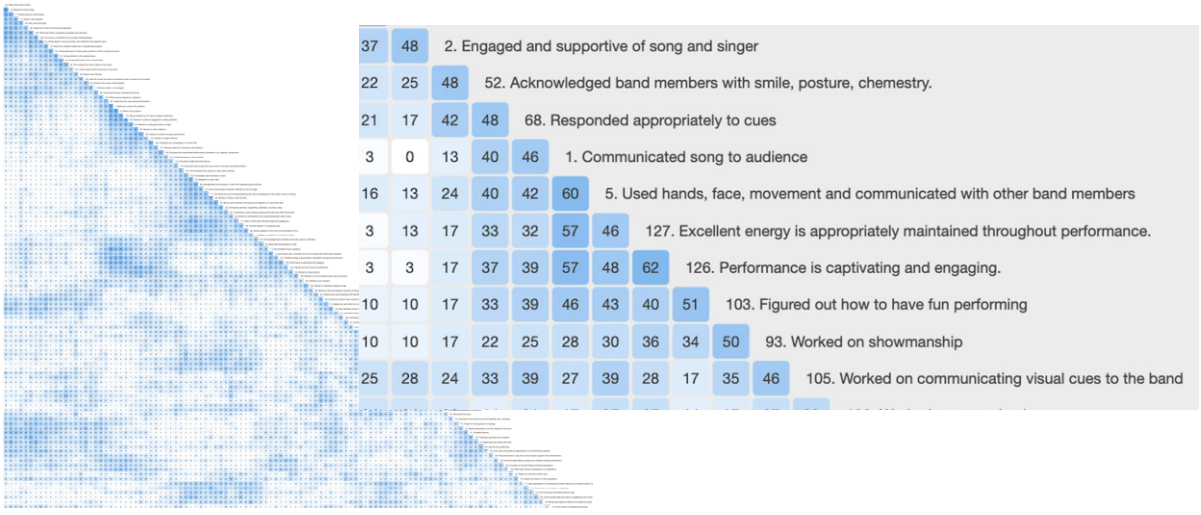


Figure 4. A magnification of selected items from OptimalSort's similarity matrix.

Multidimensional scaling results support a multidimensional structure model of performance assessment. MDS uses a function minimisation algorithm that evaluates different configurations with the goal of maximising the goodness of fit (Paea & Baird, 2018). The goodness of fit between distances and perceived similarities is measured by an index called Stress1, which is minimised iteratively by moving the points to their final locations (Kruskal & Wish, 1978; Harvey et al., 2012). OptimalSort does not report this information so MDS was applied to the matrix co-ordinates using another program that confirmed that the fit was acceptable: Stress1 = 0.18123. The OptimalSort output identified clusters within the solutions as a guide to interpretation, suggesting seven clusters as optimal. A Split-half test, where MDS was applied separately to two same-size participant groups chosen at random, generated solutions that supported the 7-cluster result.

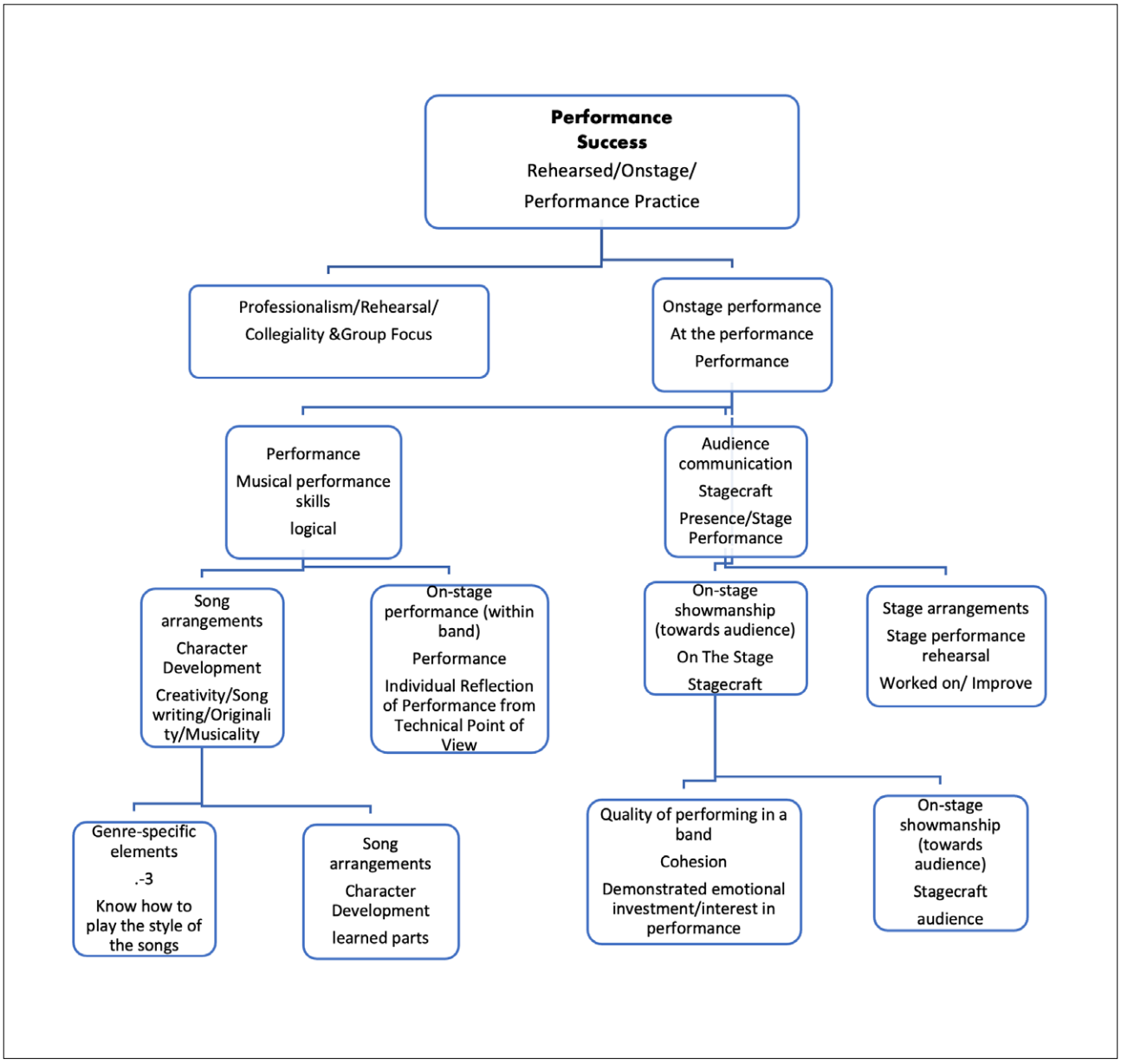


Figure 5. Clusters labelled by participants. Dendrogram or hierarchical tree from cluster analysis suggested 6 or 7 clusters at 40–50% agreement.

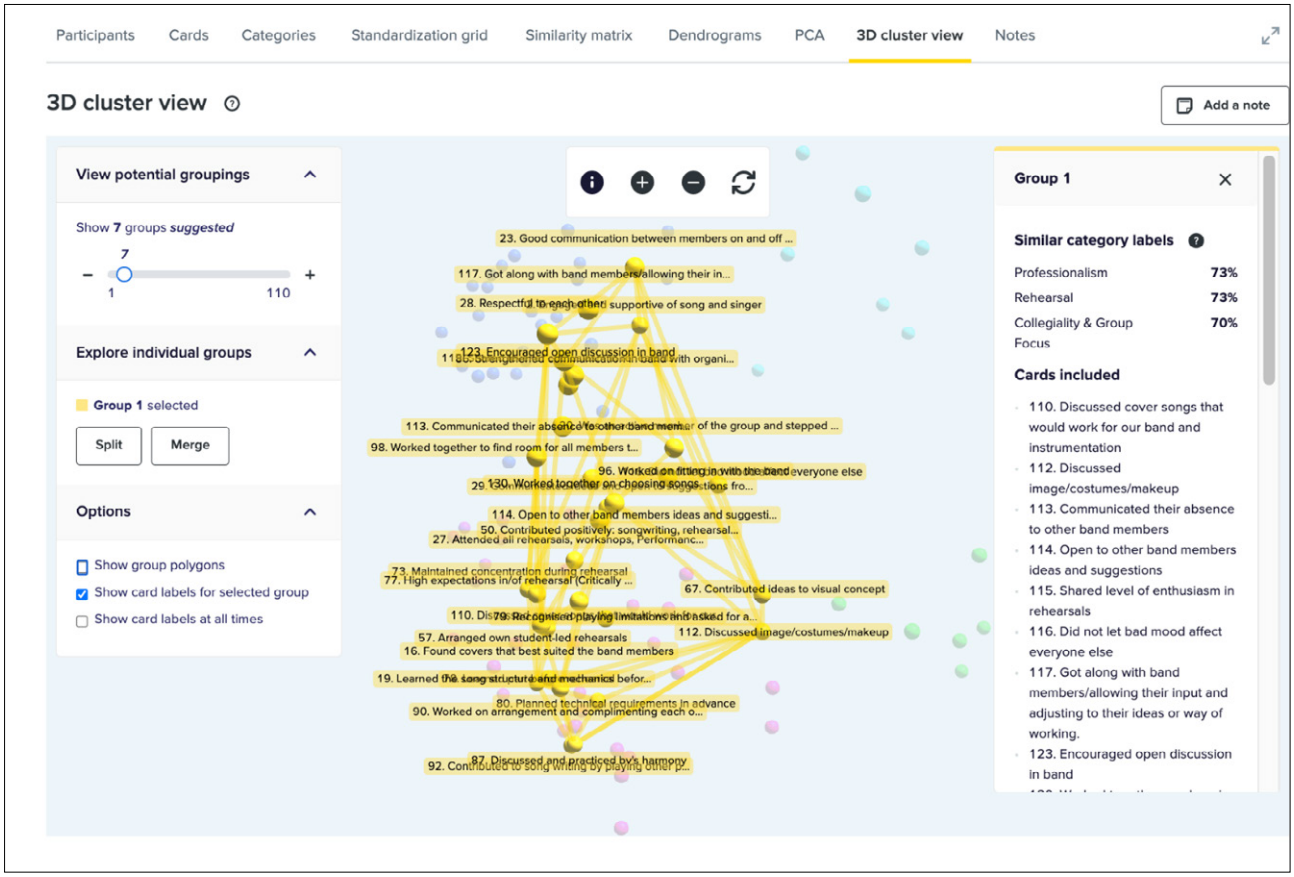


Figure 6. Example: Cluster 1.

Items are arranged across the map in clusters with identifiable themes. OptimalSort presents suggested category labels for each group based on the most common label that participants gave the categories. In the example shown here for Group 1, given labels are: Collegiality and Group Focus, Professionalism and Rehearsal. Given the exploratory nature of cluster analysis, however, the interpretation should be treated with some caution.

TUTOR RE-INTERPRETATION OF CLUSTERS

Three music tutors with long experience in assessing performance were asked to label the clusters as emergent themes within the perceptual map.

TABLE 1. A FIVE-CLUSTER SOLUTION WAS ALSO OBTAINED AND RELATIONSHIP BETWEEN CLUSTERS CLARIFIED.

5-Cluster solution	**7-Cluster solution Tutor interpretation themes**	**Participant-given similar category labels and % agreement across sorters**	**Example representative items**
Performance Preparation (Outward focus)	Cluster 2: Collaboration, Stage performance, Aesthetic design, Communication, Practice, Artistic vision	Stage arrangements 56% Stage performance rehearsal 50% Worked on/ Improve 50%	100. Worked on posture for good performance 101. Planned options for interaction with audience 102. Developed set choreography in the front line 103. Figured out how to have fun performing 105. Worked on communicating visual cues to the band
Performance Embodiment	Cluster 3: Showmanship, Energy, Performance embodiment and audience awareness, Awareness of effective live performance/ musicianship/stagecraft	On-stage showmanship (towards audience) 64% Stagecraft 64% Audience 56%	1. Communicated song to audience 119. Being confident but not rigid in audience interaction 126. Performance is captivating and engaging. 127. Excellent energy is appropriately maintained throughout performance. 26. Looked like they were enjoying themselves
	Cluster 4: Commitment/ Cohesion	Quality of performing in a band 44% Cohesion 38% Demonstrated emotional investment/ interest in performance 27%	107. Performed and played as a collective 108. Made every song an interesting or fun experience 120. Focussed on the pure feeling /emotional expression 122. Communicated feeling uniquely and creatively through performance 5. Used hands, face, movement and communicated with other band members 52. Acknowledged band members with smile, posture, chemistry.
Musicianship (Within-band focus)	Cluster 5: Musicianship, Musical & technical proficiency/skill, Musicianship, Awareness and application of technique	On-stage performance (within band) 76% Performance 67% Individual Reflection of Performance from Technical Point of View 65%	10. Played with authentic feel (cover) or intended feel (original) 104. Kept the pocket as simple as possible to open up space for the vocalist 11. Played songs at correct tempo 121. Chose octave that fit instrument to the mood 124. Phrasing is sensitive and controlled
Professionalism	Cluster 1: Professionalism, Professional collaborative repertoire development, Communication skills (incl. empathy awareness), Participation	Professionalism 73% Rehearsal 73% Collegiality & Group Focus 70%	110. Discussed cover songs that would work for our band and instrumentation 112. Discussed image/costumes/makeup 113. Communicated their absence to other band members 114. Open to other band members ideas and suggestions 115. Shared level of enthusiasm in rehearsals
Music and Artistic Development	Cluster 7: Preparation, Creative and technical exploration of repertoire, Awareness of effective performance techniques, incl. song writing craft and concepts	Song arrangements 41% Character Development 36% learned parts 33%	106. Developed soloing skills 111. Tried different instrument arrangements and song arrangements 118. Added own flavour or feel purposefully 121. Chose octave that fit instrument to the mood 133. Worked on transitions between songs
	Cluster 6: Interpretation	Genre-specific elements 44% .-3 43% Know how to play the style of the songs 40%	36. Chords and melodic lines complimented other motifs in original and re-arranged material 42. Tone supports the style or genre of the songs 43. Recognisable genre traits in the phrasing 47. Melody sits well within the music 53. Timing placement of musical parts authentic in terms of style and sound

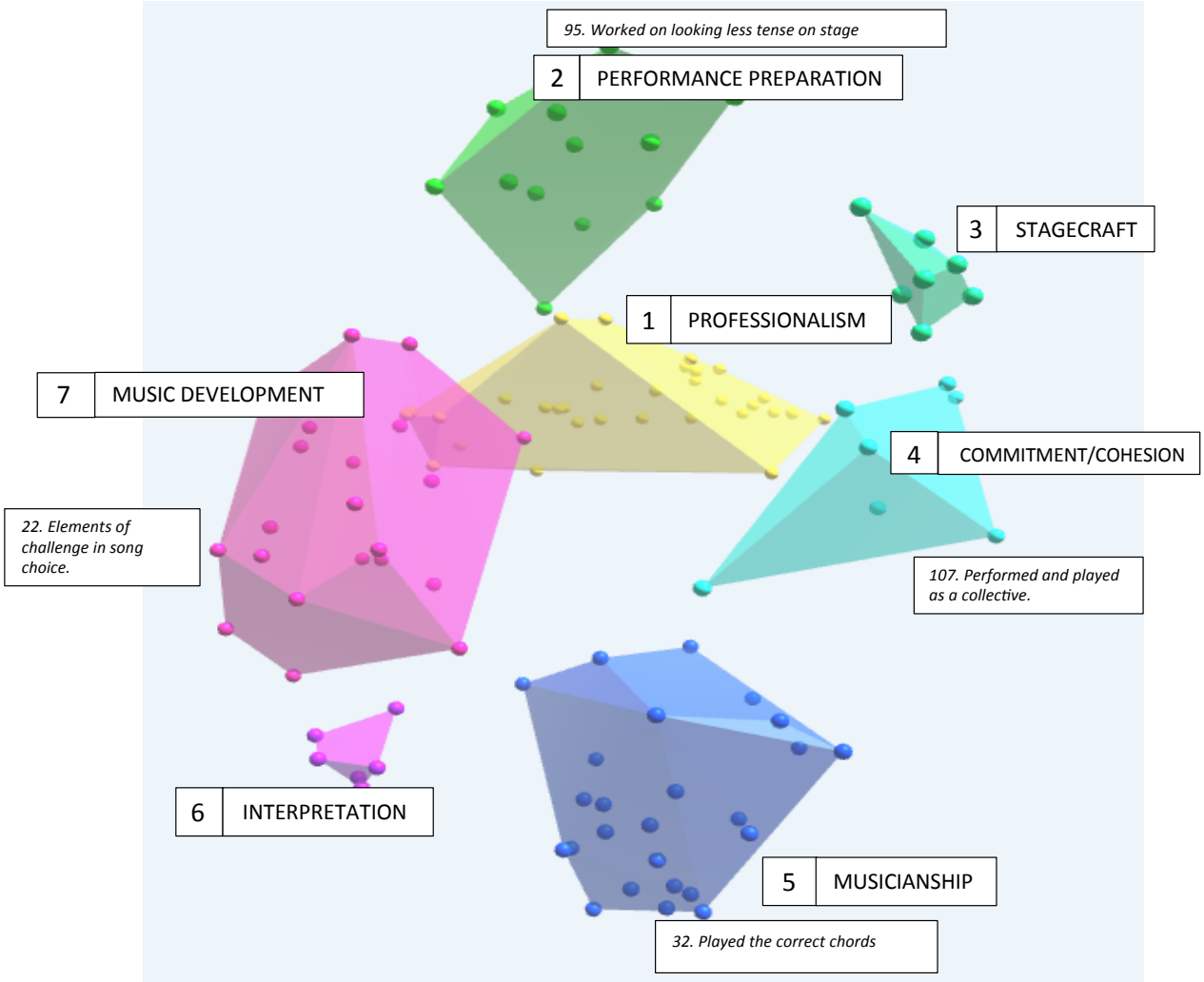


Figure 7. Three-dimensional multidimensional scaling solution for performance assessment items – showing clusters as numbered and labeled polygons. D1–D2 dimensions and items at the extreme ends of Clusters 2 and 5 (D1) and Clusters 7 and 4 (D2) are also shown.

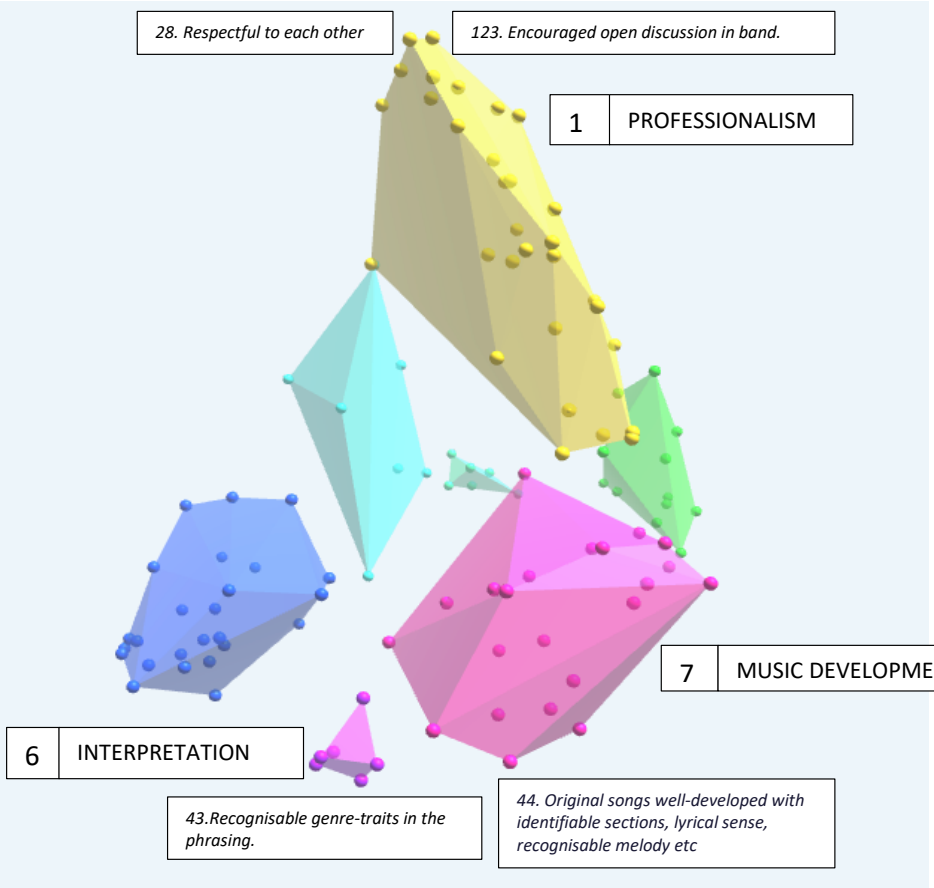


Figure 8. Three-dimensional multidimensional scaling solution for performance assessment items, showing the D3 dimension and items at the extreme end of Clusters 6 and 7.

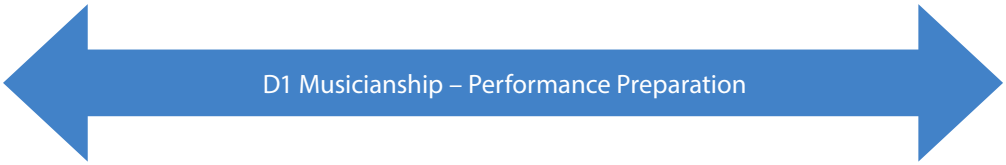
Discussion of clustering results

The 3D cluster view shows the similarity between descriptors as a three-dimensional spatial relationship. Each point represents an individual descriptor. Points that are closer together are those that were sorted more frequently into the same category. Polygons are shown over groups of cards that are clustered together. Each cluster is colour coded, numbered and labelled with participant-given names, as presented in Table 1. The seven clusters showed 46–76% agreement between participants.

Discussion of dimensions

The dimensional structure in the map can also provide information about the descriptor language domain. Item clusters that are spatially opposite in the map may form a dimension. Examining the properties of the items at each end of a dimension will determine any obvious change in attributes (Paea & Baird, 2018). Opposition in the map can be interpreted as dimensional structure. Inspecting the descriptor items at each extreme of the map suggests at least three dimensions:

Dimension 1: At the extreme end of Cluster 5 we find descriptors of skilled individual instrument playing or singing, and these closely map the original rubric band Accuracy and Musicianship. For example: *32. Played the correct chords*. Opposite these are items that reference performance preparation – outwardly-focused efforts, e.g., *100. Worked on posture for good performance* reflected in Cluster 2 (see Figure 6).

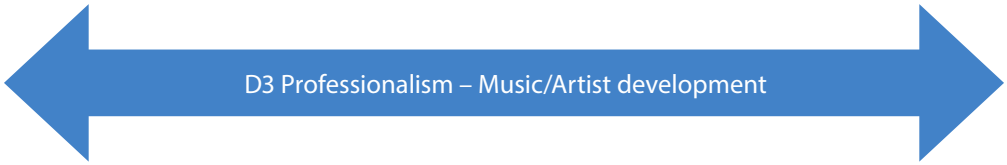


Items at extreme ends of Cluster 5: Musicianship, Musical & technical proficiency/skill, Musicianship, Awareness and application of technique	**Items at extreme ends of Cluster 2**: Collaboration, Stage performance, Aesthetic design, Communication, Practice, Artistic vision
125. Performed rhythm consistently accurately and with ease	100. Worked on posture for good performance
54. Notes played or sung accurately, and authentic to the selected piece	101. Planned options for interaction with audience
11. Played songs at correct tempo	102. Developed set choreography in the front line
13. Played the correct notes	103. Figured out how to have fun performing

Dimension 2: At the extreme end of Cluster 4 (see below) are located items that reference commitment and energy directed at cohesion and communicating emotion, and describe onstage audience-relational band 'live' energy or stagecraft, e.g., *26. Looked like they were enjoying themselves*, and includes the item, *52. Acknowledged band members with smile, posture, chemistry*. These may be subsumed under the description for the 5-Cluster solution – Peformance preparation (see Table 1). Opposite these items, at Cluster 7, are located items describing effective music preparation, i.e., groundwork for readiness to perform songs, and creative material-focused efforts.

Items at extreme ends of Cluster 4: Energy, Performance embodiment, Audience awareness	**Items at extreme ends of Cluster 7:** Preparation, Creative and technical exploration of repertoire, Awareness of effective performance techniques incl. songwriting craft
52. Acknowledged band members with smile, posture, chemistry.	106. Developed soloing skills
108. Made every song an interesting or fun experience	111. Tried different instrument arrangements and song arrangements
120. Focused on the pure feeling/emotional expression	118. Added own flavour or feel purposefully
122. Communicated feeling uniquely and creatively through performance	121. Chose octave that fit instrument to the mood

Dimension 3: Located at the outside edge of Cluster 1 are items that describe collective and collaborative efforts. There is no one cluster candidate in opposition. At Cluster 6 and 7 are located creative music development and interpretation efforts (see Figure 8).



Items at extreme ends of Cluster 1: Professionalism, Professional collaborative repertoire development, Communication skills (incl. empathy awareness), Participation	**Items at extreme ends of Cluster 6 and Cluster 7** Interpretation and Music/Artist development
110. Discussed cover songs that would work for our band and instrumentation	43. Recognisable genre-traits in the phrasing
123. Encouraged open discussion in band	111. Tried different instrument arrangements and song arrangements
113. Communicated their absence to other band members	118. Added own flavour or feel purposefully
114. Open to other band members' ideas and suggestions	14. Developed and performed parts appropriate for the genre (cover or original)/style/song

COMPARISON OF RESULTS WITH ORIGINAL MARKING RUBRIC CONSTRUCTS

When the emergent constructs of this study are compared with the original rubric (Figure 1), differences in attributions for some specific characteristics are noticeable:

Cluster 2, a groundwork Stagecraft construct, maps to Performer Stagecraft in the original rubric (Figure 1), though the latter is lacking specifics. Respondents perceived this as preparatory, planning ensemble skills like choreography and audience interaction, but also *103. Figured out how to have fun performing*. This conjunction of collective preparation and enjoyment is suggested in the study by Schiavio et al. (2022), in which affect and the collaborative dimension of music making come together: "Learning together involves an empathic, emotional, kind of musical intention, where skills can be developed within the group. This process can, in turn, help and sustain the ongoing dynamics of the lesson" (p. 3). Green draws on Csikszentmihalyi's contrasting of enjoyment with pleasure (Green, 2008, pp. 58–59) to explain her understanding of the role of enjoyment of music making. Pleasure involves bodily and mental gratification which "occur without much effort and which add no complexity to the self" (p. 57). Green relates enjoyment to issues around identity and autonomy that support the explanation put forward by Csikszentmihalyi for why the musicians in his study kept playing rather than stopping to analyse. He suggests that through acts of self-forgetfulness, an "expansion of self occurred from time to time as a result of the project activities for many pupils" (2008, p. 58). Cluster 2 also references collaborative work – onstage performance technical details, administrative tasks, and cohesion of material to be played – and it maps to both the Performer Stagecraft and Performance criteria (Figure 1). For example, *105. Worked on communicating visual cues to the band* and *132. Worked on set cohesion*.

Cluster 3 describes directed efforts at audience engagement and maps onto, but is also lacking in specifics in, the Performer Stagecraft band rubric (Figure 1): *Visual aspects and audience appeal and engagement*. However, *68. Responded appropriately to cues* and *107. Performed and played as a collective* hint at the finding in Schiavio et al.'s study that the ability to listen actively and respond to others is a skill most valued by tutors, and manifests in performance as awareness of non-verbal cues, eye contact, gestures, and responding to the other band members' playing (Schiavio et al., 2022).

Cluster 4 focuses on quality of performance – specifically emotional investment. For example, *108. Make every song an interesting or fun experience*. This also maps to Performer Stagecraft in the example rubric (Figure 1).

Cluster 5, which describes skilled instrument-playing goals, is certainly described by the specific *Timing, notes and pitch* and *Interpretation, feel* in Accuracy and Musicianship (Figure 1). However, *Cover material parts learnt* and

Parts developed (for original material including sounds) are perceived by respondents more as groundwork efforts and are related to Cluster 7. Green, in her study of the way popular musicians learn, identified a progression from parallel playing – exploring their 'voice'; group learning in a distracted sense – "loose imitation and improvisatory adaptation" (Green, 2002, p. 96) to focused, purposive rehearsal of the structure. This progression generally happens without any formal guidance, and assessment is ongoing, totally the musicians' responsibility and part of the collaborative nature of informal music-making. Green also notes that informal music-making is "seldom completely accurate." For example, in popular music the guitar solo cannot be merely accurate. This draws our attention to the dilemma highlighted by McPherson and Thompson (1998) that skill plus interpretation do not themselves alone constitute a performance, and that appreciation of the quality of a performance does not normally run from attention on components (technique, accuracy, etc.) to judgement of the whole piece. However, this cluster includes items that describe interpretation as well as those that describe skill.

Cluster 1, a construct that references collaborative, collegial, respectful rehearsal efforts directed at achieving synergy through strong communication, is most obviously mapped onto Professionalism. *Attendance – rehearsals, workshops, gig and review* are all Cluster 1 items, e.g., *27. Attended all rehearsals, workshops, performances and reviews*. Items in Cluster 1 referencing emotional regulation, e.g., *116. Did not let bad mood affect everyone else* map onto the specific descriptor *Attitude and communication* in the original rubric under the global measure Professionalism and Contribution (Figure 1). This cluster most clearly references the collaborative, collegial, group work described by Schiavio et al. (2020) as Ensemble Skills: "the interpersonal ability to foster and maintain good social and performative dynamics within groups of learners involved in joint music making" (p. 2). Items such as *114. Open to other band members' ideas and suggestions* and *115. Shared level of enthusiasm in rehearsals* reference working together as a team and involve affectivity – the capacity to feel emotions, in which empathy and emotion give depth to musical intention, and allow skills to develop within group work. This empathy can help create a safe learning environment, sustain expressivity and contribute to longevity and constructiveness of the lesson. Trust and empathy appear to be essential concepts underpinning successful ensemble performance (Schiavio et al., 2020, p. 8). They provide a foundation for skills development through collaborative music processes.

Cluster 6 describes efforts that focus on the genre-specific elements in the material to be played. Interpretation is the obvious match within the conventional rubric. *36. Chords and melodic lines complemented other motifs in original and re-arranged material.* Knowing how to play the style of the song involves understanding musical context. This cluster maps to Interpretation in the original rubric.

Cluster 7 indexes creative contribution to arrangements and performances, creativity and challenge, and preparedness to take risks in learning. This is captured somewhat in the original rubric by the item *Participation and engagement (bringing songs, suggesting arrangements, and ideas, being an active part of musical discussions)*, and in the *Artist Criteria: Original songs and song choices* (Figure 1).

LIMITATIONS OF THE STUDY

The large number of descriptor items appears to have dissuaded some participants from completing the card sorts. Although the web-based service was efficient in collecting and processing data for this study, the computer input interface may have also inhibited some participants. The present map appears to have more items and clumps in the center of the 'globe,' which makes looking for oppositions problematic. Including more participants may improve the spread.

DISCUSSION

The primary objective of this study was to examine the adequacy of domain definition in assessment of tertiary contemporary music performance. This was achieved via the two research objectives. Objective One involved developing a concourse of descriptors that comprehensively describe student and tutor perceptions of efforts that lead to successful performances. Through structured questionnaires and focus-group sessions, which included

unpacking incumbent performance assessment criteria, a concourse of 110 descriptors was arrived at that described a wide range of directed efforts. Discussions with tutors confirmed the relevance and supported the inclusion of many descriptors that they felt were absent from marking criteria they commonly use. Objective Two, an analysis of the descriptors aimed at identifying and validating possible latent structure, was achieved through MDS and hierarchical clustering analysis in OptimalSort where a 7-cluster solution was found to be acceptable. Analysis of the resultant map and investigation of the latent dimensional structure was motivated by the desire to clarify the theoretical underpinnings of music performance assessment criteria.

This MDS analysis was successful in unravelling the objective dimensions in perception underlying the performance domain, and demonstrated that while many of the specific aspects of the incumbent criteria were representative of important latent constructs in music performance learning, different dimensions accounted for the variability of specific items within the rubric structure. Results appear to support findings in the literature that the standard linear model of skills development through individual acquisition of information, and internalisation and repetition of outcomes no longer best explains music learning. Instead, as Schiavio et al. (2020, p. 9) claim, "It is within the complex, non-linear, interplay of factors internal and external to one's skillset that group dynamics can be successfully regulated and learning can take place." Music pedagogical delivery and assessment may benefit then by addressing some of the collectivist priorities described in this study, implementing the principles of Aotearoa New Zealand Maori Indigenous concept of whanaungatanga – fostering strong team culture, and a sense of belonging. Melhuish (2020), who studied collaborative potential at the same institute, proposes that in the context of Aotearoa New Zealand, "indigenous knowledge frameworks can be drawn on to help establish this team culture, for example implementing the principles of tikanga, whanaungatanga, whakaute, and manaakitanga, with the additional benefit of esteeming the worldviews of participating students who may otherwise have been sub-ordinated in the hegemonic educational structure" (p. 109).

Implications for music performance assessment

This study, then, has the potential to unravel some of the problematic aspects – the 'opposing dilemmas' – of performance assessment highlighted earlier. Emergent dimensions in this study, once validated by further research, will enable types of successful student and tutor strategies to be profiled. This may facilitate assessment that is better supported by tutor understanding of influences on learning and the effect of their own assessment decisions. Where learning strategies and tutor perceptions are made transparent, through feedback about the two-way process, insight into this complex domain of creative musical endeavour may inform a reconceptualisation of assessment. Melhuish (2020, p. 119) describes the idea of collective "sovereignty," which refers to "the agency of the members as a group, taking creative ownership of the project and controlling its path," where students' learning can be determined on their own terms. Facilitating collective, creative sovereignty may balance the neoliberal focus on private advantage that undermines opportunities for real collaboration in educational settings. With a robust tool to examine student and tutor perspectives, the potential also exists, for example, to investigate developmental consequences on music making inherited from two decades of commodification of education. Looking ahead, a similar method may be employed to map educational intervention strategies that are tailored to fit. Mapping the contemporary music performance tertiary assessment environment, then, allows us to model the way performance learning strategies are organised cognitively, and provide a framework for developing a robust rubric.

ACKNOWLEDGMENT

I would like to express my deep gratitude to David Bimler for his invaluable advice on the methodology and statistical analysis in this study.

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UNDERSTANDING AND RESPONDING TO STUDENT NEEDS IN TERTIARY AND VOCATIONAL EDUCATION: INSIGHTS FROM NORTHTEC

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https://doi.org/10.34074/proc.2206007

Teaching and Learning

This publication may be cited as:

Dang, A., and Raven, A. (2022). Understanding and Responding to Student Needs in Tertiary and Vocational Education: Insights from NorthTec. In E. Papoutsaki and M. Shannon (Eds.), *Proceedings: Rangahau Horonuku Hou – New Research Landscapes, Unitec/MIT Research Symposium 2021, December 6 and 7* (pp. 85–104). Auckland: ePress, Unitec, Te Pūkenga. https://doi.org/10.34074/proc.2206007

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ISBN 978-1-99-118340-8

ABSTRACT

Living in a low socioeconomic region, students in Northland, Aotearoa New Zealand have complex and diverse needs that interfere with their study efforts. This paper aims to understand student needs and how they are met in the case of NorthTec, the key onsite provider of tertiary education and vocational training, to tease out lessons and develop suggestions for improvement. Drawing on NorthTec's First Impression Survey (FIS) and Student Hardship Study (SHS) in 2021, the paper shows students' high satisfaction is linked to staff support, easy access to good-quality utilities and resources, and quality education and training at NorthTec. There remain unmet needs and tensions that require improvements by the institution, on which the authors will elaborate, for better educational outcomes for social justice and equity.

KEYWORDS

Northland, NorthTec, student needs and satisfaction, tertiary education, vocational training

INTRODUCTION

Northland is an economically poor region, with about 48% of its population being among the 20% most deprived population in Aotearoa New Zealand (Chiang & Exeter, 2019). Poverty is negatively associated with learning, educational achievement and overall well-being. Northland's geographic area and dispersed rural populations are characterised by limited resources and access to a tertiary education, and a lack of positive role models and support from families and the communities (Wages, 2018). In addition, socioeconomically deprived students usually have to work to support themselves and their significant others, so they are unable to focus fully on their studies. Their inability to meet basic needs can also lead to health issues (Baglow & Gair, 2019).

NorthTec is a key onsite institution offering tertiary and vocational education and training services in Northland. Many students at NorthTec suffer from hardship and have complex needs that interfere with their ability to study (Raven et al., 2021). Supporting students to meet their needs is important. This helps to improve students' satisfaction. Satisfaction has a strong connection with student retention (Dhaqane & Afrah, 2016; Eresia-Eke et al., 2020), achievement and overall wellbeing (Wilcox & Nordstokke, 2019), thus contributing to community development and poverty reduction. For NorthTec, student retention is essential to secure government funding, which is proportionate to the number of full-time equivalent students.

The First Impression Survey (FIS) and Student Hardship Study (SHS) were conducted at NorthTec in 2021, with a focus on student needs. SHS participants have multiple issues with hardship that interfere with their ability to study, while FIS participants expressed high satisfaction with NorthTec. This suggests that NorthTec has met the students' needs well, as subjectively judged by them. From their perspectives, what needs do NorthTec students have? How are these needs met? What lessons could be learned? What could be improved? This paper aims to address these questions using data from these two studies.

NEEDS AND RESPONDING TO THEM

According to Guillen-Royo (2014) human needs are motives for behaviour, a means to an end, or social requirements for a good life. Education is a considered to be a fundamental and universal need (Brock & Miller, 2019). It equips

people with skills and knowledge to learn, live and work well (Ministry of Education, 2020). Within education, needs could be the motivation for students' learning and achieving. Educators and all others who are involved also have their agendas, such as citizenship promotion for the state. These require such resources as time, effort, money, knowledge and facilities.

As needs are socially located and constructed (Watkins & Kavale, 2014), education needs are defined in the various relations between involved parties and are shaped by multiple factors across time and space. In traditional Māori society, adults in the whānau, iwi and hapū are responsible for children's education. They provide support, guidance and role models for children in daily activities to prepare them for their future adult roles and life (Calman, 2012). This reflects common features of Indigenous education and society such as collectivity, flexibility, informality, extended kinship and elder authority (Barnhardt & Kawagley, 2005). In contrast, the Western schooling system has a designated place (school), educators (teachers), peers (often the same age) and a standardised curriculum for learning (such as numeracy and literacy) (Woolsey Des Jarlais, 2009). The state provides funding and controls most aspects of education, with policies targeting national issues rather than local ones. There are complex relationships among the community, the state, learners, education providers, businesses and social services (Wood et al., 2020).

Needs are interrelated, and could be reinforcing, competing or conflicting. A learner's educational needs are linked to their other needs. They can be material, such as accommodation, food and finance (Carr & London, 2020; Leung et al., 2021), or social and emotional, such as peer connections (Hamilton, 2013). A learner engaged in learning, via which they develop good relations with peers and tutors, might be more committed to learning given the support and expectations from those peers and tutors. Life, work and study needs might work against each other and cause time constraints and stress to learners.

Needs are met by satisfiers such as practices, organisation and conditions (Brock & Miller, 2019; Mahlert, 2020). A satisfier can meet multiple needs, e.g., an apprenticeship allowing people to work, earn money, and gain experience and skills. A satisfier can meet some needs but prevent other needs from being met, e.g., work permitting people to earn money and pay for their living expenses but taking away time and energy needed for study. A satisfier can meet some needs but fail other needs. For example, Western training provides technical skills and knowledge to learners for work and better income, but its standardised approach focusing on individual learners fails to maintain collectivity and continuity of cultural heritage (Woolsey Des Jarlais, 2009). In Aotearoa New Zealand, schools have worked to assimilate Māori, and discourage and deny Māori language and culture (Walker, 2016). Satisfiers can combine to meet needs when students use both their strengths and resources from their connections to succeed.

Education needs could be met by the individual's efforts, the efforts of others, or both. Students might pay for studies using their savings from work (their efforts); receiving study grants, bursaries and scholarships (efforts of others); or study loans from the state with low or no interest rates and working to pay the loans after graduation (both). There is a high level of agency and independence if needs are met with one's own efforts. If needs are met with external support, an individual might lose agency and self-reliance. There might be abuse and control by providers, resulting in injustice and inequality. For example, well-off students benefit from the loan scheme much more than poor students because they tend to prepare, perform and achieve better, hence having better work and life outcomes (Acharya & Crampton, 2016). Many others, however, end up with debts that prevent them from buying a house or having children (Walters, 2021).

Limited and unevenly distributed resources can result in unmet needs. These particularly concentrate on the poor, disadvantaged, and/or marginalised groups who have little or no share of resources. Unmet needs could result in demotivation, dissatisfaction, lower quality of life, and even illness. For example, an individual might be unable to pursue studies given the high costs involved and no available external support. Without qualifications, they might work in unskilled jobs with low pay and be unable to afford good housing and services. This will lead to more inequity (Brock & Miller, 2019).

In sum, educational needs relate to other needs and the existing satisfiers. Together, they influence the way education and other needs are met or not met in particular cultural, social, economic and historical settings.

Examination of education needs in these relations and their contexts would help to gain insights, lessons for learning, and possible measures for improvement.

THE NORTHLAND CONTEXT

Northland has special historical and current conditions that set the scene for understanding NorthTec students' needs. The region was quite advanced by the mid-18th century, but since then has been devastated by colonisation and fallen into poverty (Coleman et al., 2005). In 2018, it scored lower than Aotearoa New Zealand's average in terms of work and income, health, education and training, quality of housing, and access to telecommunication systems for households. Social and economic disparities were higher, with 62% of the regional population earning NZ$35,000 or less per year, and 4.2% earning over NZ$100,000 per year compared to 53% and 7.6% respectively of the New Zealand population (Stats NZ, n.d.).

Despite these setbacks, Northland remains natural and culturally rich as part of its great potential. It has a warm climate, long coastlines, biodiverse fauna and flora, and other natural resources. Many outstanding historical and archaeological heritage sites remain, along with the rich and strong Indigenous language and traditions maintained by Māori, the tangata whenua, or people of the land (Orange, 2015). Of the regional population, Māori account for 36% and Pākehā account for 68%. Other minority groups include Pasifika, Asian, Middle Eastern/Latin American/African and others (Stats NZ, n.d.) This diverse population contributes rich cultural knowledge and practices to the region.

There is a high mobility rate; people circulate across rural and urban areas for jobs and vocations, while young people often move out for better education and job opportunities. People return to their rural base in times of economic difficulties, or on retirement. While this further reinforces the underdevelopment of rural areas (Orange, 2015), this migration pattern is common and sustainable, contributing to resilience because it creates a network to support out-migration and allows remittances to feed the origin economy. This, in turn, provides resources for people's livelihood if they are to return to their origin (Roohi, 2017; Shaikh et al, 2021).

Polytechnic restructuring

In January 2023 all regional polytechnics will become one organisational structure, namely Te Pūkenga – New Zealand Institute of Skills and Technology. Over the past two years, NorthTec, like all other polytechnics in the country, has contributed to the revision, planning, and resourcing in preparation. The change will mean courses and programmes will be standardised nationally in terms of structure, content and curriculum. While on one level this seems to make sense in respect of students being able to access a 'seamless' education, on another level there is the potential for loss of relevant and culturally adaptive curriculum, resources and methodologies.

NORTHTEC'S FIS AND SHS IN 2021

The FIS targeted all newly enrolled students at the start of Semester 1 and Semester 2 with 32 questions in total. The first ten questions were about respondents' sex, age, ethnicity, full-time or part-time study, and study location or campus. The next 19 questions asked for ratings of experience and satisfaction with pre-enrolment, enrolment, orientation and the first few weeks of study, and the likelihood of recommending NorthTec to a friend or colleague. Open-ended questions were "What, if anything, could we do differently to improve the enrolment process at NorthTec?"; "What additional information or support, if any, would have given you a better start at NorthTec?"; "What, if anything, can we do differently to improve the first few weeks for students starting at NorthTec?"; "Please tell us what aspects of your first weeks at NorthTec best helped your learning"; and "What one thing could NorthTec do to improve the score you gave in the above question?" The last three questions were about possible follow-up activities.

The SHS targeted students of the Social Services Pathway and the Nursing Pathway between July and August 2021. Its survey questionnaire had 37 questions, including 11 questions about respondents' study, age, ethnicity, sex, gender/sexual orientation and living situations. The remaining 26 questions asked respondents to rate their ability to meet basic needs and associated hardship, work and income, and other aspects of life and their benefits to/impacts on their study. Seven open-ended questions were Question 23, about serious health problems of respondents' children in the last 12 months; Question 28, about unpaid work and its relevance to respondents' study; Question 29, "If you are studying part time please explain how this has reduced hardship and or stress"; Question 30, "If you would prefer to study full time explain why you cannot do this"; Question 35, about the disabilities of respondents' dependents if any; and Questions 36 to 38, about aspects of life that significantly limited or assisted the ability to study, and the impacts of Covid-19 lockdown.

Both the FIS and SHS used emails and Microsoft forms to collect data online. The FIS provided hard copies for distribution to study pathways with limited access to the online survey. The pathway managers collected paper-based questionnaires and input them into the anonymous online survey. The number of hard copies used is unknown. The FIS received 759 responses in total. The SHS received 49 responses from the Bachelor of Applied Social Work (BASW) Programme and 24 responses from the Bachelor of Nursing (BN) Programme.

The authors exported the survey data from the Microsoft form into Microsoft Excel and analysed qualitative data and quantitative data separately. Qualitative data included responses to the FIS and SHS qualitative questions. We applied thematic analysis of these responses, firstly with a detailed reading of the responses to identify keywords, concepts, and other basic elements of the responses. We then searched for and developed themes (Kiger & Varpio, 2020) on needs and responses to needs. Quantitative data included FIS respondents' satisfaction ratings and SHS respondents' ratings of associated hardship, their ability to meet basic needs, work and income, and other aspects of life and their benefits to/impacts on their study. We used descriptive statistics, including frequency and cross table, to make sense of data distribution, and mean comparison to compare across age, ethnicity and sex groups of respondents.

While findings from the SHS are specific to current BASW and BN students, they illuminate the needs (and whether these needs are met) of the NorthTec student body, of which they form a part. Therefore, we combined and synthesised data analysis results to address the question of needs and meeting of needs while acknowledging that there remain gaps in the understanding of this topic.

SURVEY FINDINGS

Identified needs from the FIS 2021

The identified needs are study related and include the common ones such as information and communication; access to equipment, facilities, resources and services; staff, tutors and peers; as well as those specific to Māori, non-Māori, female and older students (see Figure 1).

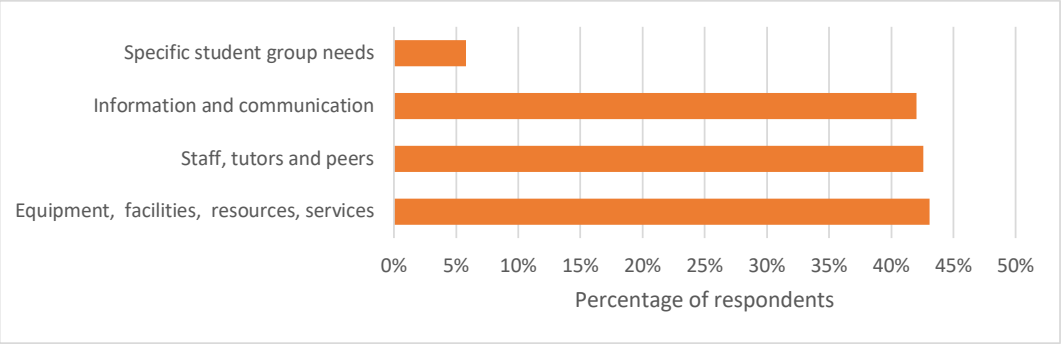

Figure 1. Major areas of needs identified in the FIS 2021.

Information and communication

About 42% of respondents needed clear, complete and prompt information about the required processes and procedures with 'step-by-step' guidance. This applied to enrolment, funding, the information technology (IT) network and services, course delivery and all general matters.

> *"Enrolment confirmation, clearer start dates and getting online logins etc. [Should be] sorted before you start your course."*
>
> *"I think being told of the wide range of supports at NorthTec and services available that your costs go towards."*
>
> *"Have a flow diagram of the steps a prospective student goes through from course selection to interview, acceptance to employment."*

Equipment, facilities, resources and services.

About 43% of respondents wanted adequate equipment, facilities, resources and services. They wanted comfortable and convenient classrooms, the library, cafeteria, student space and toilets.

> *"Upgrading bathrooms and some classrooms."*
>
> *"Having more classrooms fitting out for zoom capability."*
>
> *"Out-of-hours library access, sometime I arrive early, would be useful to be able to use the space to work easier in the morning."*

Respondents needed fridges, water dispensers, cups and cutlery for drinks and meals.

> *"We could do with a fridge at the [name removed] campus."*
>
> *"[P]acking basic cutlery, cups and plates should not have to be added to a priority on our to-do lists as travelling students."*

Respondents wanted sufficient, readily available and user-friendly resources. These included stationery, computers, learning materials, protective equipment and clothing such as bee suits in beekeeping, and learning materials such as sandpaper in carpentry.

> *"Better resources for ALL campuses."*
>
> *"Heaps more sandpaper."*

Respondents also asked for financial support, such as travel allowance, or assistance with finding some.

> *"Assistance with financial options like travel allowance."*
>
> *"Even if NorthTec cannot help, please point us in the right direction."*

Staff, tutors and peers

About 43% of respondents had needs related to staff, tutors and peers. They expected high-quality, easy and fast access to friendly, helpful staff in all support services.

> *"Have someone onsite who is a part of StudyLink to assist with any issues/queries we have."*
>
> *"Provide more staff when signing up. There was quite a wait."*
>
> *"[More] staff friendliness."*

They considered supportive and qualified tutors essential for students to have a good start at NorthTec. Tutors should have teaching capacity and be prepared.

> *"Provide a support tutor because we have a large class."*
>
> *"Ensure tutors are prepared and capable of fronting classes."*

Respondents expressed a need for tutors who were able to create a learning-enabling environment, provide for different student needs, and be technically fluent to support online learning.

> *"Some students are slower than others and fail to say; I believe tutors need to go around and check students' work more in case of help."*
>
> *"Having a tutor that knows NorthNet well to be able to show us how to use it."*

Permanent and sufficient tutor arrangement was seen as essential to ensure certainty in delivery.

> *"Not having a permanent kaiako … has caused a lot of uncertainty in our class and made the first few weeks a very unpleasant experience."*

Respondents also considered peers important for learning. Knowing classmates, making friends, and having positive and supportive classmates made them feel comfortable, engaged, and motivated.

> *"[G]etting to know your classmates as soon as you can. This will help keep you serious and focused cause you will help to motivate each other, being that at the beginning of the semester everyone has fresh energy."*

Respondents identified a need for group learning and teamwork, which positively contribute to learning.

> *"Meeting my peers. Us as a group having this hunger to learn."*
>
> *"Learning together is very helpful."*

Group-specific needs

About 6% of respondents mentioned group-specific needs. They had their preferred ways of learning and wanted these to be accommodated. Some wanted social contacts, practical hands-on experience, and face-to-face interactions with peers and tutors.

> *"More student activities on campus."*
>
> *"More … practice exercises."*
>
> *"[H]ave face-to-face inter[ractions] with tutors, to get a strong idea of what the course offers."*

Some Māori students wanted more te reo Māori, te ao Māori, tikanga, and support for their Indigenous ways of learning.

> *"Be more consistent. I thought this year had been changed to face-to-face learning and it is all online. For a Māori in Whangārei this is not good enough."*
>
> *"If it was more Māori emerged I would defi[nitely] recommend it because then I and my friends are more likely to connect better."*
>
> *"Being Māori, a pōwhiri is a must, also awareness of marae and wharekai use. Perhaps a sign or something to say it's booked or in use."*

Some other Māori students, however, were against such practices because they did not enjoy them or were not fluent in them.

> *"Not make it so Māori especially at the induction. I may be [of] Māori heritage but I don't really get into all of that stuff."*

> *"Some of us do not speak or know Māori language enough to understand, although [I] know we are Māori and I am proud. I think speaking a lot more in English than Māori whilst introducing us to NorthTec would [ha]ve been nice."*

Some non-Māori students were against such practices, thinking they were irrelevant to the subjects.

> *"Save te reo Māori for te reo Māori courses and stop including [it] in other technical subjects w[h]ere it has no relevance."*

The extra support provided to Māori students created a sense of unfairness or inequality in some non-Māori students, who wanted all to receive the same treatment.

> *"I feel a little uncomfortable with how my fellow Māori students are singled out. At times I've heard tutors talking with them about the extra assistance they can receive. I'd like to think we're all equals and any assistance should be given on an equal basis. Gratefully, we all have zero fees but there is still a financial burden that any ethnicity might have to deal with. We are forgoing full-time work, having to purchase basic tools (involving student loan), travel costs etc."*

> *"Prov[id]e the same amount of extra support for all students and not just the Māori students. It's almost reverse racism to the white students."*

A respondent raised the gender issue in the engineering programme and asked for a female tutor. Her comment indicates the need to address the gender imbalance, and possible disadvantages and adversity facing female students in this and other similar programme areas.

> *"A female tutor and more appealing to females, I am on the only woman in one of my classes and it feels awkward."*

Another group of students with specific learning needs are older students who return to study after a long gap and have retraining needs, particularly during the Covid-19 pandemic.

> *"Encourage more older students. With Covid-19 [and] many job losses, retraining would help many."*

Older students are often new to online learning, computers and information technology, and the fast pace of learning, and need more support and time to learn.

> *"[F]or older students … online learning is a huge challenge, and a gradual immersion process would have been easier … several (friends) have said that they would not be able to do 'computer-based study.' This is due to learning a different way of receiving information, having to seek out information by yourself as a student, and the different way in which older learners have been taught in their educational journey, which is generally by 'rote' or repeated learning ... off a blackboard. Many also feel they are 'too old' to learn."*

> *"Older students may need some IT support, maybe one on one."*

> *"Have classes for elderly students, which are not so fast and enable more questions to be answered as we learn at a slower pace."*

IDENTIFIED NEEDS FROM THE SHS 2021

The identified needs cover life and work, besides study, as shown in Figure 2. Of the respondents, 90% had unmet basic living needs, i.e., adequate food, clothing, shoes, housing and/or medical care, and 42% reported poor health or disability of self and significant others. Around 63% worked for money and 41% volunteered or cared for their

significant others regularly. This indicates the social expectation for them to contribute to community groups, organisations, and churches.

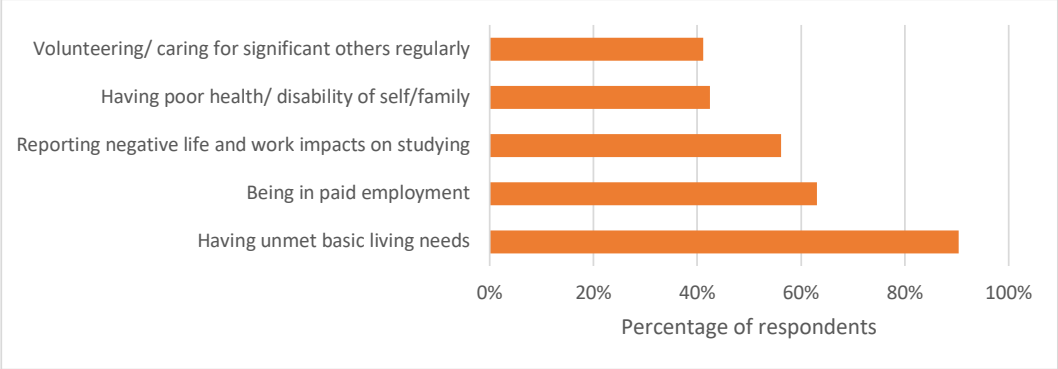

Figure 2. Life and work needs and their negative impacts on studying identified in the SHS.

About 56% of respondents reported negative life and work impacts on their ability to study. Hardship and inability to meet basic living needs made it hard for respondents to focus on study and forced them to work to earn more income.

> *"Financial hardship. It is impossible to focus when you are hungry."*
>
> *"Financial strain, that's why I started my study mid-year rather than February."*
>
> *"Finding time to work and study is hard. I have had to reduce work hours to be able to get decent grades."*

Working and caring for significant others took away time and energy from study.

> *"Juggling three children, placements impeding the ability to work and earn money."*
>
> *"Being a single parent, my child always comes first and I make sure his needs are always met before mine … my study time is limited to in-class and when he is asleep … However … after doing some much-needed housework and prepping (for him) I am generally fairly tired and find it hard to focus on my studies. I do feel if I had more time I would be able to do a lot better in my studies and put a lot more time and effort into them."*
>
> *"Parents getting sick and I am the only one who can drive them to appointments."*
>
> *"Child's anxiety around school caused many days off."*

In addition, stress and illness also hindered study.

> *"Having a baby last year and being very sick, I had to take the year off."*

MEETING STUDENTS' NEEDS: FINDINGS FROM THE FIS

Tutors, student activities, services, facilities, resources, course deliveries, peers and support staff were identified factors that best help with student learning (see Figure 3).

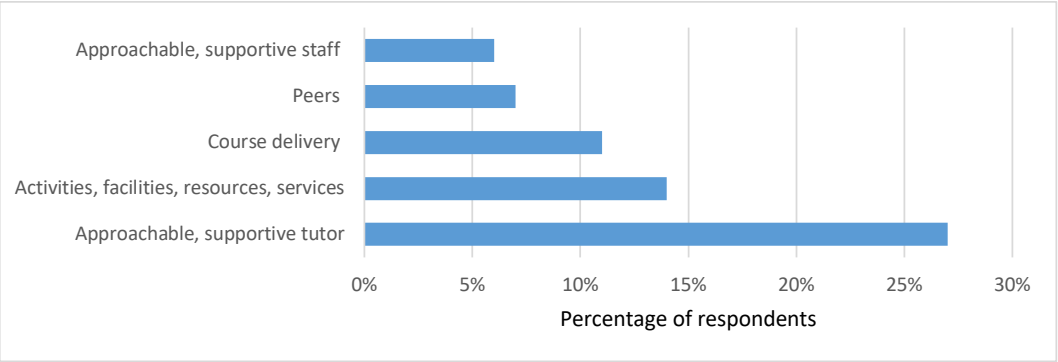

Figure 3. What best helps with students' learning in NorthTec (FIS 2021).

Over 26% of respondents considered that tutors who helped with their learning most were approachable, knowledgeable, friendly, helpful, and able to create an inclusive environment.

> *"Our tutors are really supportive and helpful."*
>
> *"Having our facilitator there to help … that one-on-one teaching time."*
>
> *"[The tutor] is an expert kaiako. As an orator, he is able to bring tikanga and te reo to life. He creates a warm and accepting learning environment, encouraging us to take risks. This is the most effective te reo teaching and learning I have experienced."*

And were informative and gave clear and hands-on instructions.

> *"I love the learning style of my teacher, it is very hands-on, a lot of student participation, and whilst there is a lot of content to learn it is fun."*
>
> *"The tutor was very helpful and thorough with her explanations, which made it easy and friendly to be there and learn at a pace that I could manage."*

Over 14% of respondents advised that student activities, services and facilities contributed to their learning experience at NorthTec. These included student support and access to study facilities such as the library, and the marae for overnight stays for students who travel from afar.

> *"The first week of orientation really helped me to find where the librarians and academic support was if needed."*
>
> *"Having the marae available to students who live afar."*
>
> *"When I have contacted IT staff they have been extremely helpful and patient with my lack of knowledge."*

Respondents reported that NorthTec also helped with brokering state funding, including student loans and student allowance from StudyLink for eligible people.

> *"StudyLink being able to pay for my study."*

More than 5% of respondents mentioned helpful and supportive staff as an important factor contributing to their learning.

> *"Thank you for such a timely response to this. IT staff and library staff have been very helpful with queries and ... FANTASTIC."*

Some respondents acknowledged NorthTec's current efforts to meet the needs of Māori students as a group.

"The tutors and the introduction and use of Māori within the learning environment made it really easy to feel comfortable."

Respondents also commended positive peers, mentors, and group learning and teamwork.

"General class feel was positive made it very easy settle in."

"Having mentors who are easy to talk to and learn from!"

"Being able to learn as a group."

Student satisfaction with NorthTec

The mean rating of survey respondents for the statement "I can say that NorthTec as an institution has lived up to my expectations so far" is 4.19 on a 5.0 scale, demonstrating high satisfaction with NorthTec. This is shared across demographic groups including ethnicity and age (see Figure 4).

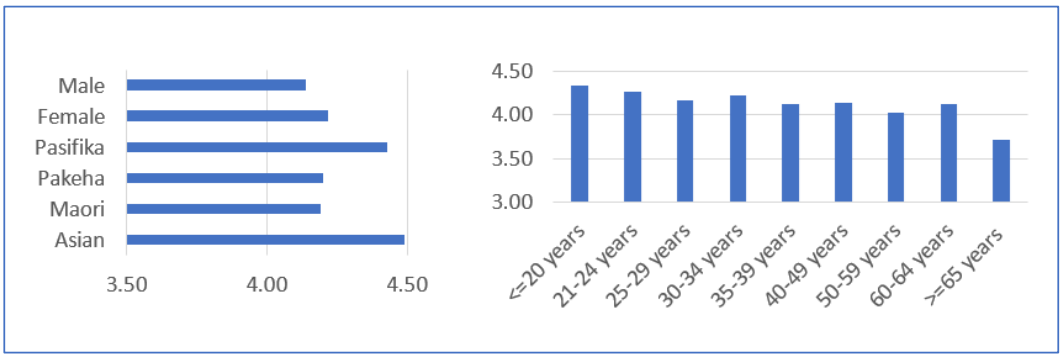

Figure 4. Student satisfaction ratings by ethnicity and age (FIS 2021).

MEETING STUDENTS' NEEDS: FINDINGS FROM THE SHS

Respondents actively sought to meet their life, work and study needs using self-support and support from their networks, including NorthTec, the state, work, whānau and community (see Figure 5). For 40% of respondents, whānau/family support, such as money, accommodation and emotion, significantly helped their study.

"My parents being able to help me with fuel money."

"[H]aving my nana living in Whangārei has allowed me to be close to course on my course days."

"My friends and family's encouragement and support."

Around 10% of respondents used support from NorthTec and the state. They mentioned the following:

"Northtec student support team. (Hardship.)"

"Online learning and Zoom. Library for peace and quiet study."

"Having the school marae open for students to stay, who live far away, is an amazing help!"

"StudyLink being able to pay for my study."

A similar percentage of respondents relied on their work and peers.

"Working part time has paid for my fees & study & living expenses."

"My job being flexible with hours."

"Friends at course are very encouraging."

Also, a similar percentage of respondents used self-support to meet their needs, that is, personal resilience, determination, perseverance, motivation and passion.

"Persevere through the hard times and having determination to meet the end goal of becoming a nurse."

"My motivation and passion to make a difference in reducing the inequities and inequalities of Māori in the New Zealand health system."

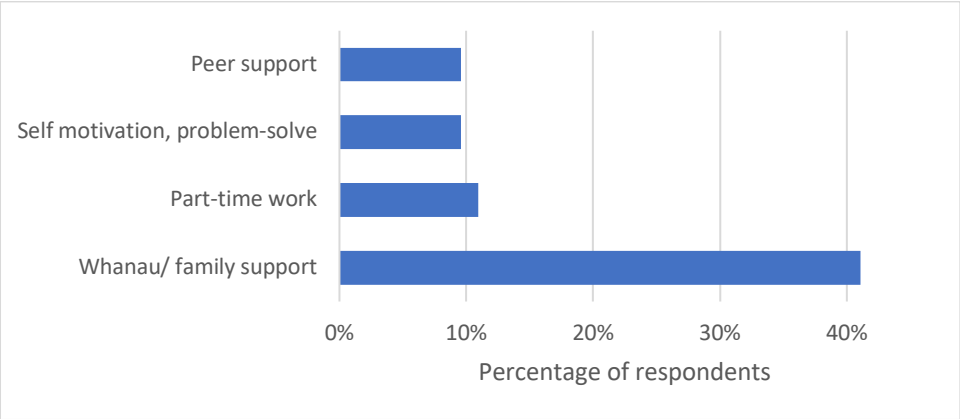

Figure 5. Aspects of life that significantly supported students' study (SHS 2021).

Respondents took self-care measures such as diet and exercise, therapy and medication, having structure and routine, ensuring stability and comfort, and following their faith.

"Therapy, medication."

"Diet and exercise."

"[M]y own faith – Christianity and daily devotions with God."

"Structure, routine and communication with family."

Respondents did gardening, participated in social services, talked to family and used good financial management practices.

"[G]rowing a vege[table] garden. [S]alvation [A]rmy, [M]iriam centre, [O]dyssey [H]ouse, whānau, my best friend [provide] support."

"Financial management, stability and comfort."

UNMET NEEDS: FINDINGS FROM THE FIS 2021

Some respondents' study-related needs remained unmet, including information and access to good-quality facilities and resources.

"I didn't receive any formal paperwork, no class timetables or class numbers. No invite to the pōwhiri for new students."

"We have no air conditioning in the class and seats are a bit uncomfortable when we have a long day in class."

"Have the café open on a Monday (which is the busiest day at NorthTec). Provide proper toilet facilities and hand-washing facilities nearer to horticulture."

Certain courses lacked learning resources and qualified and/or skilled tutors.

"Resources (coffee cups, bee suits) had not been checked in advance."

"I withdrew from my course because the tutor did not meet my expectations. She seemed to run out of energy after two hours [in class]. What we were learning didn't match the course outline and she was asking people to [do things] with no support at all. We saw what the other class was learning and it was a lot more than our class."

As previously mentioned, some group-specific learning needs stayed unmet. Briefly, pro-Māori students wanted *"More tikanga and te ao Māori"*, while some others were against such practices. Some non-Māori students wanted all students to have *"the same amount of extra support"*, given the extra support offered to Māori students. The unequal gender representation in the engineering programme was seen to disadvantage female students. Some older students were struggling with the digital enrolment process, digital learning and the new information technologies and associated styles of delivery.

UNMET NEEDS: FINDINGS FROM THE SHS 2021

As mentioned previously, the lack of adequate food, housing, heating, transportation and medical services were common for SHS respondents (see Figure 2). For many respondents, these significantly impacted their ability to study in the previous 12 months (see Figure 6). About 32% of respondents had time constraints and time-management issues.

"Finding time to work and study is hard."

"Being able to have time to study, and still work and … have time with my family."

About 28% of repondents had insufficient money to cover daily needs, petrol, car and bills, which significantly affected their ability to study.

"[F]inances[,] limitations on travel costs[,] seeing my family not being able to afford food."

Health issues of self and significant others affected 16% of respondents' ability to study.

"Mental health and wellbeing and suffering with anxiety, depression wondering how I [will] manage."

"Parents getting sick and I am the only one who can drive them to appointments."

Transportation issues, including petrol and car costs, maintenance and long distances to travel impacted 12% of respondents' ability to study.

"Travel distance, unreliable car, e[x]pensive to keep and run."

Home instability or housing issues affected about 4% of respondents' ability to study, and between 1% and 2% advised of other issues, including grief and loss, limited family support, the lack of a quiet space for study at home and a sporadic study schedule.

"Having a big family has made it harder to find time and quiet to study."

"Grief and loss, travel, home stability."

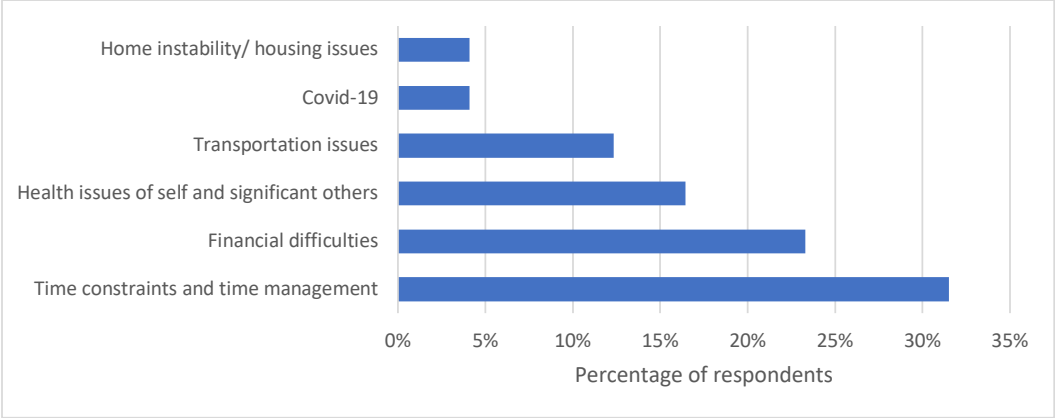

Figure 6. Aspects of life that significantly limited students' ability to study in the past 12 months (SHS 2021).

THE COVID-19 PANDEMIC: FINDINGS FROM THE SHS 2021

The Covid-19 pandemic has been a major factor restricting students' ability to study. Respondents had to do distance/online learning instead of the preferred face-to-face contact. Many found online learning to be difficult, including being easily distracted and having poor internet connections.

> *"I found Zoom very hard to follow. It is very easy to be distracted by other things when the tutor isn't physically in front of you."*

> *"I had really bad internet during lockdown due to everyone else being home and on the internet, so Zoom was not the greatest."*

Being without clinical practice was another issue caused by the pandemic.

> *"[I]t took me out of clinical and I lost valuable clinical skills."*

This left the need for social contacts and practical experience in education and training unmet and caused fear, and even mental illness.

> *"[H]ad my baby during lockdown, the isolation caused post-natal depression/affected grades."*

> *"… because of Covid a simple cough or cold makes attending class hard due to the safety of others in the class and not wanting to make them feel uncomfortable in class."*

Income shortages, travel restrictions, and isolation due to the pandemic made it harder for respondents to meet their basic life, work and study commitments.

> *"Being at home during Covid lockdown was hard to study because children were home and also with schooling needs."*

> *"Limited ability to see family, especially with un[p]redicted level changes."*

> *"[U]nable to travel to class, living rural with limited wifi, limited money due to no working due to Covid."*

DISCUSSION

Complex nature of needs

Many of the identified needs are complex and interrelated. For example, the life, work and study needs of SHS respondents and their families connect and influence each other either positively or negatively. On the one hand, resource shortages and limited or no access to adequate basic necessities go along with stress, illnesses and disabilities, and the need to work to earn more. Work and life demands, in turn, take away time and efforts from study, which reflects the findings in the literature (Baglow & Gair, 2019; Wages, 2018). In such circumstances, these needs compete for satisfiers, given limited resources. This is evidenced by many respondents reporting time constraints and time-management issues as they juggled with multiple needs of life, work and study. On the other hand, many respondents used self-support and resources from their family, friends, work, NorthTec and the state to meet their life, work and study needs.

As previously mentioned, the FIS respondents had shared and group-specific needs. Some were in conflict with each other, as in the case of Māori inclusion and extra support. Some students were happy with these measures; others were discontent, as they either considered them insufficient and wanted more, or considered them unnecessary or discriminative, and demand fewer or none.

Influence of historical development and contemporary society on needs

Many needs are linked to the historical development and contemporary contexts of Northland and Aotearoa New Zealand. The poverty and the complex associated needs of students responding to the SHS are part of Northland's current low economic status and prevailing poverty. These, in turn, are outcomes of the historical colonisation process in late the 19th and early 20th centuries (Coleman et al., 2005). As previously noted, the Covid-19 pandemic has accentuated many needs and made it harder for the SHS respondents to manage.

Student diversity, as evidenced by the FIS respondents, is part of the multicultural diversity trend, given the past colonisation, shifting migration and education policies. These policies have made Māori and Pākehā the dominant groups and other ethnic groups minorities (Simon-Kumar, 2019). The education system, which failed Māori during the colonisation period (Houghton, 2015; Walker, 2016), has now made attempts to compensate with Māori inclusion efforts (Macfarlane et al., 2012). However, the neoliberal arguments of individual rights, responsibilities and choices are underpinning other students' questioning such treatment and asking to be treated the same (Brian, 2016; Perez & Salter, 2019).

Some identified needs are influenced by past and present socially acceptable standards. The influence of the local community and relationships is evidenced in the need for SHS respondents to spend time and efforts on family, church and the local marae, or to provide care for extended family members in times of sickness. Air conditioning in the classroom, fridges, paper cups, water dispensers, coffee and sugar for community kitchens, and computers and internet access are all expectations of contemporary society. However, these were not there decades ago, which explains the needs of older students who have not been trained in nor are familiar with the use of computers, the internet and digital technologies in education. In a seemingly backward trend, engineering remains a male-dominant subject to this day (Eddy & Brownell, 2016), which explains the gender inequity and disadvantages reported by female respondents.

Dynamic relationship between needs and satisfiers

Both surveys reveal that satisfiers not only meet or fail to meet needs, but also create needs. For example, while NorthTec earns a high level of satisfaction from its students, the scarcity of resources and the complexity of needs necessitate negotiating and prioritising needs and satisfiers. Indeed, NorthTec provides extra support to Māori students, students in hardship and young students via youth-targeted programmes. Other student groups, such as non-Māori and older students perceivably receive less support or attention. These cause tensions, dissatisfaction,

and a sense of unfairness and exclusion, as shown by some FIS respondents. Another example is that NorthTec has developed online and hybrid modes of delivery in which computers and digital remote learning have partially or fully replaced face-to-face learning during the Covid-19 pandemic. However, the FIS reveals issues such as older students being unfamiliar with digital technologies or students living in rural areas with limited internet access. There is a need to support these students to overcome these issues.

The SHS shows that individual respondents and their families have demonstrated a high level of agency and independence in meeting their needs, using self-support and network resources. They have worked to earn money to cover living expenses and/or get financial support from parents and other family members. However, given the scarcity of resources, and poverty, they have had to negotiate and prioritise which needs to meet. They have had to cut their spending on essential items such as food and clothing, and delay their medical visits, or juggle life, work and study commitments. Consequently, unmet needs and inequality have continued as some students struggle to achieve learning outcomes. This could have negative impacts in the longer term, such as low work and income prospects and student-loans debt.

Areas for improvement

Based on the above insights, and in order to achieve better educational outcomes for all students, in the interests of social justice and equity in education, NorthTec should focus on better meeting the basic needs of deprived and vulnerable students, including food, housing and finance. Providing timely and adequate support to these students would help them to continue their studies, achieve well and overcome their deprivations in the long term (Carr & London, 2020).

NorthTec currently offers application-based student-hardship support, funding for wifi access and petrol vouchers. Availability of this support is communicated via student services and departments. A more pro-active approach is recommended, with early needs assessment and interventions to identify students with urgent basic needs and offer immediate interventions. Needs assessment could be done via student surveys, forums, direct feedback and discussion in class. Needs assessment could also provide input into course design and delivery that meets students' needs, and connects them with the right resources (McCawley, 2009).

To ensure the above process is effective, NorthTec should invest in developing a qualified and skilled workforce who understand and respond well to students' learning needs. This could be done via recruitment and ongoing professional development such as training, practical experience, supervision, and peer support including wellbeing support and forums on teaching and learning. Tutors and support staff could also benefit from regular supervision meetings with managers, where they could raise concerns and questions about students and how to respond to their needs. They could be paired up with an experienced mentor from the institution, to learn about the settings in Northland and NorthTec and the student population characteristics, their expectations and needs, and how to meet them. They could be guided on how to support students in learning and dealing with their life and work issues. This pooling of expertise would allow the better use of staff strengths and resources and help to develop a team spirit. Many tutors and staff could be alone in dealing with students and their difficulties, and be at risk of suffering secondary trauma and burnout (Uysal & Holloway, 2020).

Besides using the institutional and state resources, NorthTec could develop and mobilise resources from the community to meet all students' needs better. Students are resourceful, so peer networking should be promoted. Tutors could engage students in class check-ins, group activities and discussions. Peer mentoring, support groups and student forums could be safe spaces for students to communicate their needs, share interests, share information on support agencies and resources, and offer their knowledge, skills and others to students in need (Avci, 2018). For example, technically savvy students could guide others, especially older students, in computer use and digital learning, and well-achieving students could support others in subject-related matters.

As part of promoting peer networking, NorthTec should work more on inclusion and diversity. This could reduce tensions among student groups, such as those due to differential treatments between Māori and non-Māori, and

increase their understanding and support for the causes of these practices. This could also help to solve the gender issues in male-dominant programme areas. One approach could be to invest in finding and applying proven inclusive and diverse practices at all levels within NorthTec and with its partners. NorthTec should encourage staff members and students help implement of such practices.

NorthTec could partner with the community, service providers and suppliers, such as local foodbanks, housing providers, and suppliers of required learning materials, equipment and other resources, to allow better, cheaper and faster access for students.

> *"It should partner [with a] stationery shop in order to get discounts on computers and/or stationery."* (FIS respondent)

Having social workers on site, possibly coming from community services, could be useful, as they could carry out comprehensive assessments and support planning with students to address underlying issues such as mental illnesses, for students with more complex needs (Carr & London, 2020; Leung et al., 2021).

CONCLUSION

Respondents to the SHS reported complex, connected but competing life, work and study-related needs. These needs and what satisfies them are in a dynamic relationship, and are influenced by local, regional and national settings. Respondents and their families demonstrated a high level of agency in meeting their own needs using their strengths and resources from work, family and NorthTec.

In the FIS, NorthTec earned high satisfaction from most respondents, who received clear and on-time communication and efficient support services. Respondents reported having access to convenient and accessible facilities and resources, and high-quality and effective course and programme delivery. Tutors and staff members were reported as playing an essential role in meeting their students' learning needs. Good tutors were defined as approachable, knowledgeable, friendly, helpful, inclusive and informative, able to give clear and hands-on instructions that helped most with students' learning. Good staff members were also reported as being approachable, friendly and helpful, and providing excellent services. Some respondents also commended NorthTec for its support for targeted student groups, such as student hardship funding and Māori inclusion practices.

However, there were still unmet needs, such as food and housing, for many SHS respondents. Some FIS respondents reported unmet study-related needs, such as skills to use information technology and digital learning for older students. Some courses or programmes were seen as lacking resources or skilled tutors to deliver them. Some facilities and resources were considered poor. Some Māori students wanted more te reo and te ao Māori inside the classroom and on campus. These unmet needs could have negative impacts for the individuals and for NorthTec

To ensure social justice and equity in education, NorthTec should prioritise support for the basic needs of deprived and vulnerable students with a more pro-active approach, including early needs assessment and interventions. It should invest in tutors and support-staff members in order to provide good-quality and effective services to students and respond to their needs faster and better. NorthTec should develop and mobilise more resources via partnering with service providers for supplies and resources. It should also promote peer networking among students including work on inclusion and diversity.

This examination of students' needs and their satisfiers at NorthTec is based on the qualitative and quantitative responses from the SHS and FIS in 2021 and is by no means exhaustive. These responses warrant further in-depth inquiries into what has helped students most and what could be done further, as well as staff and students' experiences. In terms of improvements, a suitable approach should be identified for use to support this work, and inputs are required from the leadership, management, staff members, students and local stakeholders.

Staff and student satisfaction surveys provide timely feedback for institutions on their students' experiences and expectations. As this analysis shows, they have great potential, permitting understanding and identification of

areas for improvement and input from students. However, to fully realise this potential, more investment in terms of human resources is needed for data mining and the reporting process.

ACKNOWLEDGEMENTS

NorthTec's First Impressions Survey 2021 was implemented by an in-house team of researchers led by John Stansfield. The Student Hardship Study 2021 was jointly implemented by the Social Services Department and the Nursing Department, and led by Anthea Raven. The two studies received full support from NorthTec leadership, management, staff members and the participating students who made essential contributions to their success.

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MALE SECONDARY-SCHOOL STUDENT ENGAGEMENT RATES WITH SCHOOL COUNSELLORS, AS COMPARED WITH FEMALE ENGAGEMENT RATES

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https://doi.org/10.34074/proc.2206008

Health and Wellbeing

This publication may be cited as:

Pizzini, N. (2022). Male Secondary-School Student Engagement Rates with School Counsellors, as Compared with Female Engagement Rates. In E. Papoutsaki and M. Shannon (Eds.), *Proceedings: Rangahau Horonuku Hou – New Research Landscapes, Unitec/MIT Research Symposium 2021, December 6 and 7* (pp. 105–114). Auckland: ePress, Unitec, Te Pūkenga. https://doi.org/10.34074/proc.2206008

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ISBN 978-1-99-118340-8

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ABSTRACT

This article reports on a statistical investigation into the engagement rates of male secondary-school students with school counsellors in co-educational state secondary schools in Aotearoa New Zealand. The data analysis evidences a discrepancy between the engagement rates of male and female students, substantiating what has been known anecdotally: that male students are less likely than their female peers to meet with school counsellors. Data from 2615 counselling records across eight schools nationwide indicate that male students engage between 3% and 11% less than their female peers. Further research in 2022 is planned to investigate any barriers or constraints that could account for this discrepancy and expose possible facilitative factors that may increase male student engagement rates with school counsellors.

KEYWORDS

School counselling, male secondary-school students, youth mental health

BACKGROUND

Youth mental health has long been a concern in many countries (e.g., Arora et al., 2016; Gulliver et al., 2010; Quinn & Chan, 2009; Rickwood et al., 2005; Sagar-Ouriaghli, et al., 2019; Setiawan, 2006). Young people in Aotearoa New Zealand have poor mental health outcomes compared to youth in many other countries (Clark et al., 2013; Crowe, 2006; Gibson, 2022). The Youth 2019 report (Fleming et al., 2020) states: "youth emotional and mental health appears to have worsened compared to previous Youth 2000 surveys in 2001, 2007 and 2012, with most of this change occurring since 2012" (p. 1).

Male secondary-school students are over-represented in negative mental health/wellbeing statistics when compared to female peers (e.g., Hughes et al., 2019; Coronial Services of New Zealand, 2021). One example in the Aotearoa New Zealand context is that male youth suicide attempts increased from 2012 to 2019, while those of female youth declined (Fleming et al., 2020) and, while the Chief Coroner reports suspected suicides for females and males in the 15–24 age range held steady between 2018 and 2019, male deaths in that time period remain more than twice that of females (44 females and 94 males) (Ministry of Health, 2022).

From such mental health and wellbeing indicators it is clear male students grapple with mental and emotional difficulties and yet they make the least use of the support available to them (Gibson, 2022). It is well known anecdotally by school counsellors across Aotearoa New Zealand that, as a population group, male students are less inclined to seek counselling support to the same extent as female students do (e.g., Hughes et al., 2019; 2018). This article reports on a detailed analysis of counselling log statistics to evidence and quantify this gendered disparity in engagement rates.

A follow-up study is planned to determine whether there are barriers or constraints contributing to male secondary students' lower rates of engagement with school counsellors. Facilitative factors supporting males to seek counselling at schools will also be investigated. Thus, the current study provides a factual foundation for future research that will seek solutions.

With every young person legally required to attend school until the age of 16, the presence of counsellors at school is arguably the front line of mental health and wellbeing support for young people in Aotearoa New Zealand. The Education Review Office (2013) states that every student should be able to access counsellors at school because it's free, on-site, and within the context of a student's lived experience of their secondary-school community. The presence of barriers to males seeking this counselling support at school would indicate a need for change to enable greater access to one key mode of support.

METHODS

To build a quantitative picture of comparative engagement rates, an analysis of school counsellor logs (statistical records of appointments by age, year group, sex and ethnicity) as recorded in CounselPRO (a professional appointment-management software tool that many schools purchase to manage counselling records) was undertaken from participating schools for Term 2, 2019. This time frame was selected as 2019 was prior to the disruption of Covid-19 and, in most schools, the daily routine is well established by Term 2. The second term also tends to be a focused period in the rhythm of secondary schools, without exams or many of the other disruptions that often hinder student availability to attend counselling appointments.

The analysis undertaken examined each school's data in relation to that school's student-body demographics, as derived from the annual Roll Return required by the Ministry of Education. Thus, it was possible to construct comparative engagement data according to gender, year level and ethnicity.

A note about sex designations:

School enrolment data frequently offer only binary sex categories (Male/Female) (Hughes et al., 2018; A. Jang-Jones, Ministry of Education, personal communication, 22 October 2021). While an increasing array of sex-identity categories is being claimed by young people, this analysis focuses on male students (self-proclaimed or recorded as such in the data), as compared with female students. The author acknowledges that the experiences of non-binary, gender-fluid and transgender students are crucially important to explore, and deserve their own investigation.

THE DATA

Many schools purchase CounselPRO appointment-management software to record consultations, manage student information and produce reports. Soliciting data sets from schools using this tool was intended to provide consistent reporting of tabulated numerical data in a way that required minimum staff time (the data were already collated, and reports are easy to create). Student names were not part of the data.

From an initial list supplied by CounselPRO of over 100 schools in Australia and New Zealand, 47 co-educational state secondary schools in Aotearoa New Zealand that used CounselPRO in Term 2, 2019, were identified. An email was sent to the school counsellor at each school, outlining the research and asking the school counsellor to prepare electronic copies of five standard reports from CounselPRO.

The reports requested were of 'Student numbers by' the following criteria:

- Year level
- Classification (of student's primary concern)
- Ethnicity
- Referral source
- Number of consultations

Participant schools' 2019 Roll Returns (official roll data collected by the Ministry of Education) were accessed from the Ministry of Education website (Education Counts, 2022).

PARTICIPATING SCHOOLS

The criteria for participant schools were that they were co-educational, with school counsellors on site, and used CounselPRO to record appointment statistics in Term 2, 2019. Of the 47 potential participant schools invited to contribute, eight provided their CounselPRO reports in time for the analysis, along with consent forms co-signed by the school counsellor and principal.

A thumbnail overview of each school, drawn from recent Education Review Office (ERO) Reports (Education Review Office, 2022), is provided below to demonstrate the diversity of school cultures represented in this study. The gender (denoted as sex) break-down of each school's total roll is also provided (Education Counts, 2022).

School A: Northland *2019 Roll: 1960* *Male 51%, Female 49%*

This school serves a seaside community north of Tāmaki Makaurau Auckland. As the only secondary school in the vicinity, it has a significant place in the local community. This school provides education for students from Years 7 to 13. The school engages students and promotes their progress and achievement. Students achieve very well in National Standards and NCEA qualifications. There is also a strong focus on manaaki, in which the school ensures that positive values are promoted and that students' wellbeing needs are well met.

School B: Auckland, inner city *2019 Roll: 1699* *Male 54%, Female 46%*

This school is located in an inner-city suburb and caters for students from Year 9 to 13. The school is well supported by its community and many families in the neighbourhood choose to enrol their children there. Since 2007 the school has had an enrolment zone for the mainstream school because of demand for places. The school provides high-quality education through a responsive and innovative curriculum that offers rich opportunities for students' learning and qualifications success.

School C: Auckland, south *2019 Roll: 587* *Male 50%, Female 50%*

Situated in one of Tāmaki Makaurau Auckland's predominantly Pasifika southern suburbs, this school provides a caring and respectful learning environment. Classrooms are settled places for students' learning. The school caters for students from Years 9 to 13 and is experiencing a growing roll. For many students, generational connections promote a strong sense of family and belonging in the school. Most students have Māori or Pacific heritage.

School D: Auckland, west *2019 Roll: 1426* *Male 49%, Female 51%*

Located in a western suburb of Tāmaki Makaurau Auckland, this school caters for students in Years 9 to 13. The school has a positive profile in its community and a growing roll. Nearly 15% of students are Māori and 5% have Pacific heritage.

School E: Bay of Plenty *2019 Roll: 956* *Male 50%, Female 50%*

This school caters for students in Years 9 to 13 in a community with a choice of secondary-school options. The school's mission statement is underpinned by the values of achievement, respect and responsibility. Students are encouraged to give their best effort, to be considerate and appreciative of others, to look after the school environment, and to be accountable for their actions.

School F: Hawke's Bay *2019 Roll: 905* *Male 42%, Female 58%*

This school serves a wide geographical area. It has experienced considerable roll growth in recent years. The school's mission is to provide co-educational learning opportunities that inspire students to achieve a wide range of

successes, to grow self-esteem, and to develop high standards that enable them to become successful members of society.

School G: Wellington Region *2019 Roll: 712* *Male 49%, Female 51%*

This urban school is ethnically diverse, with 24% of students identifying as NZ Euopean, 33% as Māori, 21% as Pacific, and 22% identifying from a wide range of other nationalities. About one third of the students speak English as a second language. The college has substantial links with its local community, including contributing schools.

School H: Otago *2019 Roll: 1,143* *Male 47%, Female 53%*

The only South Island school participating, this school provides education for students in Years 7 to 13 in a provincial town. Twelve percent of students identify as Māori. The school regularly hosts a small number of international students. In addition to the New Zealand Curriculum, the school offers industry training programmes in engineering and primary industries.

RESULTS

The findings come from a total of 2615 counselling entries: 965 with male students (37%), 1483 with female students (57%) and 167 (6%) with non-binary students across the eight participating schools.

Surprisingly, the data sets were not consistent. As mentioned previously, the Ministry of Education Roll Returns do not offer a non-binary sex category, yet CounselPRO does. Counsellors in schools A, C, E and H included a non-binary category (Table 1, "% NB") while the others did not (Table 1, "n/a"). This discrepancy has resulted in some inconsistencies in male/female statistics.

In addition, different counsellors record their statistics differently. Schools B, G and H recorded data by the number of individual clients, while the remaining five schools recorded their data by the number of consultations (potentially recording multiple entries for the same client, each time they attended a consultation). The number of unique clients in these schools was not provided (Table 1, "data not provided"). Thus, direct comparisons of engagement against the school roll were impossible for those five schools.

TABLE 1. SUMMARY OF DATA.

	School A	**School B**	**School C**	**School D**	**School E**	**School F**	**School G**	**School H**
Region	Nthland	Auck Central	Auck Sth	Auck West	BoP	Hawke's Bay	Wellington	Otago
Roll	1960	1699	587	1426	956	905	712	1143
# Sessions	889	213	295	211	423	294	96	194
% M	46% -8	48% -4	22% -6	37% -26	25% -45	31% -38	29% -42	40% -19
% F	54%	52%	28%	63%	70%	69%	71%	59%
%NB	<1%	n/a	50%	n/a	5%	n/a	n/a	1%
# Clients	Data not provided	214	Data not provided	Data not provided	Data not provided	Data not provided	96	194
% M roll		11% -3.4					7.8% -11.2	14% -5
% F roll		14.4%					19%	19%
% of roll		12.5%					13.5%	17%

Despite the variation in data, when translated into percentages for each school the results definitively show male students make up a smaller percentage of clients across all schools (Table 1, "% M"). The red numbers in Table 1 quantify this disparity. Schools A, C, D, E and F (reporting by the number of sessions) indicate male students represent a significantly smaller percentage of sessions (Table 1, "% M"). For schools B, G and H (reporting by unique clients), male student clients represent a smaller proportion of the total male student population than do female student clients at the same school (Table 1, "% M roll"). Explanations for these differences are not discernible from these figures alone, indicating that more detailed data collection is required.

Table 2 shows the comparative difference in the percentage of male students engaging with the school counsellor by year level (figures in red indicate a negative percentage difference for males compared to females, Table 2.).

TABLE 2. PERCENTAGE DIFFERENCE BETWEEN MALE AND FEMALE ENGAGEMENT, BY YEAR LEVEL.

School	A	B	C	D	E	F	G	H
Yr	% Dif	% Dif	% Dif	% Dif	% Dif	% Dif	% Dif	% Dif
7	+3							-1
8	-7							+10
9	+10	+5	+17	-6	+6	+13	-9	+22
10	-3	+3	-12	+5	-13	-7	-12	-9
11	-6	-5	-7	+10	+17	+3	-4	-11
12	0	-1	+2	-5	-8	-5	-27	0
13	+3	-2	0	-4	-2	-4	+55	-1

These data show that in the two Year 7–13 schools (Table 2, "A" and "H"), the younger male students engaged more with the counsellor than their female peers (+3 for Year 7 males in School A, and +10 for Year 8 males in School H, Table 2). This scenario changes over in Year 10 for those schools and in Year 11 for the Year 9–13 schools; at those points, respectively, female students engage more (Table 2). Again, an explanation for this difference is not discernible from the data and warrants future investigation.

When the percentage of engagement is focused by ethnicity as reported in the CounselPRO reports (Asian, European, Māori, Other, Pacific, or not given), a further detail of difference appears (Table 3).

TABLE 3. PERCENTAGE OF STUDENT CLIENTS BY ETHNICITY.

School		A %	B %	C %	D %	E %	F %	G %	H %
Asian	M	11.4	5.4	-	6.5	-	15	2.1	-
	F	8.2	9	-	21	47	-	2.3	10
	NB	-	-	-	-	21	-	-	-
Euro	M	47	10.8	-	31	34	15.3	8	24
	F	58	13.5	-	16	66	18	40	27
	NB	-	-	80	-	-	-	-	-
Māori	M	48	12	27	14.5	35	28	6	14
	F	58	18	36	17	60	57	19	60
	NB	-	-	44	3.2	3.2	-	-	-

Other	M	56	28	-	25	25	-	38	-
	F	-	38.5	-	22	-	-	-	-
	NB	-	-	40	-	-	-	-	-
Pacific	M	28	19.5	28.7	72	-	-	-	16
	F	11	14.4	38.1	27	67	12.5	16.4	27
	NB	-	-	15.5	-	-	-	-	V -
Not Given	M	1.4	-	-	-	-	-	-	4
	F	3	0.1	-	-	1.3	-	-	4.8
	NB	-	-	-	-	0.1	-	-	0.5

For the schools reporting numbers by individual students (Schools B, G and H, Table 1) the percentage of the total school roll seen by counsellors was 12.5%, 13.5% and 17% respectively. This contrasts significantly with the scores reported in Table 3, which shows a higher percentage of the student body of particular ethnicities engaged with the school counsellor in every school (e.g., School A, Euro M 47% and F 58%, Māori M 48% and F 58%, Table 3). The orange areas pinpoint where female rates exceed male rates (Table 3).

Of significant difference is the incidence of higher percentages for male students (highlighted in red) than their female peers.

The current analysis was not able to theorise a rationale for these higher engagement rates.

DISCUSSION

Existing literature clearly recognises that a significant number of young people in Aotearoa New Zealand secondary schools experience mental health and wellbeing issues that may be ameliorated through work with school counsellors (Crowe, 2006; Clark et al., 2013; Dewhurst et al., 2017; Knight et al., 2018). And yet the Youth 2000 national youth health and wellbeing survey (Adolescent Health Research Group, 2003) reports that half of the students surveyed had not sought assistance from health services during a time of need due to a wide range of barriers (no gender breakdown was provided). This article shows that something is up for male students in particular that has them less engaged than their female peers in utilising the resource of school counsellors.

While this article reports on an analysis of counsellor statistics from a small number of schools (n = 8) with different recording processes, the case is evident that male students appear less often as counselling clients across all the schools, according to the percentage of the total school roll these male clients represent (Table 1, "% M"). While the data sets analysed cannot shed light on the factors contributing to this discrepancy, the statistical difference in engagement rates is clearly evidenced.

While the data for schools A, C, D, E and F were based on consultation numbers (rather than individual students/ unique clients) they could still indicate that for a variety of ethnicities in many schools, higher percentages of both male and female students are accessing the counsellor (Table 3). Contrast this finding with schools B, G and H, for whom the statistics gathered were for unique students (rather than "by consultation"). In those schools, 12–16% of the total school roll was shown to engage with school counsellors (Table 1, "% of roll"), which could suggest a more typical percentage rate of engagement. Again, the higher engagement rate for these ethnicities lies outside of the scope of this analysis and cannot be explained by the current data; further investigation is warranted.

The data also show that while male students from a wide array of ethnicities identified in the demographic data engage with school counsellors at a higher rate than an overall male rate of engagement (Table 3), there are still only a few instances in which male engagement rates are higher than those of female peers of the same ethnicity

(e.g., Table 3, School A, "Pacific", and School D, "Euro" and "Pacific"). Similarly, there is an indication in the data that younger male students might be more amenable to engaging with school counsellors than older male students. Explanations for both of these findings lie outside of the scope of the current analysis and cannot be explained by the data presented here. These topics are worthy of further investigation.

This analysis raises many questions: Why are male students engaging with school counsellors less frequently than female students when there is clear evidence of the extent of mental and emotional distress among young males in Aotearoa New Zealand? Why do males from some ethnicities in some schools have higher engagement rates than in other schools (e.g., Table 3, "Pacific" in School A and D but not in school C)? Does the age of male students affect their willingness to engage with school counsellors? How can the varying rates of male engagement across these schools be accounted for? More generally: are there constraints and barriers (real or perceived) that disincline male students from seeking the support of school counsellors, and are these unique to males (i.e. not experienced by female students); or, do female students enjoy more facilitative factors than male students? What could schools or school counsellors do that might encourage male students to seek support from the counselling offered in their co-educational secondary schools?

Further research, currently underway, explores such questions. The aim is to identify any barriers male students may experience when seeking or considering accessing the school counsellor, and to identify facilitative factors to support male students' engagement with counselling at school. The longer-term goal is to help create conditions whereby these students are more likely to obtain services that could contribute to their wellbeing.

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USING SOCIAL CAPITAL TO MITIGATE IMPACTS OF COVID-19: LESSONS FROM RETURNING MIGRANT WORKERS AND THEIR FAMILIES IN A LAOTIAN PROVINCE BORDERING THAILAND

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https://doi.org/10.34074/proc.2206009

Community and Society

This publication may be cited as:

Dang, A. (2022). Using Social Capital to Mitigate Impacts of Covid-19: Lessons from Returning Migrant Workers and Their Families in a Laotian Province Bordering Thailand. In E. Papoutsaki and M. Shannon (Eds.), *Proceedings: Rangahau Horonuku Hou – New Research Landscapes, Unitec/MIT Research Symposium 2021, December 6 and 7* (pp. 115–130). Auckland: ePress, Unitec, Te Pūkenga. https://doi.org/10.34074/proc.2206009

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ISBN 978-1-99-118340-8

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ABSTRACT

In the global context of the Covid-19 pandemic, migrant workers and their families are subject to job cuts, state-imposed restrictions, hostility, discrimination, prejudice and harassment from communities who fear catching the virus from them. They receive little or no state support compared to other population groups. How have migrant workers and their families managed these challenges? What could be learned from them in terms of pandemic management and support to vulnerable groups? Findings from a study in a Laotian province bordering Thailand show that returning migrant workers and their families sourced and used social capital to mitigate the impacts of the first wave of Covid-19. Their social-capital strategies have helped them to cope with the pandemic. Implications are discussed along with recommendations for support and intervention.

KEYWORDS

Covid-19 impacts, migrant workers in Laos, resilience, returning migrants, social capital

INTRODUCTION

Social capital is represented by the resources available to individuals via social networks. It is essential in mitigating the multiple effects of adverse conditions such as conflicts, wars, natural disasters, and most recently the Covid-19 pandemic (Behera, 2021). However, the ways that social capital contributes to the responses to these conditions by individuals, families and groups are diverse and much remains unknown.

Migrant workers are vulnerable in the Covid-19 pandemic. Like others, they have been subject to travel restrictions and quarantines, social distancing, and lockdowns by the authorities (Ritchie et al., 2020). They face job cuts amid rising unemployment and economic recession (Jones et al., 2021), and social and health issues such as rising domestic violence and mental illnesses (Javed et al., 2020; Sharma & Borah, 2020). There is hostility, discrimination, prejudice and harassment from the communities given the fear of the virus infection caused by migrants (Fauzi & Paiman, 2020; Guadagno, 2020; Leng & Saravanamuttu, 2020). They receive few if any relief measures in comparison to local groups (Takenaka et al., 2020).

Migrant workers without jobs have reportedly returned to their origins during the pandemic (Takenaka et al., 2020). There, their positions have shifted from money earners to dependants who relied on others' support. Their families and communities have lost their remittances, which had been important sources of income (Takenaka et al., 2020). This, in turn, has limited investment and future income-generation activities (Fox et al., 2020).

This paper looks at the ways in which social capital was sourced and used to mitigate Covid-19 pandemic impacts by returning migrant workers and their families in three villages of a Laotian province bordering Thailand in the first wave of Covid-19. The paper first reviews the concept of social capital. It then elaborates on the impacts of the Covid-19 pandemic on returning migrant workers and their families, and their use of social capital to cope with these impacts. The conclusion draws on the discussion, provides recommendations, and identifies further needs for study and support.

SOCIAL CAPITAL

Social capital is represented by resources that are available to individuals, families and groups through their social connections or networks. Such social networks are created and maintained via exchanges or investments by their members who are mutually acquainted and recognised (Bourdieu, 1986). Migrant workers accumulate and invest in social capital throughout their migratory journey. This starts from before their departure to settlement in the host communities, and continues after their return and resettlement in the home communities. They are involved in networks of kin, friends, workmates, fellow migrants, shared religion and shared origin, among others (Massey, 1988; Gill & Bialski, 2011).

Social networks and social capital are shaped by geographical factors (Mohan et al., 2005). The social networks developed by migrant workers in their places of origin are fundamental and often enduring. Shaikh et al. (2021) found that migrants strongly maintain their kinship, firstly via the families that exist naturally, and other origin-based networks such as connections with friends in their villages. These networks have major socio-cultural significance for migrants, as demonstrated by their strong desire to contribute to them in different ways. For example, it could be returning to live permanently and to improve the village life with amenities and economic activities (Shaikh et al., 2021), or to achieve the desired mobility while maintaining cultural practices and connections with the original communities (Roohi, 2017).

The social networks developed in the destinations are dynamic and can be short lived. Gill and Bialski (2011) found that low-socioeconomic or low-skilled migrants often engage in instrumental, circumstantial and weak connections with people in the destinations. They might not select friends as they wish because of limited opportunities, limited access to established local social networks, and barriers such as language differences and discrimination. This differs from migrants with higher socioeconomic status and high skills, who have better resources to migrate and settle in the destination. These migrants have access to the local professional networks via the workplace. They associate with people of the same status and tend to avoid forming connections with low-skilled migrants from the same origins.

Social networks and ecosystems are interdependent. Social networks are built on the natural environments that provide natural resources for human activities. Individuals and societies access natural resources and other types of resources via their social networks (Bourdieu, 1986). They can use them for both the private and public good (Adger, 2003). They can facilitate actions and increase efficiency, adaptability, creativity and learning (Nahapiet & Ghoshal, 1998). Human activities, in turn, create changes to the natural environment and natural resources, as clearly shown in the multiple climate-change issues (Adger, 2003). Human activities also shape social networks and social capital, particularly in the case of state policies and actions. For example, privatisation of natural resources results in diminished community capacity to respond to natural disasters (Adger, 2000; 2003). State lockdowns and movement restrictions reduce connections with friends and neighbours while increasing ties with family and the state via social media (Yu et al., 2021).

Both origin-based and destination-based networks facilitate the migration and settlement process by cutting down migration costs. Massey (1988) details these costs to be expenses for transport, food and accommodation. Migrants have to spend time, money and efforts on information and job searches, resulting in a loss of earning opportunities during this time. Migrants also suffer from psychological impacts as they leave their home places for strange places. The migration networks provide information such as requirements for migration, and living conditions. They offer useful support and services such as accommodation, transportation, and job opportunities for migrant workers in the host countries (Massey, 1988; Shaikh et al., 2021). In this way, the networks encourage their members to migrate to the destinations involved. The network members, in turn, expand the networks through their kinship and friendship (Massey, 1988).

Besides benefiting individuals and families, social capital is used for the common good or overall wellbeing of society. This applies to community resources and the collective management of them, because information flows and connections facilitate collective decision-making for social actions and practices (Adger, 2003). Planned and voluntary migration, for instance, has commonly been effective in improving resilience in resource-dependent

communities. People move to other communities to find jobs, earn a better income, and send remittances home to support their families. This helps to diversify household income and reduce the risks of local job shortages, low and unstable income, poverty and natural disasters such as droughts. Therefore, it enriches resources with remittances, diversifies livelihoods and reduces risks of resource dependency (Massey, 1988; Shaikh et al., 2021). This is in contrast to people moving to escape dangers or threats such as famine or wars, of which the impacts are negative on both the origin and destination societies (Adger, 2000). Forced migrants lose livelihoods and resources from their origins while exerting stress on the host societies and their environments, contributing to negative outcomes on the wellbeing and employment of host communities (Verme & Schuettler, 2019).

Because of its enabling power, social capital positively correlates with community resilience against adversities such as natural disasters (Noel et al., 2018) and the Covid-19 pandemic (Bartscher et al., 2021). Social networks provide resources and support for individuals and families to cope with and recover from crises and the multiple impacts of natural disasters (Aldrich & Meyer, 2014; Ritchie & Gill, 2007). The Covid-19 pandemic has negatively affected work and income, increased social isolation, and limited access to essential consumables and services to many individuals and families across societies (Hossain et al., 2020). Social capital has mitigated these impacts; for example, with the resources available to cope as in the case of the state providing relief support to individuals and groups in difficulties.

Social networks also encourage collective actions to problem solve at the community and society levels. For example, communities take responsibility for disaster response, relief, recovery and preparedness (Behera, 2021). They develop social connections and infrastructure to cope with disasters (Reininger et al., 2013). This is because information flows and connections facilitate collective decision-making for collective actions and social practices (Adger, 2003). In the Covid-19 pandemic, the actions and practices include, for example, practising social distancing (Makridis & Wu, 2020) or implementing vaccination to prevent the virus infection (Ferwana & Varshney, 2021).

Social capital has proven useful in illuminating migration and community behaviours in general as well as difficult situations. Social capital also points to how individuals and communities could deal with arising issues, overcome difficulties, recover and redevelop. Therefore, social capital is used in examining how returning migrant workers and their families cope during the Covid-19 pandemic and developing recommendations for support and intervention.

STUDY OVERVIEW

The study was conducted in three villages northwest of a Laotian province next to the Mekong River, which is the natural border with Thailand. Their population ranged between 683 and 973, with under 25% of the population having vocational training or university qualifications. Over 90% did farm work. Around 5% were unemployed and the rest raised livestock for a living. None of the three villages had trades, factories, major businesses or other sources of livelihood (Sengdala et al., 2021).

Between October and November 2020, the study collected field data using semi-structured questionnaires targeting returning migrant workers, their family members, and local authorities. Questions focused on work, income, spending and saving, family relationships and social relationships, education of children, and health. These areas were selected given their visibility and importance to overall wellbeing (Stoewen, 2017).

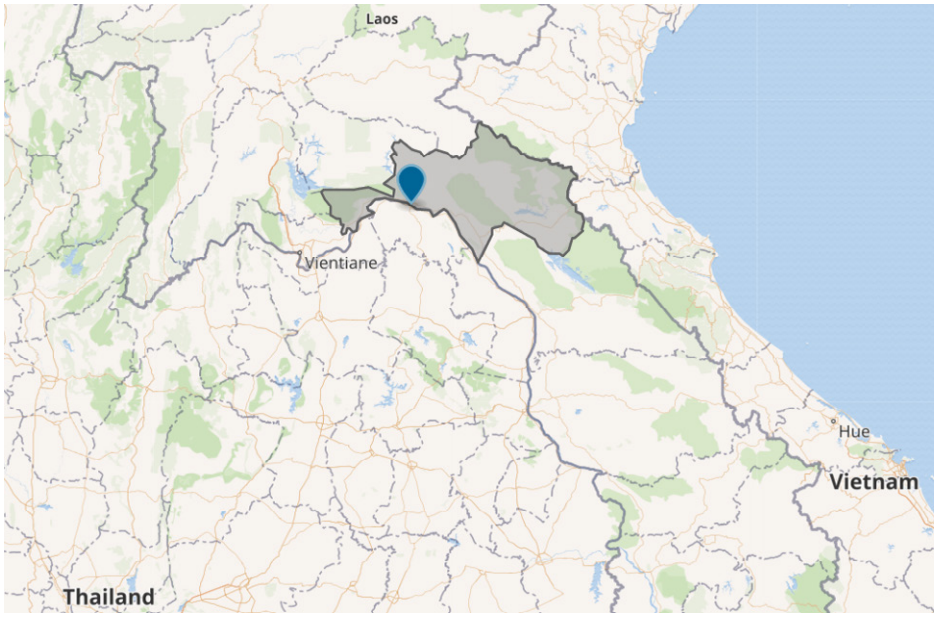

Figure 1. Research location. Source: Wikimedia Commons.

A local consultant was engaged for onsite data collection, given Covid-19-related travel restrictions and border control measures at the time of the study. This consultant facilitated recruitment and engagement with research participants. Convenience sampling was used to maximise the sample. Anonymity was assured and note taking was used if respondents did not consent to be recorded (Sengdala et al., 2021).

Fifteen village officials took part in focus-group discussions. Three village officials participated in in-depth interviews. Twenty-three family members and 38 returning migrant workers responded to the questionnaire survey, including 34 females and 27 males aged between 17 and 75. The survey respondents had limited education. Only 16 people had secondary education as the highest level of education. Understandably, their occupations were predominantly farming and livestock raising, followed by unskilled labour, shop assistants or domestic servants. About 80% had children aged three to 25 years old, some of whom were studying at tertiary level (see Table 1).

TABLE 1. DEMOGRAPHIC INFORMATION OF SURVEY PARTICIPANTS.

	Village 1	Village 2	Village 3	Total
Returning migrants	6	13	19	38
Male/Female	2/4	5/8	9/10	16/22
Age (<= 18/>= 51)	0/0	0/0	2/1	2/1
With secondary education	1	5	5	11
Have a partner	1	1	4	6
Have child(ren)	4	11	15	30
Family members	8	5	10	23
Male/Female	4/4	2/3	5/5	11/12
Age (<= 18/>= 51)	0/1	0/1	0/4	0/5
With secondary education	2	1	2	5
Have a partner	8	3	7	18
Have child(ren)	5	5	8	18

Data were also drawn from field observation and secondary sources such as existing records, policies and statistics. These sources were limited, as recent flooding had washed away most village records. Thematic analysis of qualitative data was conducted to identify underlying themes that could provide answers to the research questions.

MIGRATION AND MIGRATION NETWORKS BEFORE COVID-19

Low job opportunities and low and/or unstable income in the localities caused about 5% of the population in the studied villages to migrate out, mainly to Thailand and Vientiane, the capital of Laos. These areas were close to the villages, had better economies, more jobs and better earning opportunities, and shared languages and cultural practices. Migrant workers found predominantly low-skilled jobs. These jobs were shop assistants, house servants or farm workers for females, and labour and construction work for males. These jobs could be seasonal or year-round (Sengdala et al., 2021).

The migration-support networks firstly involved families. Families exist naturally and are essential for the reproduction of migrant workers. Within families, parents nurture and provide for children. Adult children are expected to contribute and support their parents. This is evidenced by survey respondents' reported remittances (see further below) and expectations of children's education, future job prospects and family contributions. In particular, 72% of respondents wanted their children to have vocational training or tertiary education, and 66% of respondents wanted their children to start working when they completed their education, after the age of 20 or older. Many respondents expected their children to contribute money within the range of current migrants' remittances to their families as they work in the future.

Peers formed another important support network for migrant workers, and could be accumulated along the migration journey. Over 68% of surveyed migrant workers found jobs when they migrated with peer support. Peers also helped with accommodation. Over 60% of these migrant workers stayed with their friends and the other 24% stayed with their workmates as they worked. Besides peer support, job brokers or middle people, who could be available inside or outside the villages, assisted around 15% of migrant workers to find jobs, for a fee.

The networks of families, peers and job brokers, however, cannot deal with issues such as human trafficking, discrimination, poor working and living conditions, sickness and injuries, which require the state and authorities to be involved. No state-supported networks were reported because official policies in Laos disapprove of low-skilled migrants. Migrant workers, therefore, often have to do without official paperwork and usually avoid state involvement for fear of being executed (Sengdala et al., 2021).

Migrant workers invested in these networks by making regular contributions in money, support and job opportunities. They were expected to, and did, send remittances home. On average one person sent US$76 per month, around 32% of the mean total monthly earnings of US$236. (Income and expenditure data were originally collected in Laotian kip. They were later converted to US dollars and rounded up to the nearest dollar. The exchange rate was 10,000 Laotian kip equivalent to 1.077 US dollars as of 11 December 2020, according to xe.com currency converter. See Figure 2 for more details.) The families or households then used the money to invest in themselves, such as paying for children's schooling, purchasing household items, servicing debts, and making savings and investments. Besides remittances, migrant workers also accumulated savings for themselves. On average a person saved US$75 per month, approximately 32% of their mean income, which could be mobilised for use in the future. Migrant workers also brought new work contacts to their migration networks and created job opportunities for other members.

The expected exchange also included making regular contacts and visits. Most migrant workers visited their villages and families. They maintained contact with their families regularly using mobile phones and the internet. Some survey respondents reflected that money contribution and frequent visits and contacts helped to improve the family relationship. The lack of contribution, visits and contacts could negatively affect the connections. Some survey respondents noted that family bonds could be weaker because of the distance while they worked away. Such a distance was a barrier to communication and relationship enhancement.

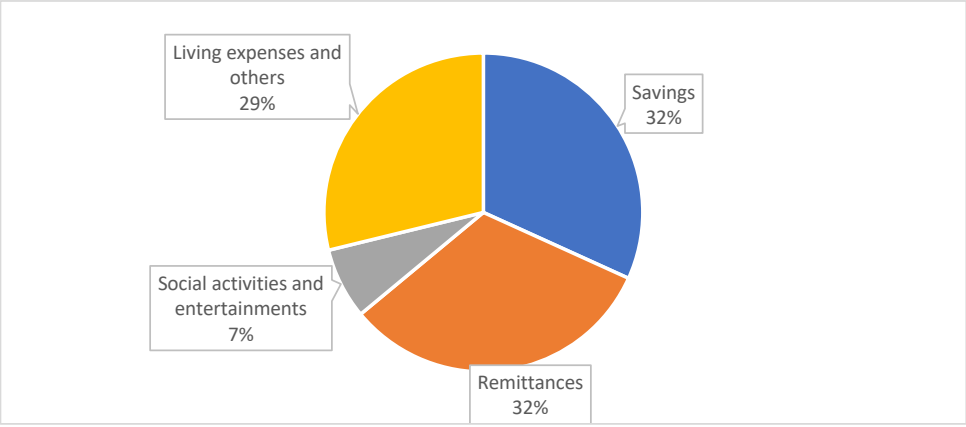

Figure 2. Migrant workers' use of earnings.

Another way to network was to join social activities and entertainment. On average, migrant workers spent about US$17 per month, i.e., 7% of their mean income, on these activities in their host communities. At the same time, their families or households used remittances to cover social expenses in the villages, which were practical investments in the home social networks. Paying job-broker fees helped to maintain the job-broker services for those who used them. Fees were usually small, about $US14 on average for a job obtained.

IMPACTS OF THE COVID-19 PANDEMIC

In the first wave of Covid-19 in March 2020, Thailand and Laos imposed lockdown and travel restriction measures. That left migrant workers, both domestic and overseas, with neither work nor income. Many migrant workers chose to return to their villages. Laotians returning from overseas had to be quarantined for 14 days. After this, if they were issued with medical clearance, they could return to their families. The Covid-19 pandemic had extensive negative impacts on livelihoods. It had both positive and negative impacts on relationships, education and health, as detailed below.

Unemployment and low, unstable income with spending deficits

Only 30% of returning migrants managed to find a job, leaving at least 60% without one. Most of those with a job earned between US$5 and US$8 per day. The mean monthly income was one third and the mean monthly household income and income per capita were around 60% of the levels before the pandemic (see Table 2).

TABLE 2. SUMMARY OF INCOME AND EXPENSES IN US$ (OUTLIERS EXCLUDED).

	Before pandemic	During pandemic
	Range / Mean	Range / Mean
Income of a returning migrant	108–323/236	54–108/83
Household monthly income	54–323/206	11–215/120
Household monthly income per capita	12–72/41	2–54/25
Household monthly expenses	33–285/106	24–232/80
Household monthly expenses per capita	5–67/22	4–58/16

The major sources of income, however, remained largely unchanged. Of the survey respondents, wages were a major source of income for over 90%, followed by agriculture for 75%, remittances for over 50%, trade for over 30% and forestland, business and other sources for 15% (see Table 3).

TABLE 3. MAJOR SOURCES OF INCOME.

	Before pandemic	During pandemic
Wages	93%	95%
Farming	75%	75%
Remittances	56%	54%
Trade	30%	31%
Forestland, business and others	15%	17%

Families and individuals had expenses for food, clothing, bills, transport, medical costs, children's schooling, debt payments and purchases, and social events. With low and unstable incomes, returning migrant workers and their families faced deficits when spending exceeded income. Thirty-one percent of respondents had family expenses exceeding their incomes during the pandemic compared to 13% who experienced similar issues before the pandemic. Thus, the affordability rate reduced from 87% to 69% of respondents. Furthermore, family expenses were reduced by around 35% from the expense level before the Covid-19 pandemic.

Mixed impacts on family and social relations

The pandemic had mixed negative and positive impacts on family relationships. Three survey participants reported bad relationships because of either the past distance or low family income. However, 37 respondents reported good to very good relationships now that returned migrants could spend time with family, taking care of each other and helping with household chores and family jobs. Thirteen respondents mentioned remittances and regular contributions as important factors in maintaining good relationships.

Twenty-three returning migrant respondents reported having issues with their social relationships. Six rated their social relations with villagers as bad or very bad. Ten stated that they sometimes or often had difficulties in communication with villagers. Twelve reported discrimination from other villagers due to the nature of their work outside the village. For example, some were excluded or restricted from peers and social groups and activities, subject to offensive comments, embarrassed or ignored in public. Eleven family-member respondents advised similar issues of difficult communication and discrimination. In addition, they mentioned being asked to contribute things differently from other villagers and having their possessions stolen or damaged. Respondents acknowledged the villagers' fear of widespread infection and the state quarantine measures being major causes of these issues.

Impacts on health and child education

The Covid-19 pandemic had limited negative health impacts on returning migrant workers and their families. Seven family respondents noted that their returning family members appeared to be angry, frustrated, worried or stressed more often. Seven family respondents stated that they experienced the same issue. One respondent noticed their returning member had worse sleep. One reported increasing substance use and another reported more illnesses.

The pandemic changed schooling and had negative impacts on child education, as seen by many respondents. Of the respondents, 66% advised of school closures. Two percent mentioned school moving to distance learning. Twenty-three percent thought that such changes worsened their children's schooling.

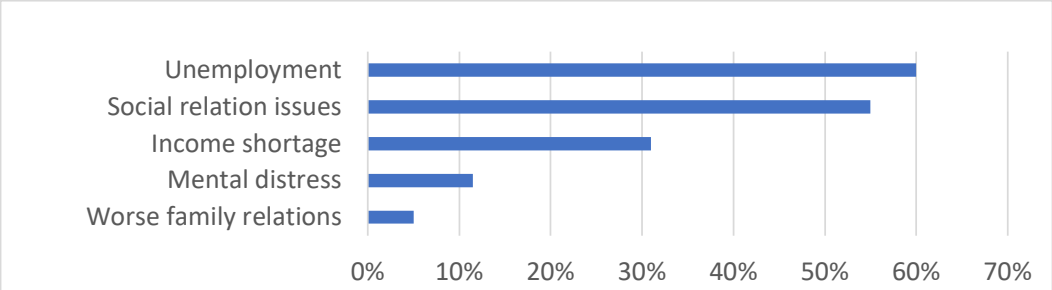

Figure 3. Covid-19 pandemic impacts.

Sourcing and using social capital to cope

Social capital was a major factor that helped returning migrants and their families cope with the negative, multi-faceted impacts of the Covid-19 pandemic. Social capital was sourced from three major networks, which were families and/or households, neighbours and peers, as further explained below.

Families and/or households

Families and/or households were a major source of resources for returning migrants, offering accommodation, food, essential items, money and work. All respondents but one lived in houses that were owned by a family member, who was predominantly the respondent's parent or themselves. Their households often included close family members such as children, parents, partners or siblings.

About 87% of these households owned agricultural land, mainly rice with a mean area of 3.05 hectares. Forty-one percent owned forestland with a mean of 2.76 hectares. Both types of land were predominantly owned by the respondents' parents, partners or themselves. Returning migrants could work on their family farmland, including rice fields and gardens. They could do other related activities such as selling their farm products. Over 88% of respondents advised that they and/or their family members worked on their farm. However, only about 15% of respondents said that they and/or their family members worked in their forestland. While these jobs did not offer stable and decent earnings, they were considered helpful and supportive to the family. They also generated values and farm products that could help to sustain the households.

Returning migrants could use their savings and the family savings, to which they contributed with their remittances while working outside the villages. This happened to 62% of survey respondents.

Neighbours, friends, private lenders, villages and the state

Around 87% of survey respondents advised of seeking help and 95% reported receiving help from others to cover their needs. On average, they received help from two sources outside their households.

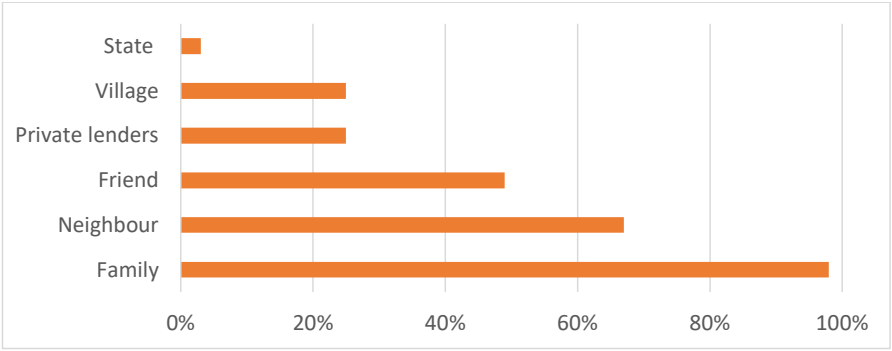

Figure 4. Percentage of survey respondents receiving support from available sources.

Neighbours were the most popular sources of support, assisting 67% of survey respondents. Friends were the second most popular sources of support, providing for 49% of survey respondents. Private lenders and the village reportedly assisted 25% of survey respondents. The state and others were the least popular sources, providing support to around 3% of survey respondents, demonstrating limited state support for the studied population.

Resources came in diverse forms. Neighbours and friends provided food and essential items, income support, job search support and money loans. Villages provided all these forms of help except for food and essential items. Private lenders offered money loans and helped people to find jobs. The state's assistance was limited to money loans only.

Money loans were the most popular form and 72% of survey respondents reportedly had at least one loan. Food and essential items, job search support and income support were also popular. The percentages of survey respondents who received these resources were 34%, 31% and 25%, respectively.

These resources covered their daily needs and alleviated issues caused by unemployment and low, unstable income and spending deficits, as in the case of food, essential items, income support and money loans. Job search support was used for job searching and job creation. Respondents considered this to be the key to work and income, issues with family and social relationships, health and children's education.

DISCUSSION

At its early stage, the pandemic had both positive and negative impacts on returning migrants and their families. On the positive side, they reunited with families and had better communication and care, which improved their family relationships. The village living environment was more spacious, cleaner and greener compared to the cities with overcrowded, substandard accommodation. On the negative side, they suffered from work and income shortages, mental distress, social stigma and discrimination, and their children could not go to school due to school closures.

The identified negative impacts were consistent with the literature on the pandemic. However, work and income shortages were more severe compared with the general population. The returning migrants' employment and income declined by 60% and 40% respectively, compared to 17% for the general population as of March 2021 (The World Bank, 2021). Understandably, they did not have a job in the locality before their return and had to compete for one in the more difficult economic environment of the pandemic. These factors could explain the noticed increase in anger, frustration, worries and stresses in response to the pandemic's pressure (Javed et al., 2020). Furthermore, if the infectious, deadly virus reached these locations, negative health impacts would be massive, as evidenced in other rural communities across the world (Leonardelli et al., 2021; Mueller et al., 2021).

Returning migrant workers and their families focused their coping measures on work and income shortages. They considered solutions to these shortages would alleviate distress and strained family and social relationships. This focus was part of the physiological and safety base of Maslow's hierarchy of needs, the latter of which prevailed in time of crisis (Maslow, 1943). This was also consistent with people's behaviours in other parts of the world in this pandemic (Duygun & Şen, 2020).

In the absence or scarcity of state support, returning migrants and their families have sourced and used resources from family, neighbour and peer networks, private lenders and the village. These networks either existed naturally or developed before and during the migration process. They not only supported the migrant process before the pandemic but also the return process under the pandemic. The mobilised resources met their short-term needs. Households or families provided for the essential needs of housing, food and work for most returning migrants. They accumulated savings and allowed their use to cover the spending deficits in the pandemic, which was typical for low-income groups (Schembri, 2021). Neighbours and peers offered food, essential items, money loans and job search support. The village and private lenders provided money loans and job search support, and the state only offered limited money loans.

The above networks are part of rural society and its ecosystems. They are essential for the capacity of these systems to survive major shocks and crises and redevelop afterwards (Adger, 2000). The ecosystem provided resources for agricultural activities to produce and generate sustained income for the local population, including returning migrant workers and their families, who farm and run forests in the locality. The networks of families, friends, neighbours, private lenders and villages further generated and distributed these resources to their members. They positively contributed to the capacity to cope with the pandemic.

The pandemic exerted huge stresses on social capital and the capacity of the social and ecological systems. In terms of savings, for example, some survey respondents were already in deficit before the Covid-19 pandemic. Most other survey respondents had limited or no savings, so the usage of savings was also limited. As savings ran out, returning migrant workers and their families would be left with no savings for future needs or other unexpected events.

The pandemic has had stronger impacts on small-scale family farming due to such factors as limited market access because of travel restriction, farm market closures, the lack of storage facilities for perishable produce, and reduced demands (Food and Agriculture Organization of the United Nations, 2020). Low-skilled, labour-intensive service and production areas such as agriculture, construction and retail struggled with varying prospects for recovery (International Labour Organization, n.d.). Jobs and business opportunities were thus much more limited in the economic downturns that the pandemic created (Jones et al., 2021). These were barriers to livelihood development for returning migrants and their families.

Resources from other people in the community were equally limited and loans had to be repaid. The use of private lenders raised questions about possible high interest rates and the potential for resulting huge debts. Only one respondent's family had to service debts before the pandemic. At the time of the survey, 19 respondents advised that they had received help from private lenders and 13 took loans from them. The community was not used to debts and might struggle after they incurred debts during the pandemic.

It is unclear how these networks could be affected by the pandemic. The fear of infection and the reduced ability to invest in social exchange by network members could undermine such networks. Indeed, most respondents reported that their family cut down spending, including social spending, to two thirds of the pre-pandemic levels. Social spending dropped by US$8 on average. This confirmed the global trends of consumption cuts and spending drops (Baker et al., 2020; Jones et al., 2021). Social spending is essential for social connection, and community participation and development. It also brings about subjective wellbeing, happiness and a sense of fulfilment and generosity, among other effects (Aknin et al., 2018; English, 2013). Limited social spending could place constraints on these areas. If the pandemic prolongs and if there are other shocks such as natural disasters that impact the crop yields, the ability to exchange and pay back loans and other supports would greatly diminish. These would threaten to damage social connections and access to social capital.

Added to the above situation was the policy in Laos against low-skilled workers' overseas migration. This policy is contrary to people's natural tendency to migrate to areas with better opportunities, more jobs, higher earnings, higher living standards or other attractions (Castelli, 2018; Mohamed & Abdul-Talib, 2020). This state's dysfunctional behaviour (Adger, 2003) leads to exclusion and vulnerability for the population and undermines social capital, and creates fear among people who defy it. In the pandemic, illegal or undocumented migrants have tended to avoid or refuse to provide information or co-operate. This has hindered the implementation of Covid-19 measures such as quarantine or contract tracing, and could make the pandemic worse (Guadagno, 2020). After the pandemic, out-migration will continue, given the local shortages of jobs and earnings and the opportunities elsewhere. Without state protection and support, the abuse and maltreatment at work, and multiple social, economic, education and training barriers will continue. Migrant workers struggle to cope with multiple issues while working and living away from their homeland (Reed, 2018).

RECOMMENDATIONS

Given the above considerations, the state should play a stronger, better role in providing basic social security for groups in need (Adger, 2003). In this situation, the state should mobilise and provide support for returning migrants, their families and communities to cope with the pandemic. The support could include relief measures for needy families and individuals, and hygiene education to prepare for the eventuality of the virus reaching the villages. Healthcare services and supplies, and appropriate state quarantine measures would be also necessary.

Research participants suggested that the state should adopt a pro-migration policy and work with host countries such as Thailand and Vietnam to set up better services and supports for Laotian migrants in these countries. This, along with campaigns and anti-discriminatory education, would ease the mental distress for migrant workers and their families. It would promote a change in the public attitude towards migration for work, from poverty alleviation and second-class jobs into acceptable and desirable jobs in society (Sengdala et al., 2021).

Research participants wanted quality vocational training, education and scholarships, job creation and job-broker services, income support and income-generation activities, capital for business start-ups, and Covid-19 vaccinations. In order to succeed, such livelihood development would need support and guidance from the state and wider society, including non-governmental organisations and the richer communities. Development included, for example, assistance in the identification and provision of suitable training for the required skills in the labour market post-pandemic (Sengdala et al., 2021).

Critical, strategic thinking and technologies would be required to shape training and economic development targets towards meeting the needs of communities, society and the economy post-pandemic. Innovative ideas would be helpful to ensure that the villages could achieve a balanced development that gives proper attention to social, economic and environmental dimensions (Millard et al., 2016; Roy et al., 2018; Watkins et al., 2008). For example, successful community, social and economic changes can reduce poverty and enhance sustainable development.

To facilitate these changes, the drivers for change such as solidarity and networking, financial resources, governance and technologies should be enhanced. Barriers such as conflicting interests in different aspects need to be properly addressed (Millard et al., 2016). Open, democratic participation, self-regulation and sustainable resource management would help to achieve successful co-operation between the stakeholders (Agrawal, 2001).

CONCLUSION

The migrant workers have developed and maintained connections with families, friends, neighbours, private lenders and villagers in three Laotian villages prior to and throughout their migration journey. They are part of the rural social and ecological systems that support farming and forestry to produce and generate sustained income. These connections further generate and distribute these resources to their members. The connections help people to cope with and recover from major shocks and crises. These networks have been effective in assisting migrants to move and work outside their villages, as well as to return and settle during the Covid-19 pandemic. As the study shows, they sourced and used social capital from these networks to cope with work and income loss.

The pandemic exerted stresses on these networks and threatened their ability to survive, given the limited resources within the networks and diminished capacity of members to exchange and maintain the networks. The current strategies to source and use social capital, therefore, have been effective in the short term but could fail in the long term.

The situation suggests that the state and wider society should play a stronger, more supportive role. Before the pandemic, the state, with its anti-migration policies, had created difficulties for migrant workers working outside the villages. During the pandemic, the policies and the lack of support have increased their vulnerability. External support, including short-term relief and livelihood development with critical, strategic thinking and technologies and pro-migration policies in the long term, is necessary. The co-operation between the state and wider society

requires self-regulation, democracy and sustainable management of resources (Adger, 2003). Continuing monitoring of the pandemic and its impacts in the localities could help to identify and source timely support, given the known devastating impacts of the pandemic on other places in the world.

ACKNOWLEDGMENTS

The study was funded by Rosa Luxemburg Stiftung Southeast Asia (RLS-SEA) Hanoi Office. The Global Association for People and the Environment (GAPE) and Homelao Service Individual (NPA Consulting) provided full support and collaboration in the study.

The research team includes Manisone Sengdala (Co-Team Leader), Ou-ee Kittikhoun (Co-Team Leader), Hanh Hong Hoang (team member) and Nguyet Thi Anh Dang (Research Advisor). The research team has allowed the author to use research data for this paper.

The author wishes to express special thanks to the 61 respondents to the survey questionnaires, 15 participants in focus-group discussions and three participants in in-depth interviews.

The opinions in this paper belong to the author only and in no way represent RLS-SEA, GAP, NPA Consulting or those of any other research team members.

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FORECASTING WATER-LEVEL FLUCTUATION IN WATER-SUPPLY DAMS OF THE AUCKLAND AND WAIKATO REGIONS

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https://doi.org/10.34074/proc.2206010

Business and Infrastructure

This publication may be cited as:

Waidyaratne, P., & Phillips, D. (2022). Forecasting Water-Level Fluctuation in Water-Supply Dams of the Auckland and Waikato Regions. In E. Papoutsaki and M. Shannon (Eds.), *Proceedings: Rangahau Horonuku Hou – New Research Landscapes, Unitec/MIT Research Symposium 2021, December 6 and 7* (pp. 131–160). Auckland: ePress, Unitec, Te Pūkenga. https://doi.org/10.34074/proc.2206010

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ISBN 978-1-99-118340-8

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ABSTRACT

Dams play a vital role in supplying fresh water to many cities all over the world. With increasing pressure on and demand for natural resources, water supply remains a scarce resource worldwide. During times of uncertainty, predicting the future availability of water supply by considering various hydrometric and anthropogenic variables will provide a framework for future scenario forecasting and a model-based approach to sustainable water management. To this end, this project proposes a multivariate time-series analysis and forecasting model to both analyse and forecast daily water-level fluctuations in three water-supply dams: Upper Nihotupu, Waitākere and Mangatangi, located in the Tāmaki Makaurau Auckland and Waikato regions of Aotearoa New Zealand.

KEYWORDS

Environment, dams, water supply, forecasting, sustainable water management

INTRODUCTION

Scarcity and increasing demand for natural resources is an inevitable outcome of a growing population faced with the uncertainties of climate change. Municipal water supply represents one such challenge. In April 2020, the total storage in all Tāmaki Makaurau Auckland dams dropped to below 50% for the first time in 25 years (Morton, 2020). With long dry spells and lower than average rainfall, the city enacted Stage 1 water restrictions in the following month, May 2020, which consequently resulted in loss of revenue for businesses and further increased funding towards capital projects aimed at water-supply resilience (Watercare, 2020). Due to the volatility and intermittent characteristics of hydro-climatic variables, reservoir operation and managing water supply is inherently difficult to manage and quantify. Faced with growing climate uncertainties, studying the relationships between hydrological processes, particularly during times of climatic extremes, provides a crucial step in efficiently leveraging finite resources. In the Tāmaki Makaurau Auckland region, smart water networks (e.g., SCADA) are currently used for supply operations, with daily abstraction flows (i.e., outflows for treatment) from reservoirs being carefully managed to balance supply with existing reservoir availability. While these smart networks aim to efficiently model existing supply to meet demand, a reliable forecast of future supply is required for more proactive resource allocation.

This research project focused on three separate water-supply dams supplying the Tāmaki Makaurau Auckland region – Upper Nihotupu, Waitākere and Mangatangi – and proposes several established statistical and machine learning (ML) models to both analyse and forecast the daily water levels of these dams. Specifically, the proposal aims to explain and forecast dam water levels as a function of hydrological and anthropogenic variability.

The hydrological balance model

The dam level at any time-step (t) is an outcome of complex and related interactions between natural hydro-meteorological and anthropogenic variables. Therefore, in a multivariate forecasting task to predict water level, a range of variables is required to be used as inputs to the models. Forecasting daily fluctuations will therefore involve the careful selection of these variables (or features) and, subsequently, obtaining time-series datasets for each feature in the form of separate time-series datasets.

Consider a generalised water balance equation for a given watershed (Equation 1):

$$P = R + ET + \Delta S (1)$$

Where P is the precipitation, R is the runoff, ET is the evapotranspiration and ΔS is the change in storage (Sposób, 2011). Equation 1 is a general representation of the water cycle for a closed watershed. In a dammed reservoir, this equation can be further summarised into Equation 2:

$$\Delta SR = P + \Delta R - ET + Ab (2)$$

Where ΔSR is the change in reservoir level, P is the precipitation, ET is the evapotranspiration, ΔR is the change in runoff and Ab is the abstraction of water for consumption. This causal relationship between in hydrological and various anthropogenic variables is summarised below in Figure 1. This hydrological balance model will serve as the basis for selecting input features that will be used for the prediction task.

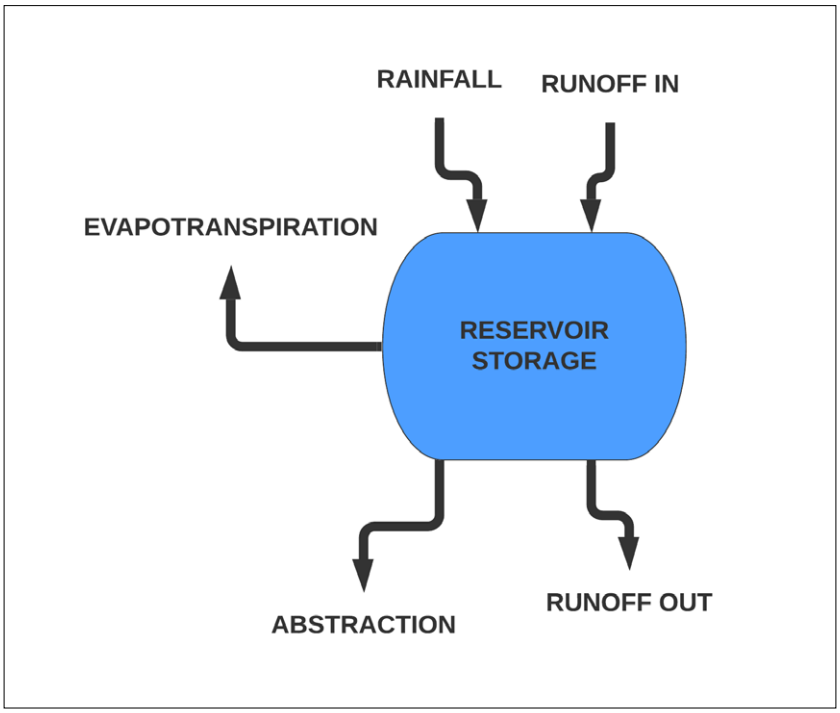

Figure 1. Hydrological balance model.

Machine learning (ML) and artificial neural networks (ANNS)

A broad range of research has been conducted on ML and deep learning (DL), and their applicability to hydrological modelling. Bowden et al. (2005) analysed the structure of ANNs and the validity of the input variables to model hydrological outputs, while more recently Anindita et al. (2016), Filho et al. (2020) and Hu et al. (2018) have all used either ML and/or DL models for the purpose of predicting reservoir water levels and runoff. Perhaps the most relevant pieces of literature on the use of recurrent neural networks (RNNs) for hydrological modelling have been made by Choi et al. (2018) and Kratzert et al. (2019), in which each have successfully used a variation of RNNs, a long short-term memory (LSTM) model, for water level and rainfall run-off predictions. Both papers show reasonable degrees of statistical accuracy with predicting water levels or runoff as a function of temporal hydrological variability. Kratzert et al. (2019) in particular found that a single LSTM model calibrated regionally can perform better than a single LSTM model trained specifically for each catchment.

A commonly used linear multivariate forecasting model is the vector autoregression (VAR) model. VAR is a classical statistical model that was initially used for modelling econometric time-series (Sims, 1980); however, VAR models have since been used as multivariate models in climate and hydrological sciences. Kumar et al. (2009) used a VAR to model the interdependence among O_3, NO, NO_2, and various other volatile organic compounds in Delhi, while Zhao et al. (2019) used a VAR model to measure the runoff response with respect to various contributing parameters in the Loess Plateau, China. Abdallah et al. (2020) presented a short-term weather forecasting model using VAR, and found VAR models to be generally more accurate than more-traditional forecasting models.

Classical hydrological process models depend, to a large degree, on formulating a relationship between catchment characteristics (i.e., area, slope, soil class, vegetation cover, etc.) and the various hydrometric variables (precipitation, solar radiation, wind, etc.). However, most catchments are highly heterogeneous and variations in catchment characteristics are often unknown or not recorded (e.g., soil characteristics, soakage performances, etc.). Moreover, hydrological interactions often take place underground, where, to a large extent detailed information is unavailable (Kratzert et al., 2019). In this context the classical process-based model attempts to describe a system that is relatively unknown.

In contrast, ML and artificial neural network (ANN) models aim to predict an output based on available historical data (e.g., precipitation, temperature, radiation, etc.) and do not necessarily rely on describing a catchment and its underlying processes.

Fundamentally, ML and ANN models are data-driven models that 'learn' patterns and variations in those data based on statistical modelling. To that end, the model utilises a learning algorithm that compares predicted value (ŷ) with the actual values (y) and aims to reduce the difference between the two. This is often achieved by reducing a loss (or cost) function. ANNs achieve this through a process known as back-propagation, which involves adjusting certain parameters (e.g., weights and biases) in the algorithm via the chain rule. This is achieved by minimising the gradient of the cost function through a process known as gradient descent (Goodfellow et al., 2016). Figure 2, below, provides a visual understanding of a typical ANN architecture.

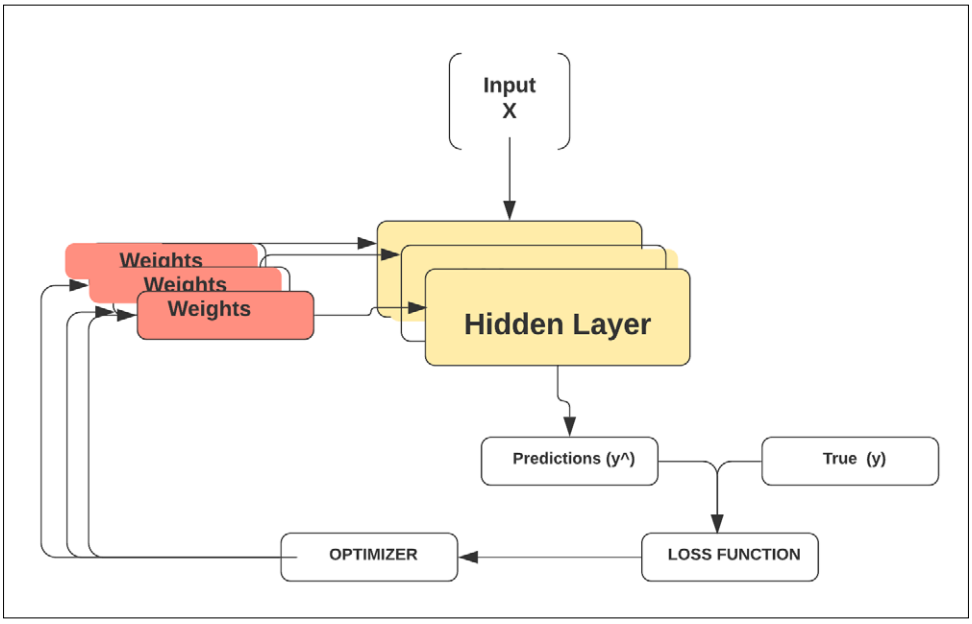

Figure 2: Architecture of a general ANN.

ANNs are unique in that they have hidden layers built into the algorithm. Each hidden layer takes an input from the previous layer, adjusts its weighting and, through an activation function, passes the output to either another hidden layer or an output layer (Gèlron, 2019). ANNs comprise of the following main objects:

- Layer(s) – Which transform input data, usually in the form of tensors, and output a single or multiple value(s).
- Weights – Internal parameters that will be adjusted during each training step.
- Loss function – Which determines the training performance; in other words, quantifies the error between the predicted output and the true output.
- Optimiser – Determines the way neural networks are trained, usually by a gradient descend step to update the weights based on the loss function.

Recurrent neural networks (RNNs)

Based on the above, the main goal of training a neural network is to identify the appropriate parameters to build and compile the model. While a detailed description of ML or ANNs is not the objective of this project, the reader is encouraged to refer to Geìron (2019) for further understanding of the topic.

The proposed ANN model for this research project will be an RNN, which is an ANN that processes data sequentially while retaining a memory (or cell state). It is recurrent because the output of the previous sequence becomes the input of the next sequence (Fausett, 1994).

This ability to process data sequentially while retaining a cell state at each recurring step makes RNNs particularly useful in the context of predicting sequential data, including time series that have a sequential dependency. Unlike many ML and ANN methods that are well suited for regression analyses, the ability to handle sequential dependencies makes RNNs a suitable choice for this project.

An RNN architecture includes a hidden cell state, where the output at a previous step is fed back into the model, which updates the model's internal parameters (or state). Although this process theoretically allows RNNs to have an internal 'memory,' many traditional RNNs, however, suffer from long-term dependencies in which their architecture causes the information to decay or 'explode' after each training iteration, often called the 'vanishing gradient' problem (Bengio et al., 1994). LSTM and gated recurrent units (GRUs) solve this problem by introducing a 'gated' architecture to each recurring cell.

Originally proposed by Hochreiter & Schmidhuber (1997), LSTMs have specialised 'gates,' commonly known as input, forget and output gates, which together control and filter information at each time-step by utilising specific algorithms built into them (Geìron, 2019). Each gate has a specific activation function which either allows or restricts the flow of information at each time-step. GRUs, introduced by Cho et al. (2014), function like LSTMs, however with only two gates, an 'update' and a 'reset' gate. GRUs are therefore less complex than LSTMs; however, their functionality is similar and the often have faster computing times (Yang et al., 2020).

Building an ML model

There are few software frameworks available to build and train ML and ANN models. The most common framework is TensorFlow, which has several inbuilt libraries and tools to create models (Abadi et al., 2016). The most common of these is the Keras library, which has been developed specifically for building and running ANN models (Chollet et al., 2015).

The process of building ML and ANN models involves selecting the appropriate hyper-parameters. Hyper-parameters typically control how the model 'learns' by adjusting various parameters such as its learning rate and number of hidden units, as well as specifying the types of loss (cost) function and optimisers used. Selecting the correct hyper-parameters is often an iterative process, but it can be done by using a grid search method in which multiple combinations of parameters are inputted into the model to select the most appropriate parameter that has the best performance (Geìron 2019).

METHODOLOGY

Study area

The utility owner Watercare currently operates 12 water-supply reservoirs in the Tāmaki Makaurau Auckland and Waikato regions. Five of these dams are in the Waitākere Ranges in Northwest Tāmaki Makaurau Auckland, while four are in the Hunua Ranges (Southeast Auckland and the Waikato region). From these, three dams were chosen for this project: the Upper Nihotupu, Waitākere and Mangatangi Dams. The Upper Nihotupu Dam is a concrete dam built in 1923, with a current lake area of approximately 12.5 hectares and a capacity of approximately 2.2 gigalitres. The catchment area is approximately 980 hectares, with more than 99% of the area covered by native bush. The Waitākere Dam was completed in 1910, and currently has a lake area of approximately 25.1 hectares and a capacity of approximately 1.76 gigalitres. The catchment area is approximately 810 hectares, which is almost exclusively covered by bush. Located in the Waikato region, and completed in 1972, the Mangatangi Dam is the largest of the three dams, with a lake area of 185 hectares and a capacity of approximately 35.3 gigalitres (Watercare, 2021).

Data collection

Two main sources were used to obtain time-series datasets to represent the hydro-meteorological and reservoir operational (anthropogenic) features previously described in the hydrological balance model.

1. Watercare Services Ltd
2. National Institute of Water and Atmospheric Research (NIWA)

Watercare Services Ltd is an Auckland Council-controlled organisation that owns, manages and operates the water supply for the Tāmaki Makaurau Auckland region, including the Upper Nihotupu, Waitākere and Mangatangi Dams (Watercare, 2021). Watercare maintains a historical database and actively monitors and records various metrics related to dam levels and reservoir operation.

NIWA is a Crown Research Institute responsible for monitoring and recording hydroclimatic data for all of Aotearoa New Zealand (National Institute of Water and Atmospheric Research, 2021). NIWA maintains a Virtual Climate Station Network (VCSN), a database that records and estimates hydroclimatic data on a virtual grid by spatially interpolating measurements at each grid point using actual measurements at various automatic weather stations located across the country (Cichota et al., 2008). User access to climate and weather data are provided via the NIWA data portal, which grants the user non-exclusive and non-transferable licence to access the datasets. Access to the data is provided to a user account for a limited time and the data have solely been used for this study, with no commercial use intended.

Table 1 shows the co-ordinates of the virtual grid points used to collect hydrometric data. These have been selected to be representative of the climate data for each catchment as best as possible.

TABLE 1: CO-ORDINATES OF THE NIWA VIRTUAL CLIMATE STATION NETWORK.

Site	Co-ordinates of VCSN
Upper Nihotupu	36.925°S, 174.575°E
Waitākere	-36.925°S, 174.525°E
Mangatangi	-37.1151°S, 175.2080°E

Data preparation

Raw data obtained from each source were sampled and prepared in the Python programming language using the Python Library-Pandas (McKinney et al., 2010). The time-series datasets of each feature were imported to Python and converted to a Data Frame – a Pandas class that allows manipulation of tabular data. Several samples obtained were historically measured at varying time intervals that ranged from daily and hourly to every 15 and 10 minutes; these data were upsampled into daily values either by taking the mean, sum or the last measurement for the day as the daily value. The resample function in the Pandas library was used for this purpose. For example, data obtained for the dam level ('Level') were upsampled by using the final measurement of each day to represent the daily reservoir level. Flow data over the spillway ('Spill') were aggregated to obtain a daily sum of the total volume of discharge.

Following the resampling process, any missing values in the dataset were handled by linear interpolation using the interpolate function in Pandas. It is important to note that two features – 'Abstraction' and 'Compensation' had large quantities of data missing prior to the year 2009 for all three dams. 'Abstraction' refers to the water abstracted to the treatment plant, while 'Compensation' refers to the discharge released to maintain the downstream environment and ecology. Given the importance of these features in forecasting reservoir levels, and since model inputs require data ranges of equal length, for the forecasting component of this project, the historical time-steps only extend back to the year 2009. Additionally, since linear interpolation or other data imputation methods are only statistically meaningful for a limited number of missing values, interpolating large amounts of data was not seen as a feasible option.

Table 2 displays the date ranges of the time-series datasets from all features to be used as inputs to the forecasting models.

TABLE 2. DATE RANGES OF TIME-SERIES DATA USED IN THE FORECASTING MODELS.

	Upper Nihotupu	Waitākere	Mangatangi
Date Range	02/12/2009– 04/03/2021	01/03/2009–04/03/2021	01/01/2009–22/03/2021

ANALYSIS

Prior to the forecasting task, the prepared data was analysed to observe historical trends, and inform decisions related to the importance of each feature (variable) during the modelling process. The analysis part involved the following:

1. Trend analysis
2. Feature engineering
    a. Feature selection and feature creation
    b. Correlation tests to identify correlations between features
    c. XGBoost machine learning (ML) test to measure feature importance

Trend analysis

Broadly speaking, a time series can fall under two main classifications:

1. Stationary
2. Non-stationary

A time-series dataset is assumed to be stationary if the underlying statistically observable properties such as mean, variance and autocorrelation do not change over time (Hyndman & Athanasopoulos, 2018). Mean and variance are fundamental properties that describe the distribution of a given sample. During trend analysis, values can be grouped into segments (e.g., by using moving averages) and the mean and variance between each segment can then be computed and analysed for stationarity. There are several statistical tests that can perform this function. The Augmented Dickey-Fuller (ADF) test has been widely used for trend analysis and was used here to analyse trend (Hamilton, 1994). An ADF test was carried out using the Adfuller function in Statsmodels, an open-source Python library that provides functions and classes for a range of statistical models (Seabold & Perktold, 2010).

Visual representations of the trend, including monthly mean and percentile distributions, were obtained using standard time-series plots and box plots using the Matplotlib and Seaborn packages (Hunter, 2007).

Normalcy tests

An important sub-task of trend analysis is to understand the underlying distribution of the time series. Understanding the distribution also allows the selection of appropriate tests, since statistical tests are typically dependent on whether a dataset has a parametric or non-parametric distribution. Parametric datasets assume an underlying normal (or Gaussian) distribution, while non-parametric datasets do not fit a known or underlying distribution (Hyndman & Athanasopoulos, 2018).

A Shapiro-Wilk Test was used to test the likelihood a given sample was taken from a normal distribution (Shapiro & Wilk, 1965). The Shapiro function in the SciPy Python package was used to obtain two values for each feature, a test statistic (W) and a p-value. The null hypothesis (denoted by the p-value) of this test is that the sample is normally distributed; by convention, the null hypothesis H0 is rejected when the p-value is <0.05, and failed to reject if the p-value is >0.05 (Mishra et al., 2019). The underlying equation for the test statistic is displayed in Equation 3.

$$W = \frac{\left(\Sigma_{i=1}^{n} a_i x_{(i)}\right)^2}{(\Sigma_{i=1}^{n}(x_i - \bar{x})^2} \quad (3)$$

Where $x_{(i)}$ is the value of x at the $(i)th$ order, n is the sample size, $\bar{x}$ is the mean of the sample and a_i are normalised constants based on the scale and sample size of the data (Shapiro & Wilk, 1965).

In addition to the statistical tests, visual representations of the data were displayed using the Matplotlib package. Visual representations are important in exploratory data analysis, and complement purely numerical tests by graphically showing distributions and trends in the dataset. These visual representations complement numerical results and provide an intuitive understanding of the time-series data.

Autocorrelation

Autocorrelation refers to the property of a time series where its values at a specific time-step (t) are correlated with its values in the past (t-1....t-k). Autocorrelation measures the strength of the relationship between an observation and the observations at previous time-steps (or lags) (Hyndman & Athanasopoulos, 2018).

A strong autocorrelation in a time series implies that the value of the observation at the current time-step is strongly related to its value in previous time-steps, which is an important indicator in forecasting. The VAR model, which is used in this project, is an autoregression-based statistical model that uses lag orders (number of previous time-steps) of multiple variables to predict future values of each individual variable. Autocorrelation was presented graphically through correlograms displayed using the Statsmodels library.

Feature engineering

In the field of ML, feature engineering is the process of using domain knowledge to select and/or create new features (variables) to use as inputs to train a model (Geìron, 2019). As multivariate forecasting models rely on multiple input features to make predictions by mapping the relationship between the input and output, feature engineering is an important step to ensure only the most useful features are used in the model. The feature engineering process in this project contains two main steps:

1. Feature selection
2. Feature creation

Feature selection

A simple theoretical relationship between features has already been established using the water balance model. With this theoretical grounding, the basic idea of feature selection is to identify the features that will affect the daily reservoir levels at each subject site. The input features used for this project are displayed in Table 3, below. Based on hydrological intuition and domain knowledge, a general hypothesis can be applied to the relationship of each variable to the target variable – daily water level at time-steps t+ 7 and t+ 30.

TABLE 3. INPUT FEATURES AND THE INITIAL HYPOTHESIS OF ITS EFFECT ON DAILY WATER LEVELS.

Feature	Description	Hypothesis	Data Source
Level	The target variable Units: m	N/A	Watercare
Spill	Flow rate over the dam spillway Units: m3/s	Can be positively and negatively correlated to the water level. Higher spillway flows are caused by high water levels, but high flows will reduce the water level to a baseline above the mouth of the spillway.	Watercare
Rainfall (WSL)	Rainfall depth over 24 hours Units: mm/day	Positive correlation to the water level.	Watercare
Rainfall (NIWA)	Rainfall depth over 24 hours Units: mm/day	Positive correlation to the water level.	NIWAData
Abstraction	Abstraction flows to the treatment plant Units: m3/day	Negative correlation to the water level.	Watercare
Compensation	Flow release to meet downstream demands Units: m3/day	Negative or positive correlation to the water level.	Watercare
Soil moisture	Soil moisture deficit Calculated using rainfall and outgoing daily potential evapotranspiration (PET) and a fixed available water capacity of 150mm (NIWA, 2021). Units: kg/m2	Positive correlation to the water level.	NIWAData
Max Temp	Maximum daily temperature Units: °C	Negative correlation to the water level.	NIWAData
Penman evaporation	PET value using the Penman formula (Burman & Pochop, 1994) Units: kg/m2	Negative correlation to the water level.	NIWAData
Solar radiation	Solar radiation over 24 hours Units: MJ/m2	Negative correlation to the water level.	NIWAData

Feature creation

The features mentioned in the previous section provide useful hydrometric and anthropogenic variables that will be useful in the forecasting task. For a forecasting model, the input features are merely vector or matrix representations of numbers without the added context. Unless specifically designed, an ML or statistical model does not have the theoretical understanding of the data it is trained on. While this is an inherent drawback of these mathematical models, a solution is to introduce new features or representations of existing real-world phenomena as inputs.

One such feature is the representation of time. Since hydrological process are, to a large extent, seasonal, it is important to have features that represent seasonal periodicity. To make the model more time-aware, simply passing the date, month or year at each specific time-step is not particularly useful to a model, as the pure numerical representation of date is meaningless without the underlying context. A work-around is to represent periodicity as sine and cosine waves with a defined seasonal interval. With the intuitive assumption that the target output (i.e., reservoir water-level) has a seasonal cycle of 12 months, periodicity can be represented by a time-of-year signal in a unit circle with a repeating pattern at every 365 time-steps (TensorFlow, 2021). Figure 3 graphically presents the values of sine and cosine inputs that correspond to the time of year at each time-step in the time series. These sine and cosine values were then used as two separate features to represent periodicity.

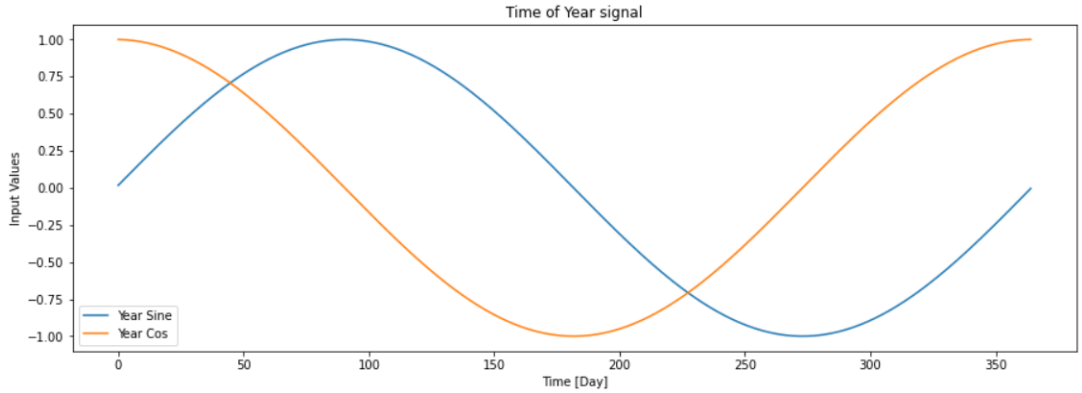

Figure 3. Cosine and sine waves representing the time-of-year inputs.
Source: colab.research.google.com.

Figure 4, below, shows the first 10 and last 10 values for all 13 features in the time-series DataFrame for the Mangatangi Dam. The dataset for Mangatangi, for example, has 13 features and 4464 time-steps, written in matrix form as a 4464 x 13 matrix, where each time-step is represented as a row vector and each feature is represented as a column vector.

Date	Level	Spill	Rainfall (WSL)	Abstraction	Compensation	Rainfall (NIWA)	Soil Moisture	Max Temp	Penman Evaporation	Vapour Pressure	Solar Radiation	Year sin	Year cos
2009-01-01	52.137	0.0	2.35	124727.6250	15000.0000	2.5	-77.3	25.5	3.2	21.2	14.8	0.0172	0.9999
2009-01-02	52.094	0.0	7.99	125076.5000	15000.0000	11.2	-72.4	25.1	4.5	20.8	16.6	0.0344	0.9994
2009-01-03	52.057	0.0	13.63	124547.2500	15000.0000	0.0	-77.4	21.9	6.0	12.5	31.9	0.0516	0.9987
2009-01-04	52.013	0.0	0.00	125002.0000	15000.0000	0.0	-81.4	22.7	5.1	14.1	28.4	0.0688	0.9976
2009-01-05	51.958	0.0	0.00	125034.8750	15000.0000	0.0	-84.6	22.9	5.5	15.0	29.9	0.0859	0.9963
...	...	...	...	...	...	...	...	...	...	...	...	...	...
2021-03-18	43.938	0.0	6.44	62259.6897	24150.0007	0.0	-100.1	21.7	3.9	11.5	16.7	0.9698	0.2437
2021-03-19	43.887	0.0	0.00	53520.3622	24480.8511	0.0	-101.9	21.1	3.4	11.4	17.2	0.9739	0.2270
2021-03-20	43.851	0.0	0.00	39548.6537	24593.3167	0.0	-106.8	22.0	3.3	11.2	17.7	0.9777	0.2102
2021-03-21	43.815	0.0	0.00	39530.8389	24489.1570	0.0	-108.5	22.5	3.5	12.6	18.7	0.9811	0.1933
2021-03-22	43.781	0.0	0.00	39513.0961	24449.8240	0.0	-106.6	22.8	3.4	12.7	16.8	0.9843	0.1764

4464 rows × 13 columns

Figure 4. Mangatangi time-series DataFrame. Source: colab.research.google.com.

Correlation tests

Statistical correlations tests provide insight into the relationship between two features. While they do not directly imply causation, correlation between the data can be a useful indicator of prediction performance and feature relationships.

With the assumption that the data distribution of features is non-parametric (i.e., not normally distributed), the Spearman's rank correlation test was chosen to calculate the correlation between features (Hyndman & Athanasopoulos, 2018). This correlation test describes the strength of the linear relationship between the ranked values of each feature and is achieved by ranking the values at each time-step (based on scale) and calculating the rank coefficient using Equation 4, below.

Where, ρ is the Spearman's rank correlation coefficient, d_i is difference in rank between the two observations and n is the number of observations (Spearman, 1904). Spearman's correlation test provides a coefficient result between 1 and -1 between two variables, where coefficients closer to 1 will be strongly positively correlated, while coefficients closer to -1 will be strongly negatively correlated with each other.

$$\rho = 1 = \frac{6\sum d_i^2}{n(n^2 - 1)} \quad (4)$$

Feature importance and Shapley values using XGBoost

Extreme gradient boosting (XGBoost) is a decision-tree-based supervised ML algorithm that uses gradient boosting techniques for regression and classification tasks. XGBoost was proposed by Chen and Guestrin (2016) to be more computationally efficient than regular boosting methods, and has since proven to be more accurate at prediction tasks than many traditional ML models. Although XGBoost is not used for any direct prediction tasks in this project, the architecture of decision-tree-based algorithms allows extraction of feature importance. Bouktif et al. (2018) used XGBoost to determine feature importance to forecast electricity load, while Zheng & Wu (2019) used XGBoost to forecast wind power using various hydro-meteorological features as inputs.

To this end, Shapley values were used to plot feature importance scores, showing the relative contribution of each feature to the final prediction outcome. Shapley Additive exPlanations (SHAP), proposed by Lundberg and Lee (2017) describe the contribution of a feature to the prediction compared to the average prediction value of the dataset. A description of Shapley values and its uses in the ML context is given by Molnar (2021).

The goal of SHAP is to explain the prediction of an instance x by computing the contribution of each feature to the prediction. The SHAP explanation method computes Shapley values from coalition game theory. The feature values of a data instance act as players in a coalition. Shapley values tell us how to fairly distribute the 'payout' (= the prediction) among the features.

The reader is encouraged to refer to Chen and Guestrin (2016) and Molnar (2021) for further theoretical explanations on XGBoost and Shapley values. For this project, the XGBoostRegressor class in the SHAP library was used to compute the Shapley values for the features (X) in predicting the target (y), which is the dam level at each time-step.

FORECASTING

The forecasting component of this project used two separate forecasting methods: VAR and RNNs, to forecast daily dam levels at a 7- and 30-day horizon. The predictions from both models were made using a walk-forward validation method in which new inputs are given to the model at each time-step. This process is illustrated below in Figure 5 for the +7-day forecast.

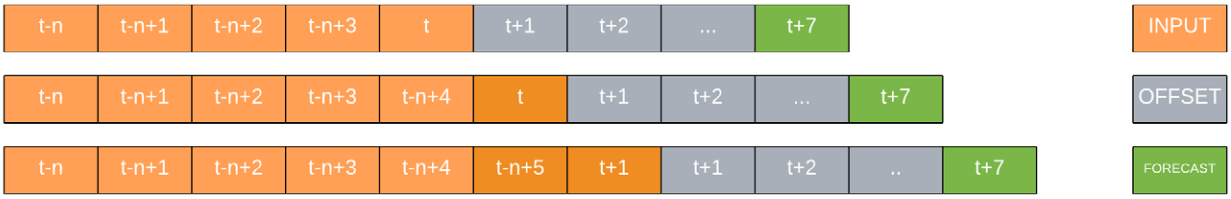

Figure 5. Walk-forward validation.

To accurately gauge model performance, a baseline persistence model was used to further compare and evaluate the performances of the models. The persistence model simply used the most recent observation at the current time-step (y_t) as the forecast for the 7- and 30-day target ($y_{t+7} y_{t+30}$). Due to its simplicity, this naïve forecasting model acted as a baseline to compare the performances of more sophisticated models (Hyndman & Athanasopoulos, 2018).

Model performance was measured for each dam using the root mean squared error (RMSE) and mean absolute error (MAE) between the observed (y) and forecasted ($\hat{y}$) values for the target variable at each future time-step (i.e., at 7 and 30 days).

$$RMSE = \sqrt{\frac{\boldsymbol{\Sigma}_{i=1}^{n}(\hat{y}_i - y_i)^2}{n}} (5)$$

$$MAE = \sqrt{\frac{\boldsymbol{\Sigma}_{i=1}^{n}|\hat{y}_i - y_i|}{n}} (6)$$

RMSE and MAE are shown above in Equations 5 and 6 respectively. Where $\hat{y}$ is the predicted value, y is the true value and n is the sample size. All models are evaluated on a test set that comprises the forecasts for the final 365 time-steps of the dam level.

VAR model

The VAR model was introduced by Sims (1980) and is still widely used in an econometric context to model multivariate time series. The VAR model was used to model macroeconomic variables but has since been adopted in many different fields.

$$y_t = c + \phi_1 y_{t-1} + \phi_2 y_{t-2} + \cdots + \phi_p y_{t-p} + \varepsilon_t (7)$$

Consider an autoregressive (AR) model of the order P. The order represents its lag component.

Where c is the intercept term, ϕ is an adjustable parameter (constant), and ε is the error. This linear function for a univariate time series indicates that the value of y at time-step t is a function of the intercept, a constant and an error term (Hyndman & Athanasopoulos, 2018).

$$y_{k,t} = c_k + \phi_{1k} yk_{t-1} + \phi_{2k} y_{t-2} + \cdots + \phi_k y_{kt-p} + \varepsilon_{k,t} (8)$$

The VAR model expands this idea to include multiple time series, where each variable is modelled as a linear function of the past values of itself and the other variables (McKinney et al., 2018). The vectorised AR function for k number of variables with P lags is shown in Equation 8, above.

Equation 8 contains multiple equations for each variable up to k number of equations. In simple terms, each variable (feature) in a VAR model, has a specific equation that describes its temporal distribution based on three main components:

1. Its own lagged values
2. Lagged values of other variables
3. An error component

Unlike most traditional statistical forecasting models, VAR assumes the total variables presented to the model are endogenous in nature. This means the variables themselves are dependent and interrelated with one another (Hyndman & Athanasopoulos, 2018).

For the forecasting task in this project, k is be the number of variables (13), while the lag order (P) was selected by using three information criteria to select the optimal lag order (P). Information criteria measures the goodness of fit for a set of given parameters. The select_order function in Python's Statsmodels library was used to select the most suitable lag order from three different information criteria: Akaike information criteria (AIC), Bayesian information criteria (BIC) and the Hannan–Quinn information criterion (HQIC) (Hatemi-J & Hacker, 2019).

A custom function was built to predict the 7- and 30-day forecasting result at each time-step using the walk-forward validation method, where new inputs are given to the model at each time-step.

RNN models

Two separate sets of LSTM and GRU models were created to forecast the 7- and 30-day time horizon for each dam using all 13 features as inputs with a target output as the water level at 7 and 30 days. An additional set of models (no 'Level' input, or NoL) were created, in which the inputs to the model did not contain the 'Level' feature. Instead, the 'Level' feature was only provided as the target variable (y) and the model was trained on the remaining 12 features. While this model would not be useful for the main prediction task, it would be important in further determining whether there was a 'learnable' relationship between the remaining features and the water level, thereby giving an indication as to how useful the remaining 12 features were in predicting the dam water levels. Table 4, below, summarises the RNN models used for this project.

TABLE 4. RNN MODELS USED IN THIS PROJECT.

+7 Day Forecast		+30 Day		No 'Level' input (NoL)	
GRU+7	LSTM+7	GRU+30	LSTM+30	GRU-NoL	LSTM-NoL

Additional data preparation was required prior to training the model. Namely, a 'Target' variable (y) was created to represent the true forecast values at the 7- and 30-day horizon. This was achieved by creating a copy of the 'Level' column and shifting the data up by the specific time-step (7 or 30). The dataset was then split into training, validation and testing sets. The last 365 values were used for the test set, while the rest were split into 85% training

and 15% validation sets. The aim was to train and fit the model on the training set while using the validation set to prevent overfitting to the training data. Once trained, model performance was evaluated by performing predictions on the test set. The data partitioning used for training, validation and test sets for each dam is shown in Table 5, below.

TABLE 5. PARTITIONING OF TRAINING, VALIDATION AND TESTING DATA.

	Upper Nihotupu		**Waitākere**		**Mangatangi**	
	+7 Day	+30 Day	+7 Day	+30 Day	+7 Day	+30 Day
Training Data	3172	3133	3406	3367	3472	3433
Validation Data	560	553	602	625	620	606
Test Data	365	365	365	365	365	365

Once the data was partitioned, the next stage was to scale the input data to within acceptable ranges for the model. As an example, the raw feature data for the Upper Nihotupu Dam had a range between -139.9 and 34101.375. Since the features had different scales/units associated with them, the range of values was large, and large ranges often result in unstable model performance. Since ML models rely on adjusting weights, large data ranges will cause models to train and perform poorly (Goodfellow et al., 2016). To standardise the data the MinMaxScaler object in Scikit-Learn was used to scale the feature values between 0 and 1, while still preserving the underlying shape of the original distribution. The RNNS models (LSTM and GRU) were created, compiled, and run on TensorFlow (Abadi et al., 2016) and Keras (Chollet et al., 2015). The models were created using the Sequential class in Keras. Table 6 summarises the steps taken to create, compile, train and predict each model, including the hyper-parameters used at each stage.

TABLE 6. MODEL HYPER-PARAMETERS USED.

Steps	**Hyperparameters/description**
Create and define model	Model type: Sequential Model layers Input layer Hidden layer with 512 units Dense output layer
Compile model	Optimiser: *Adam* Loss Function: *Huber* Learning rate: 0.001
Fitting the model to the training data	Epochs: *100* Steps per epoch: *30*

RESULTS

Analysis

Trend

Results from the Augmented Dickey-Fuller (ADF) tests are shown in Table 7, below. The statistical test shows a p-value <0.05 for all features in all three dams, which rejects the null hypothesis and gives an indication that the time-series data for all features of the three dams have no observable trend for the chosen time period.

TABLE 7. P-VALUES FROM THE ADF TEST.

	Upper Nihotupu	**Waitākere**	**Mangatangi**
	P-value	**P-value**	**P-value**
Level	4.02E-05	7.22E-06	0.010597
Spill	1.54E-12	3.57E-30	1.41E-26
Rainfall (NIWA)	0	0	0
Rainfall (WSL)	0	0	0
Vapour pressure	6.54E-05	2.77E-05	9.19E-06
Penman Evaporation	6.67E-04	6.65E-04	0.000117
Abstraction	4.13E-11	1.54E-14	2.16E-06
Compensation	1.92E-04	3.48E-04	0.000169
Max temp	1.82E-02	0.010292	3.59E-04
Soil moisture	2.40E-04	1.27E-04	0.000179
Solar radiation	0.002754105	8.26E-03	7.03E-04

Normalcy test

The results from the Shapiro-Wilks normalcy tests reject the null hypothesis for all features in all three dams, which indicates the data is non-parametric and may not be normally distributed.

Box plots displaying the yearly and monthly distribution of dam levels show clear seasonality with changing means during different months of the year. Moreover, the yearly box plots clearly show historical periods with low dam levels that correspond to lower yearly means and greater percentile distributions. Figure 6, below, displays the box plots (both yearly and monthly) for the Waitākere Dam.

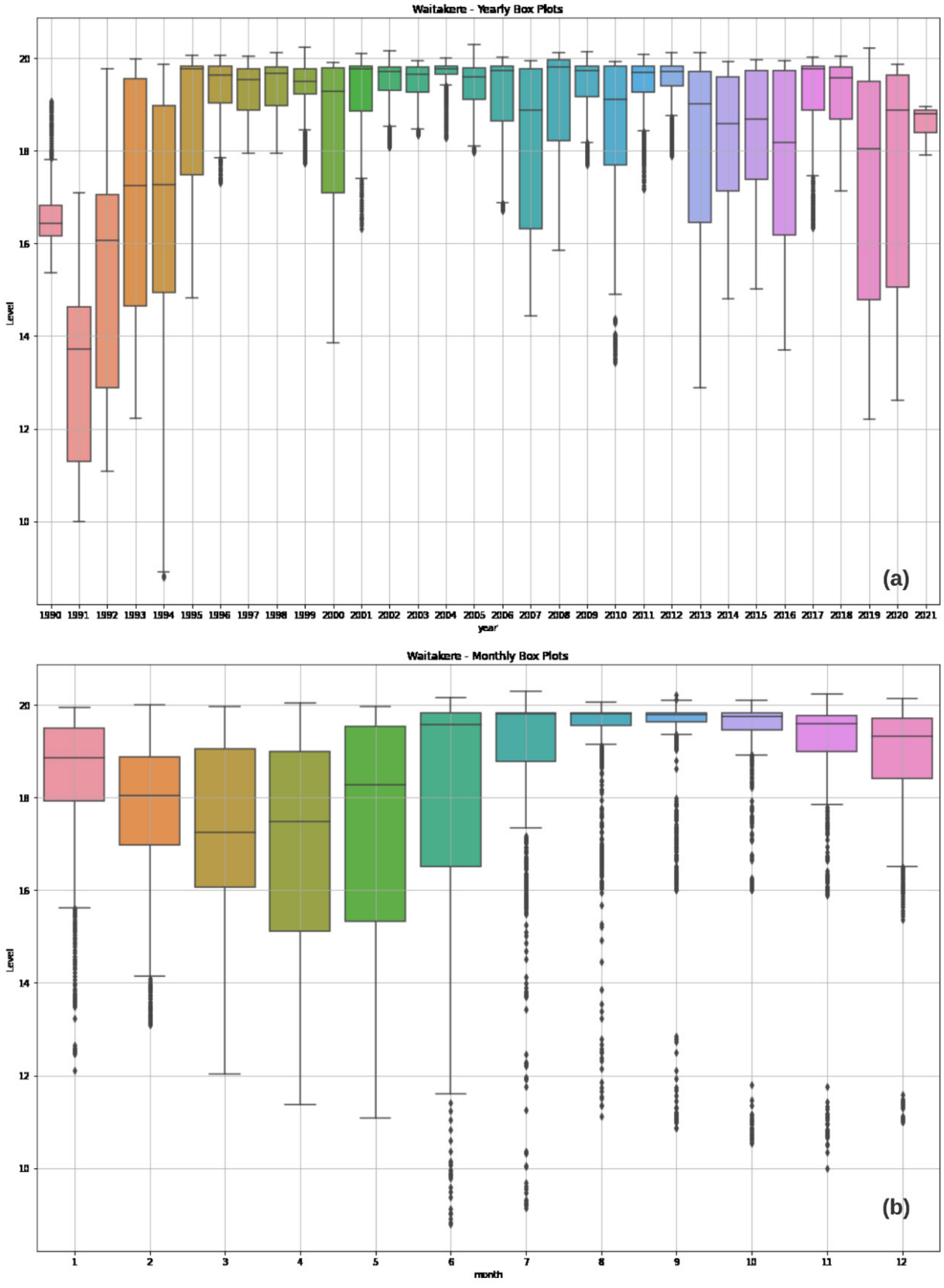

Figure 6. Box plots for the Waitākere Dam level. Showing (a) yearly and (b) monthly aggregations.
Note: Level shown in metres.

Autocorrelation plots

Autocorrelation plots are displayed in Figure 7, below. The autocorrelation is displayed at a lag of 3000 time-steps. The y-axis shows the autocorrelation coefficient, where a coefficient of +1 displays strong positive autocorrelation, while a coefficient of -1 displays strong negative autocorrelation. The light-blue shaded area shows the 95% confidence intervals; values outside of this box can be assumed to have a strong autocorrelation.

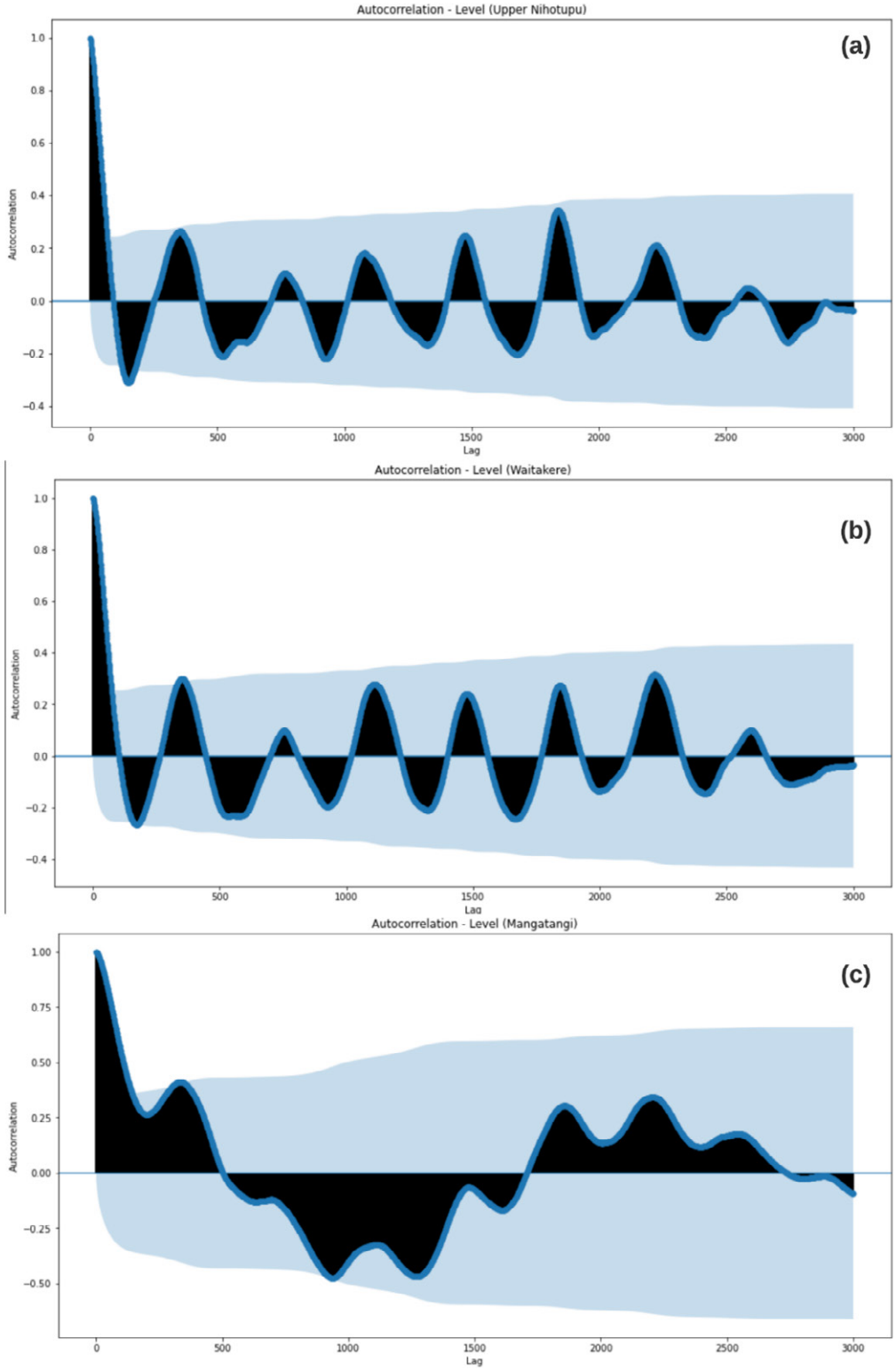

Figure 7. Autocorrelation plots for the (a) Upper Nihotupu, (b) Waitākere and (c) Mangatangi Dam levels. Results are displayed at a lag of 3000.

Feature engineering – correlation tests

Spearman's rank correlation coefficients heatmaps are shown in Figure 8. Dam levels at Upper Nihotupu and Waitākere show a high degree of positive correlation with 'Spill' and 'Soil Moisture.' The dam level at Mangatangi show a high degree of positive correlation with 'Abstraction' and 'Spill.' Strong negative correlations can be observed in the Upper Nihotupu and Waitākere Dam levels for 'Max temp' and 'Vapour pressure.'

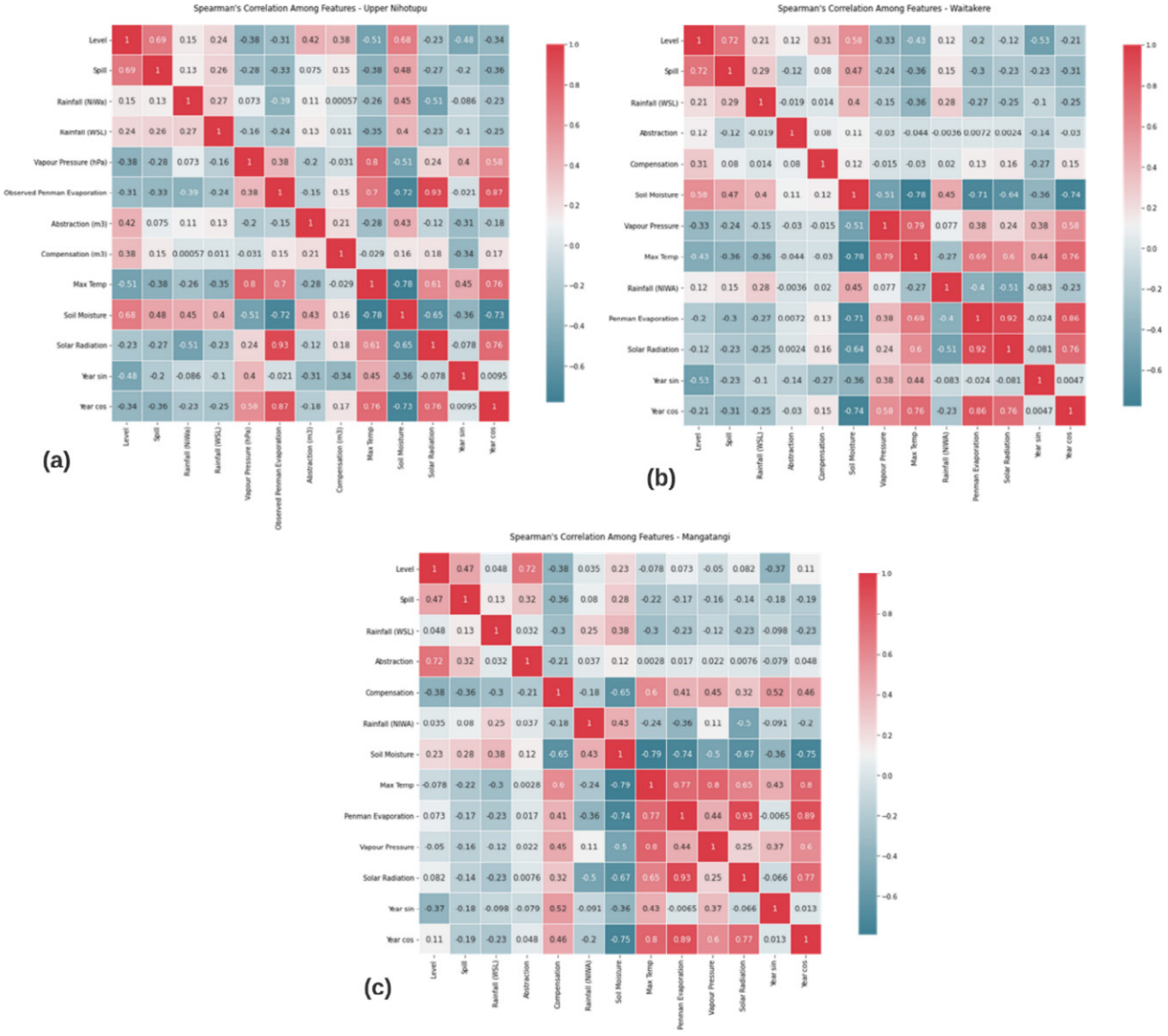

Figure 8. Heatmap of Spearman's correlation among features: (a) Upper Nihotupu, (b) Waitākere, (c) Mangatangi.

The Shapley values for the features obtained from the XGBoost tests are shown in Figure 9, below.

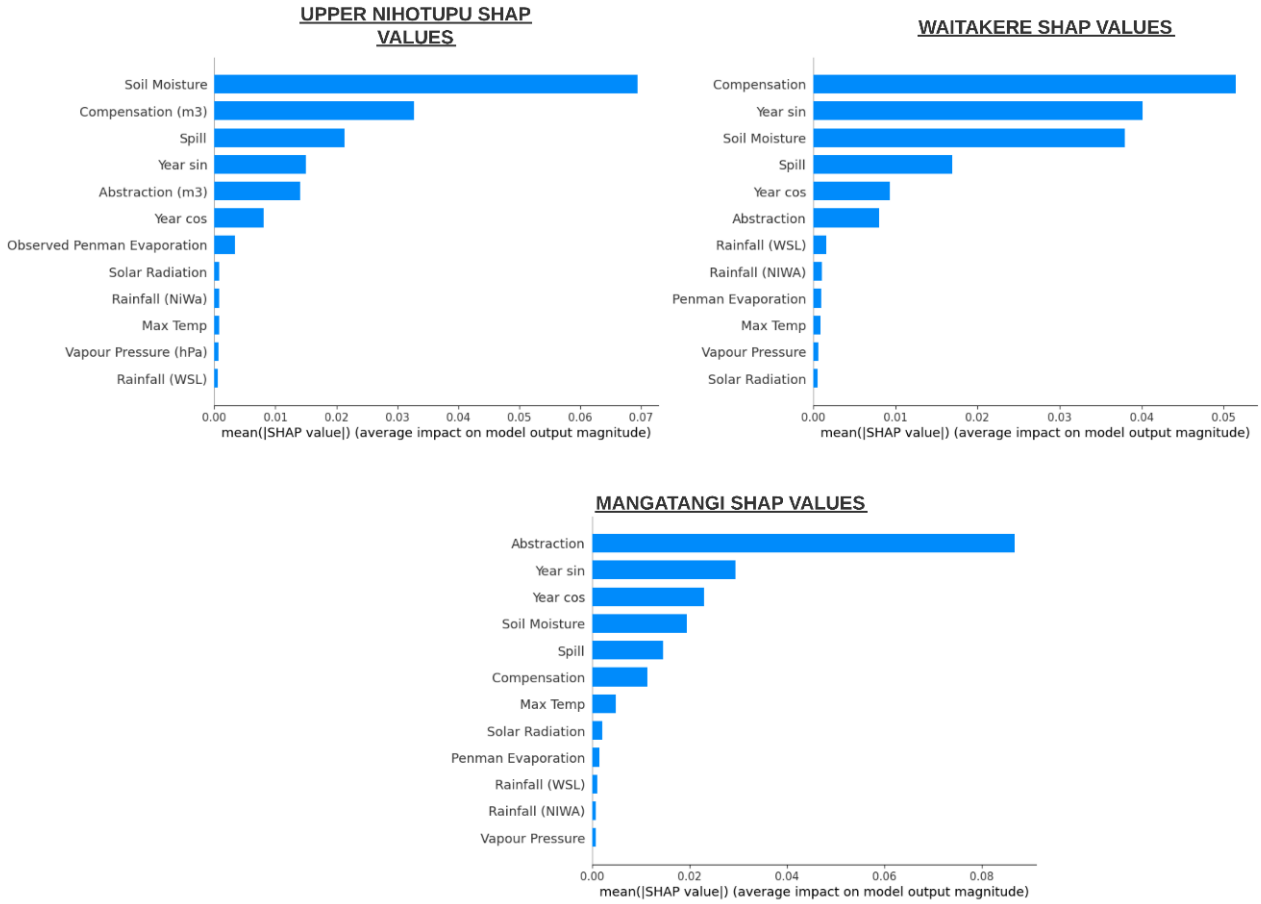

Figure 9. Partitioning of training, validation and testing data.

Forecasting

The overall RMSE and MAE results for the Upper Nihotupu, Waitākere and Mangatangi Dams water-level forecast for the 7- and 30-day periods are shown in Tables 8, 9 and 10, below.

TABLE 8. UPPER NIHOTUPU, FORECASTING RESULTS (MAE AND RMSE).

Upper Nihotupu								
	VAR(3)+7	**VAR(3)+30**	**GRU+7**	**GRU+30**	**LSTM+7**	**LSTM+30**	**Pers+7**	**Pers+30**
RMSE	1.189	2.692	1.115	2.668	1.306	2.362	1.419	3.919
MAE	0.686	1.928	0.684	1.955	0.914	1.762	0.834	2.981

TABLE 9. WAITĀKERE FORECASTING RESULTS (MAE AND RMSE).

Waitākere								
	VAR(5)+7	**VAR(5)+30**	**GRU+7**	**GRU+30**	**LSTM+7**	**LSTM+30**	**Pers+7**	**Pers+30**
RMSE	0.533	1.227	0.518	1.268	0.547	1.167	0.622	1.670
MAE	0.255	0.843	0.195	1.040	0.316	0.966	0.291	1.063

TABLE 10. MANGATANGI FORECASTING RESULTS (MAE AND RMSE).

Mangatangi								
	VAR(2)+7	**VAR(2)+30**	**GRU+7**	**GRU+30**	**LSTM+7**	**LSTM+30**	**Pers+7**	**Pers+30**
RMSE	1.199	2.684	1.115	2.668	1.306	2.362	0.407	1.455
MAE	0.667	1.894	0.684	1.955	0.914	1.762	0.334	1.326

Both VAR, GRU and LSTM models performed better than the persistence model for the 7- and 30-day prediction task at Upper Nihotupu and Waitākere, with only slight performance variations between them. Perhaps surprisingly, the persistence model outperformed the more sophisticated models for both prediction tasks for the Mangatangi Dam. Figures 10 and 11 display the forecasting-error distribution plotted for each month. These results show certain months are prone to larger errors in forecasting. The Upper Nihotupu and Waitākere results show greater prediction errors in the months of April, May, June and July, while the Mangatangi results showed the largest errors in the months of February, April and October.

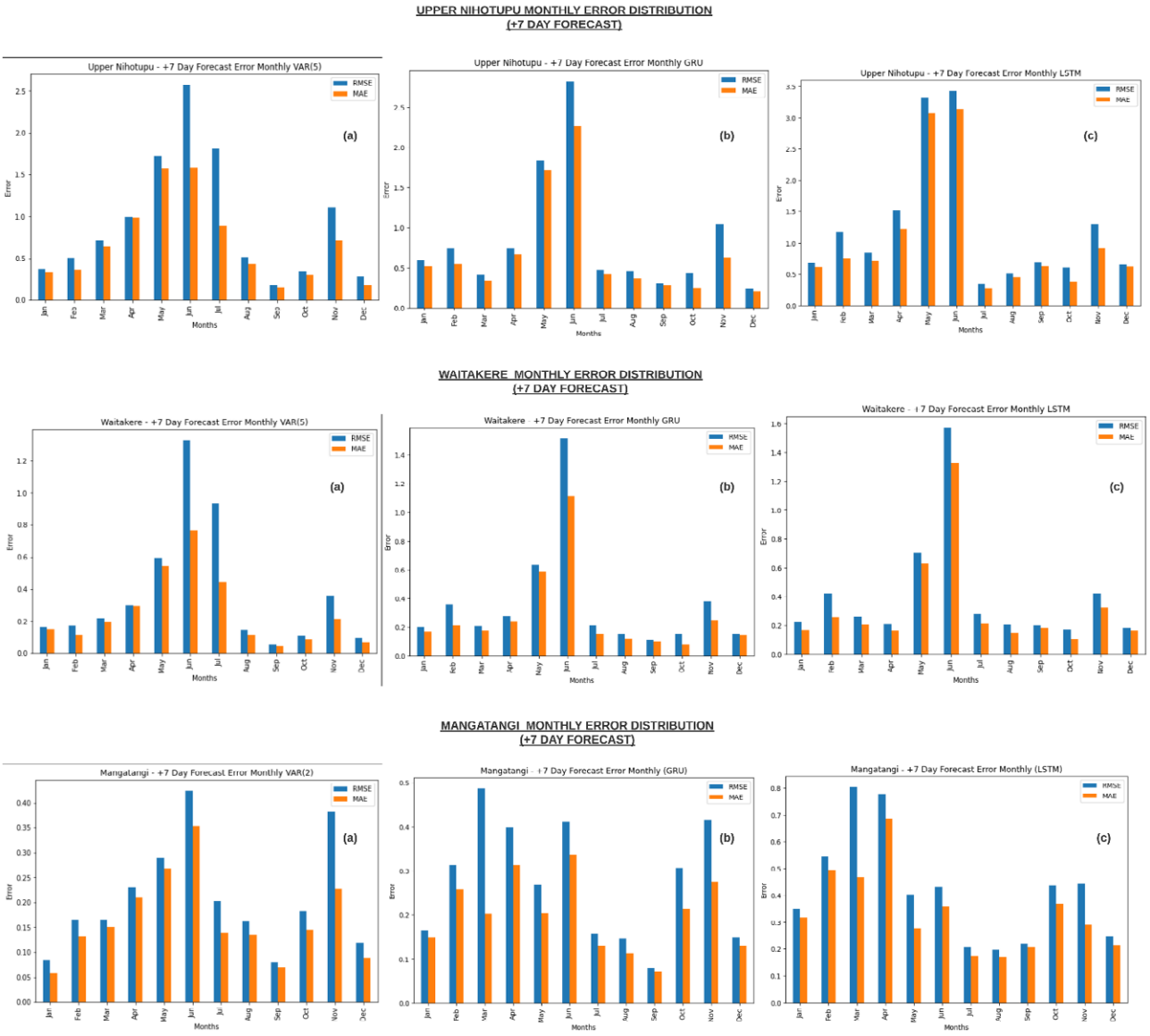

Figure 10. +7-day Forecast, monthly error distribution: (a) Upper Nihotupu, (b) Waitākere and (c) Mangatangi.

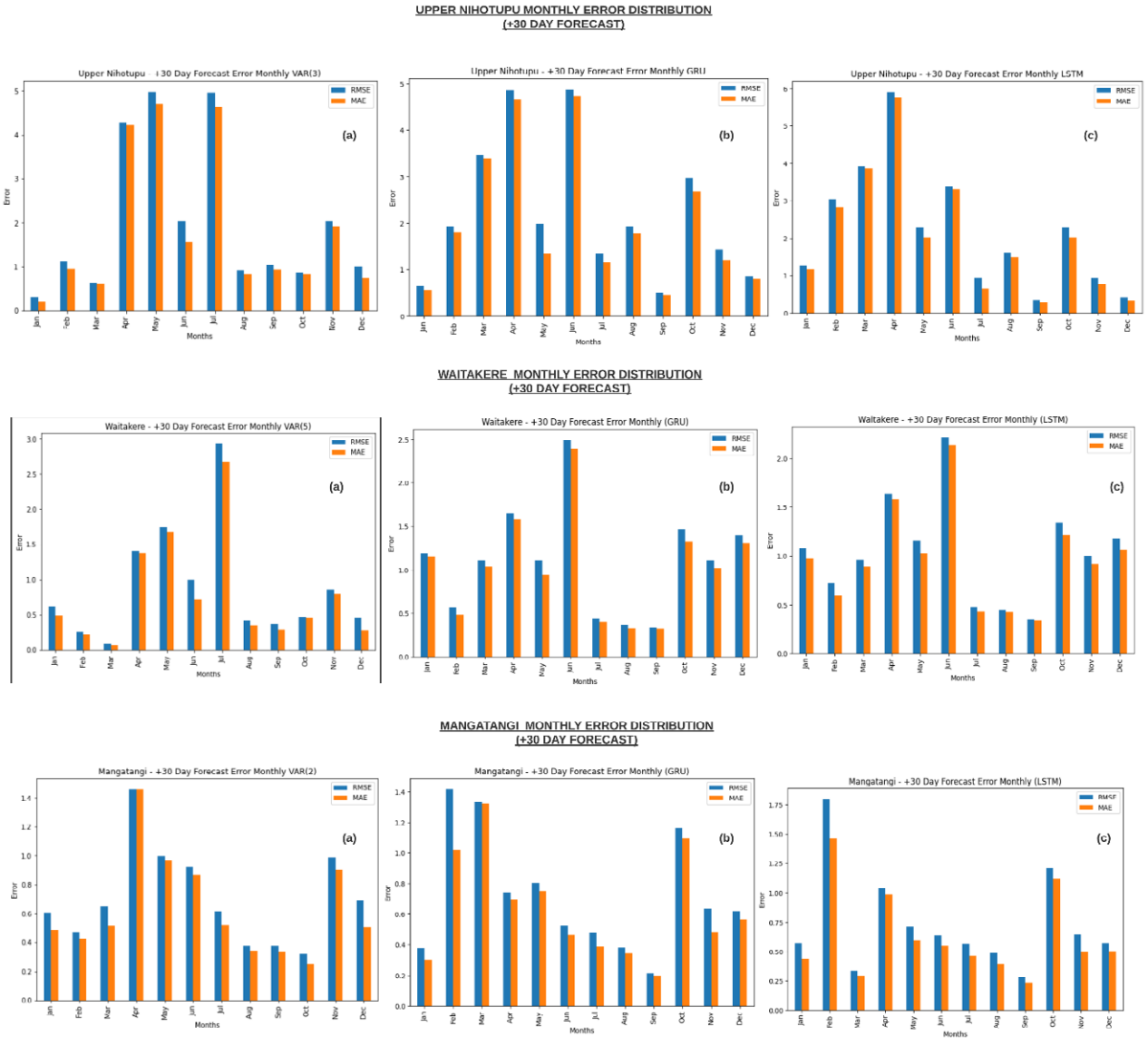

Figure 11. +30-day forecast, monthly error distribution: (a) Upper Nihotupu, (b) Waitākere and (c) Mangatangi.

The +7-day and +30-day predictions for each model are plotted in Figures 12 and 13, below. The plot results show relatively poor forecasting performances in the 30-day forecasting task (Figure 13), with the Upper Nihotupu and Waitākere models failing to accurately forecast the lower extremes.

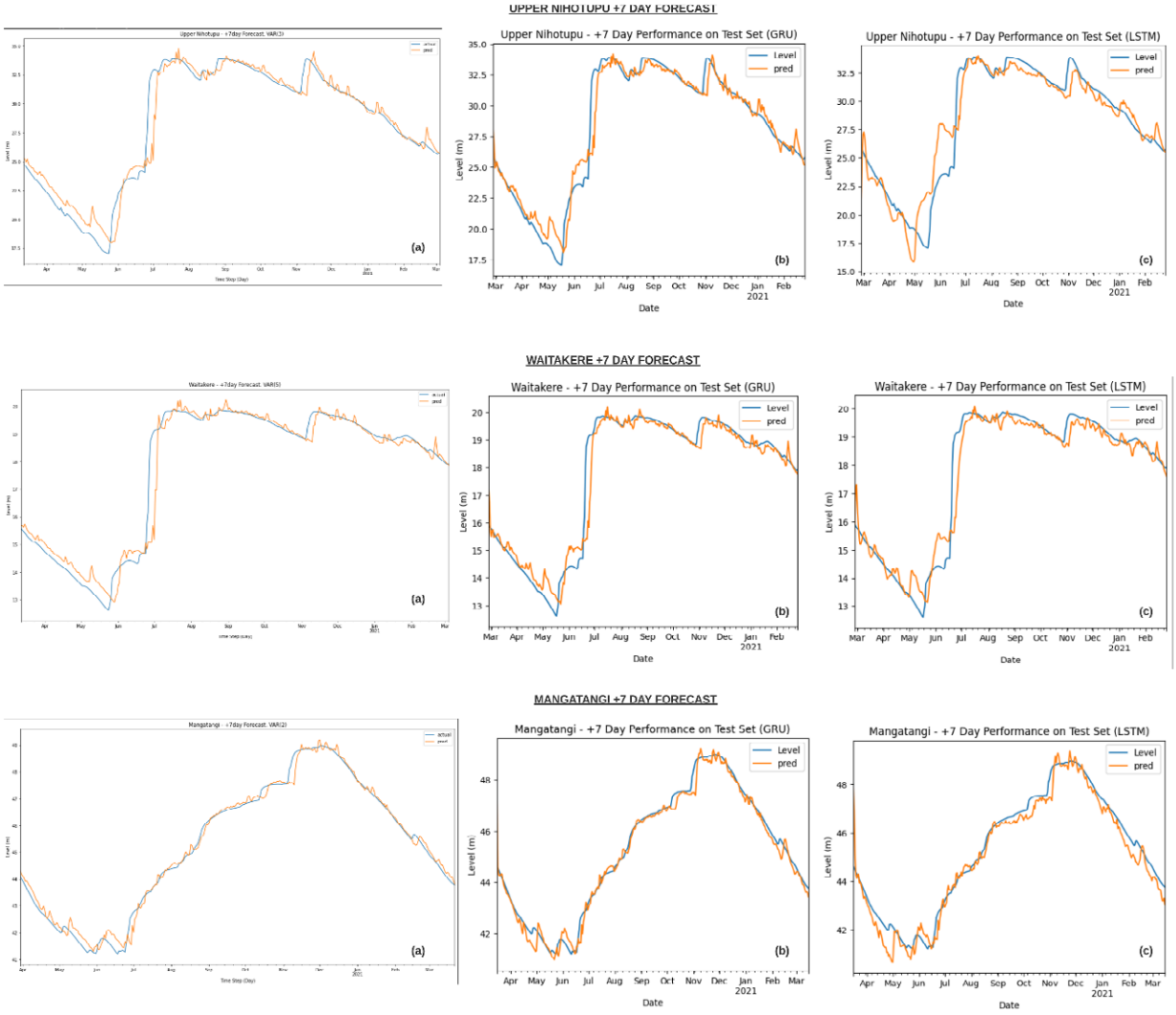

Figure 12. +7-day prediction results for each dam: (a) VAR, (b) GRU and (c) LSTM.

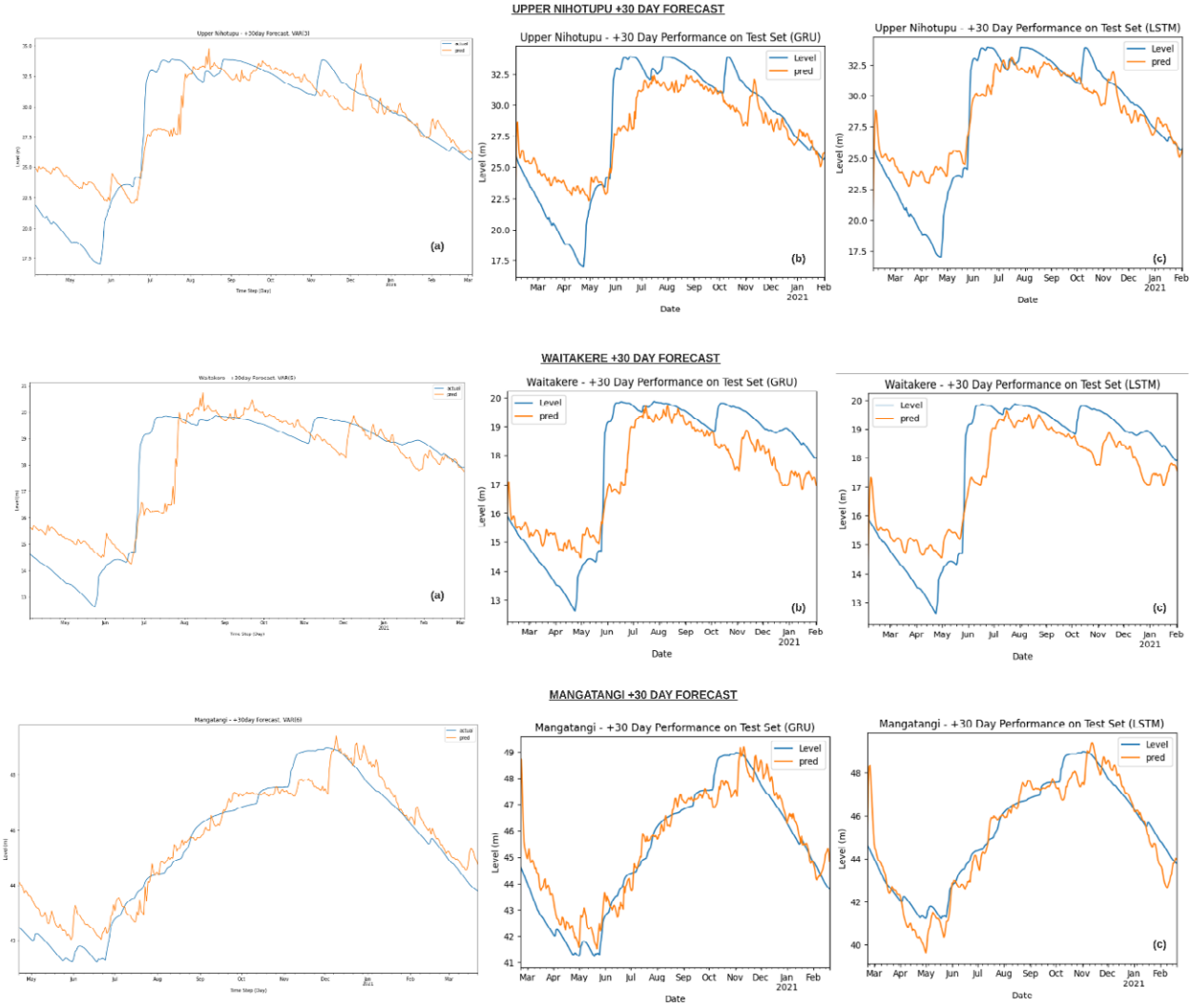

Figure 13. +30-day prediction results for each dam: (a) VAR, (b) GRU and (c) LSTM.

The RMSE and MAE results from the NoL models (GRU-NoL and LSTM-NoL) are shown in Table 11, below. Figure 14 shows the NoL predictions for each dam. The Upper Nihotupu and Waitākere Dams show relatively acceptable predictions while the predictions for the Mangatangi Dam had poor and noisy prediction results.

TABLE 11. MAE AND RMSE RESULTS FOR THE NOL MODELS.

	Upper Nihotupu		**Waitākere**		**Magatangi**	
	GRU NoL	**LSTM NoL**	**GRU NoL**	**LSTM NoL**	**GRU NoL**	**LSTM NoL**
RMSE	2.754	3.724	1.516	1.326	3.152	3.407
MAE	2.499	2.930	1.316	1.194	2.446	3.121

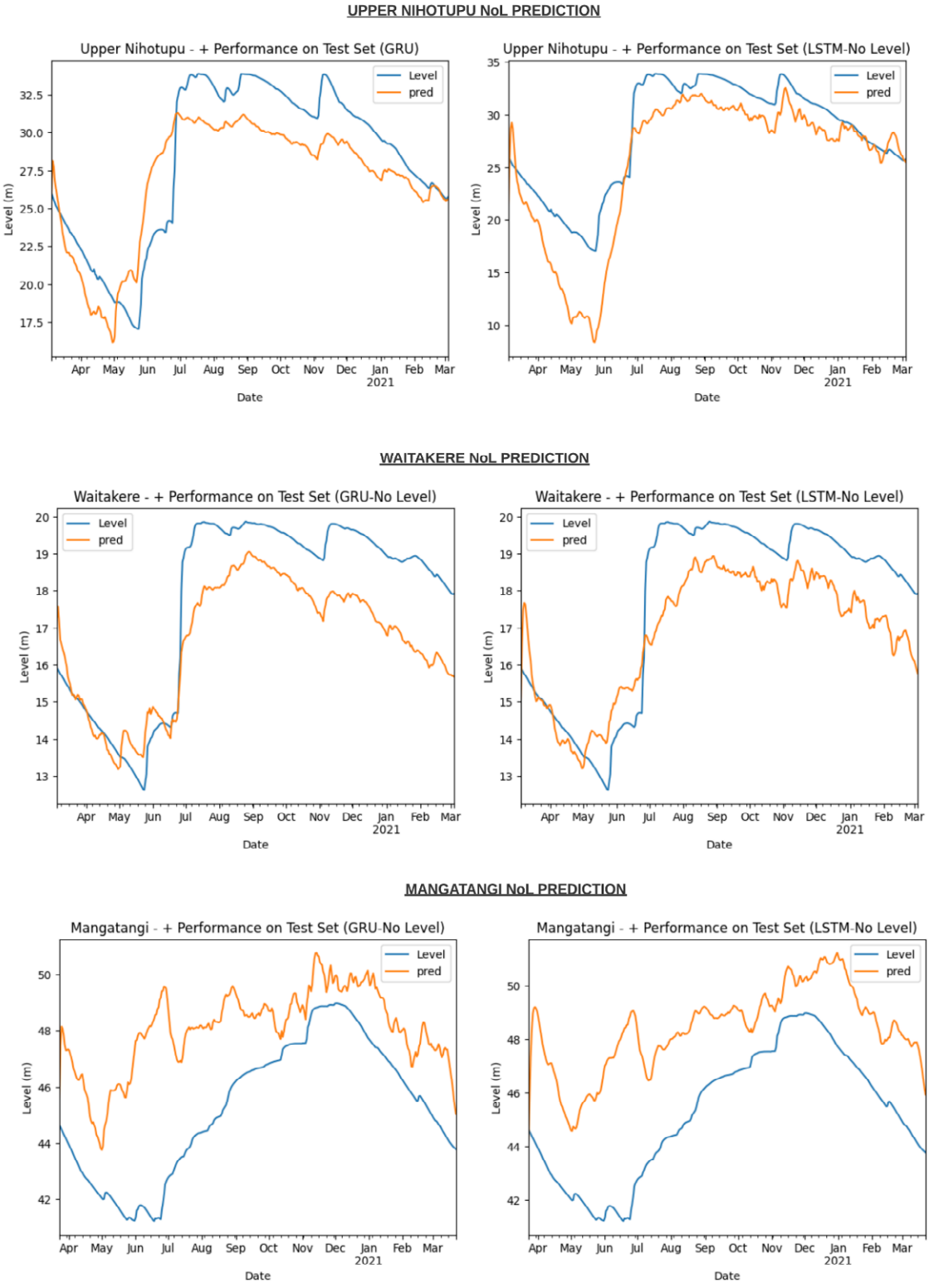

Figure 14. Prediction results from the GRU-NoL and LSTM-NoL models.

DISCUSSION

Analysis

The analysis task focused on three main components of time-series data. Trend, distribution and correlation. Inspection of the individual time-series plots for all three dams does not show a clearly recognisable trend for any of the listed features. This is further evidenced by the ADF results, which indicate a lack of a clearly discernible trend. Further inspection of the time-series plots, however, does show seasonality, with intermittent cycles corresponding to historical droughts. As an example, a historical decrease in water levels for all three dams can be seen in in the years 1993–1994. This is consistent with the Tāmaki Makaurau Auckland drought of 1994, which saw historical lows for dams in the city (Fowler & Adams, 2004).

Further investigation into the box plots shows monthly seasonality, where lower mean and percentile values are evident in the months of April and May for all three dams. Additionally, the yearly box plots show the mean and distribution of the 25th percentile dam levels since 2013 have been comparatively lower than previous years. This may suggest a decreasing trend.

The autocorrelation plots (Figure 7) indicate strong autocorrelation and seasonality of dam levels for the Upper Nihotupu and Waitākere Dams. The dam levels for the Mangatangi Dam seem to show cyclical behaviour as opposed to yearly seasonality.

The Spearman correlation heat maps (Figure 8) show strong correlation between dam levels and 'Soil Moisture,' 'Abstraction' and 'Spill.' Stronger correlation results can be observed between features, especially the yearly cosine signal ('Year cos') which has strong positive correlations to 'Max Temp,' 'Penman Evaporation,' 'Vapour Pressure' and 'Solar Radiation,' and a strong negative correlation to 'Soil Moisture.' This suggests further evidence of seasonality.

The Shapley values of the features for each dam (Figure 9) show 'Soil Moisture,' 'Compensation,' 'Abstraction,' 'Year sin' and 'Year cos' as having stronger feature importance scores for predicting the dam level using XGBoost. This is fairly consistent with the results obtained from the correlation analysis.

Looking at these results, the lack of significant correlation and poor feature importance values for the rainfall features could suggest that rainfall may not have an immediate effect on the dam levels, and soil moisture may have a stronger immediate effect in dictating dam levels. This could be due to low antecedent moisture conditions of the soil, which results in delayed runoff responses to rainfall. During prolonged drought conditions, low antecedent moisture conditions may lead to delayed rainfall responses to meet soil saturation before runoff can occur. Moreover, native bush coverage in all three catchments is high, which may indicate greater interception by vegetation during rainfall events, which can lead to less through-fall of precipitation into the surface. A technical report by Manaaki Whenua Landcare Research for the Ministry for the Environment (MfE) shows approximately 33–37% of interception loss can be observed for native Aotearoa New Zealand bush (Rowe et al., 2002). Which means, for an average yearly rainfall depth of 1000mm, approximately 350mm can be lots due to interception.

However, care should be taken when using data-driven models to explain physical processes. The data used in this project came from two separate sources, and while the measuring variables are different, both organisations may have vastly different measurement accuracies and procedures. Additionally, derived features, such as 'Penman Evaporation,' 'Soil Moisture,' etc., that are not directly measured add another layer of uncertainty and error to the analysis and forecasting tasks. Furthermore, the accuracy of modelled data from the VCSN grids may have varying degrees of accuracy based on topography and the time of year. According to Tait and Woods:

> An error analysis at 20 validation sites has shown that the average RMSE of the daily PET interpolations for the validation sites varies between about 1 mm in summer and 0.4 mm in winter. The average relative error (the RMSE divided by the average daily PET) is between 22% and 26% throughout the important growing season months (October–April), but increases to 60%–70% over winter when the average daily PET at the validation sites is only around 0.6 mm. (2007, p. 436)

Forecasting

The forecasting results at the 7- and 30-day time-steps for both VAR and RNN models show promising results for the Upper Nihotupu and Mangatangi Dams. While the RNN models (in particular the GRU variant) had better performance for the 30-day forecast, the difference between the two methods are marginal at best, suggesting traditional linear models such as VAR can perform as well as more complex neural network-based models for the forecasting task.

Comparatively, the results for the Mangatangi Dam favour the naive persistence model, which suggests, based on the forecast at the 7- and 30-day horizon, the dam level may not fluctuate much from the measurement at the current time-step. The VAR and RNN models output a noisier signal at each time-step, which may suggest models are potentially overfitting to the training data, which results in poor generalisation on the test set. Additionally, relatively low fluctuations in dam levels in Mangatangi are further demonstrated by the relatively small standard deviation 3.78 (with mean: 50.24). By comparison, both Upper Nihotupu and Waitākere Dams show greater fluctuations, as shown in their relatively high standard deviations from the mean. These might indicate that VAR and RNN models might be better at prediction tasks where fluctuations and standard deviations are relatively high, while for lower rates of fluctuation, a simple naive model may work better.

The NoL models had poor performance; however this was expected as the model inputs did not contain the 'Level' feature (i.e., the dam level at the current time-step). This meant the NoL models had to 'learn' to predict an output for the dam level, given only the 12 hydrometric and anthropogenic parameters. The NoL results for the Upper Nihotupu and Waitākere Dams show reasonable prediction accuracy in this regard and this might indicate that there is, in fact, an underlying relationship between the features and the water level.

CONCLUSION

This project presents a statistical analysis and forecast of the dammed water-level in three water-supply dams in the Tāmaki Makaurau Auckland and Waikato region: Upper Nihotupu, Waitākere and Mangatangi Dams. An analysis of the time-series data reveals no underlying trend component; however, there is strong indication of seasonality. The correlation and feature importance tests show certain variables have a stronger correlation with the dam levels, while others show little to no correlation. However, interpreting these results must be done with caution due to the uncertainties in the accuracy of data. Seasonality, in particular, had a strong effect on results, as greater prediction errors were found for the months of April, May, June and July.

The forecasting component of this project used two models, VAR and RNN, to forecast the model water level at a 7- and 30-day time horizon. An additional persistence model to base performance on was utilised in the assessment. Both VAR and RNN models performed better than the persistence model for the Upper Nihotupu and Waitākere Dam level predictions, however the persistence model had better performance for the Mangatangi Dam. Prediction accuracy between VAR and RNN models was nearly identical, with RNN models having a slightly better prediction accuracy as shown by the RMSE and MAE results. An additional model – NoL RNN – was created, in which the model was trained to predict the water level by only using the hydrometric and anthropogenic features as inputs. The performance of these models showed that these features might contain learnable parameters that can be used to forecast water levels.

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USING CHATBOTS IN CUSTOMER SERVICE: A CASE STUDY OF AIR NEW ZEALAND

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https://doi.org/10.34074/proc.2206011

Business and Infrastructure

This publication may be cited as:

Thi Phuong Anh, L., and Rajah, E. (2022). Using Chatbots in Customer Service: A Case Study of Air New Zealand. In E. Papoutsaki and M. Shannon (Eds.), ***Proceedings: Rangahau Horonuku Hou – New Research Landscapes, Unitec/MIT Research Symposium 2021, December 6 and 7*** **(pp. 161–176). Auckland: ePress, Unitec, Te Pūkenga. https://doi.org/10.34074/proc.2206011**

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ISBN 978-1-99-118340-8

ePress
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ABSTRACT

The use of chatbots in a customer-service context is one instance of the application of digital technology to generate a competitive advantage for business. Chatbot service offers precise, instant and tailored responses for customer enquiries through a range of communication channels to many users simultaneously. However, there are concerns about customers' perceptions of whether chatbots offer a human-like experience in customer-service interactions. The focus of this study is to investigate customers' perceptions of the use of Air New Zealand's chatbot customer service and its effects on customer satisfaction. This exploratory study adopted qualitative methodology using semi-structured interviews for the collection of primary data from 11 users of Air New Zealand's chatbot service, Bravo Oscar Tango (Oscar). The results show that the chatbot service is appropriate for solving routine customer problems, providing standardised information for frequently asked questions (FAQs) and resolving non-complex customer issues. Generally, respondents were satisfied with Oscar's service quality. However, customers perceived that the customer-service interactions lack the human-like qualities of a human customer-service agent for resolving complex customer queries. The quality of the chatbot service did not substantially impact on customers' overall satisfaction with Air New Zealand.

KEYWORDS

Chatbot, customer service, Air New Zealand, customer satisfaction

INTRODUCTION

Chatbots in customer service

Adamopoulou and Moussiades (2020), Nasereddin and Faqir (2019), and Cui et al. (2017) define chatbots as computer applications that enable users to seek help or information through text and/or voice. Chatbots have the potential to deliver customer service effectively, with intelligent automation, and to be readily available at all times. A number of airline brands have adopted chatbot services – for example "Jess," AirAsia; "MHChat," Malaysia Airlines; "AVA," Jetstar – to provide customer-service tasks such as retrieving customer bookings, resending itineraries, adding baggage services to bookings, completing a transaction and making a secure flight payment (AirAsia, 2021; Malaysia Airlines, 2021; Jetstar, 2021). Likewise, Air New Zealand introduced its chatbot service, Bravo Oscar Tango (Oscar), on multiple channels (mobile apps, Facebook Messenger, and the web) in 2017.

While there are some studies that have explored the issue of customers' perceptions of chatbot services in the USA, Australia, the Netherlands and France (Brandtzaeg & Følstad, 2017; Meyer-Waarden et al., 2020; Duijst, 2017), extant literature points to a limited number of studies on this issue for the context of Aotearoa New Zealand. Furthermore, the issue of chatbots is becoming more important as more businesses start adopting this technology to serve their customers, hence knowledge on how to make chatbots both efficient and effective adds to the body of knowledge and practice on how to improve chatbot technology for customer service. Effective implementation of chatbot customer-services provides a point of difference for a business to enhance customer satisfaction and loyalty.

Chatbot definitions

We evaluated several chatbot definitions to evaluate the most appropriate definition of chatbot to apply into this study. Table 1, below, presents a number of definitions of chatbots. These definitions show that chatbots possess common elements: software programme, robotic agents, artificial intelligence (AI), conversation, interaction, chats, dialogue, voice and text capability. Hence, the most appropriate definition of chatbot encompassing the above characteristics synthesised for this study is as follows: "chatbot service is a computer application powered by artificial intelligence (AI), which responds to text or/and verbal questions, queries, requests (mostly text-based) using natural language processing (NLP) to mimic human interactions, providing information in the place of a human agent in real-time" (Um et al., 2020, p. 3).

TABLE 1. CHATBOT DEFINITIONS.

Author	Context	Definitions of chatbot	The use of chatbot
Um et al., 2020	Tourism and hospitality	Automated system that emulates person-to-person dialogue through text or voice messages.	Save labour costs, quick response to customer requests, socialising with customers.
Chandra, 2020	Banking	A computer program that uses AI, usually machine learning (ML) to have a conversation with humans; a chatbot could support text input, audio input, or both; tend to support simpler conversations and more singular tasks.	Analyse the customer's queries and understand the customer's messages: loan, account, policy, etc., which are bank-related queries; solves customer issues.
Wailthare et al., 2018	Engineering and technology	Computer program that conducts a conversation via auditory or textual method. A chatbot is a software agent that interacts with the user for conversation in natural language.	Customer service, call centres.
Abdulquadri et al., 2021	Finance	Robotic virtual conversational agent, which can interact and exchange voice and text messages with one or more simultaneous users via a computer network.	Provide 24-hour service, engage with customers and support the drive for financial inclusion through the provision of accessible financial services and products, to enhance customer satisfaction and increase digital capabilities.
Bulla et al., 2020	Medical	A program that uses AI, capable of chatting with a user in a natural language from, or over the internet, virtual chat rooms, forums, tablets, and messaging applications.	Customised recommendation centred on the symptoms; know-how for a safe life; appointment with patients, medical consultant and provide the correct safeguards.
Winkler & Soellner, 2018	Education	Computer programs used to conduct auditory or textual conversations, intelligent tutoring systems.	Provide immediate and customised feedback to lecturers and students; allows students to remain in the driver's seat and actively control their learning process; deliver future managers the right information at the right time to make the right judgements and decisions.

Chatbot benefits

Chatbot applications for customer-service support offer several benefits. A chatbot is adopted to respond to fast-changing customer demands and expectations, conveniently from anywhere, reducing customers' wait times (Trapero et al., 2020; BARNZ, 2018; Adamopoulou & Moussiades, 2020; Winkler & Soellner, 2018). The airline sector receives the most customer inquiries of any field (Statista, 2020). During the Covid-19 period, inquiry volumes

related to flight cancellations, postponements or travel restrictions have put massive pressure on customer services, making it difficult to give customers adequate information in a timely manner (Kasinathan et al., 2020; Dixon et al., 2020). As stated by Debecker (2016), 69% of customers expect to access information immediately; about 50% of customers expect a business to be available 24/7 and able to be contacted through messaging platforms, moving away from email or pressing phone buttons to navigate across various departments.

Chatbots have shown that they provide high-quality support with fewer errors than their human counterparts through AI applications (Kurachi et al., 2018). Chatbots cut down on human errors, based on a historical database to better support consumers' future purchase decisions and increase trust in customers' minds about a trustworthy business (Brandtzaeg & Følstad, 2017). The main challenges with getting support from human agents are inadequate knowledge and inconsistency among agents, and websites are unable to deliver answers throughout the travel-planning process (Barber & Goodman, 2011). A lack of consistency, such as conflicting information, might force customers to contact the airline or business several times, leaving them frustrated and confused (Susskind, 2004). Consistency is closely associated with trust when it comes to brand loyalty. Hence, achieving consistent and precise information across multiple communication platforms where people engage with the brand is vital for the customer experience (Herath et al., 2019).

Chatbots with better functionalities automate business processes to personalise user experience and increase customer engagement by creating a smooth experience across every stage of the customer journey (Ukpabi et al., 2019; Ubisend, 2021; Brandtzaeg & Følstad, 2017). Chatbots navigate users during the buyer-awareness stage to find relevant information on an airline's website, introduce products and educative information, and shorten the time it takes to obtain the desired information (Zarouali et al., 2018). A survey of 1000 Americans seeking accommodation online found that during the purchase evaluation process, 62% of customers had difficulty in finding the right deal, and a further 49% of users visited from four to seven web pages to find appropriate accommodation information (Rokou, 2018). In this regard, chatbot algorithms provide solutions by giving a customer relevant, tailored information in accordance with the customer's preferences and browsing history (Ukpabi et al., 2019; Rokou, 2018). For example, the Kayak bot can deliver a wide range of relevant information for passengers before, during and after the purchase stages of the customer journey. Users can find hotels, rent cars, book flights and receive live updates about their trips, flight delays, check-in status and trip-planning recommendations (Kayak, 2016). Thus, chatbots have the potential to improve the customer's purchase experience and simplify the travel decision-making process, resulting in improved customer retention and advocacy (Wereda & Grzybowska, 2016).

Chatbot usage challenges

By developing a better user perception, a business can spot common user pain-points and improve the experience in the customer journey (Chan & Yazdanifard, 2014). A survey by Beaver in 2017, of more than 5000 users from six countries, showed that overall positive feeling (38% of customers) towards chatbots outweighed the negative (11% of customers). However, in other studies, customer perceptions about the human-like features of chatbot performance present varying evidence, as shown in Table 2. One category of challenges that chatbot technology faces is that there is a customer segment for whom the lack of human-like features in the functionality of chatbots has a negative effect on whether they are likely to use chatbots. This issue presents a challenge in how to develop a chatbot that can mimic human-like features in interactions with customers.

TABLE 2. PERCEPTIONS OF HUMAN-LIKE FEATURES OF CHATBOTS.

Perceptions	Positive	Negative
Human-like emotions	Positive impact on emotional connection, people feel more understood and derive more usefulness from the website (Meng & Dai, 2021). Injecting emotion into conversation content might decrease customers' stress, more in line with their expectations, leading to enjoyable, likeable, empathic feeling (Meng & Dai, 2021).	Do not have real emotions like humans and cannot imitate human conversation perfectly (Sanguinetti et al. 2020). Chatbot may not, or may naively, display empathy, deliver cultural sensitivity, act with urgency, understand human tonality, understand non-standard questions (Carter & Knol, 2019).
Human-like cues	The more anthropomorphic design cues present in the chatbot, the more highly customers rate positive social interactions with machines as human agents (Fink, 2012; Adam et al. 2020; Čaić et al., 2019). Chatbot is non-judgmental, so customers can overcome the fear of being judged and stop worrying about what others might think, especially when making a complaint or disclosing sensitive information (Lucas et al., 2014).	Setting up too many human-like features might disappoint users because of false expectations resulting from an imbalance between a chatbot's design and its knowledge; or the creepy/scary feeling when users encounter a computer programme that is almost human (Holtgraves et al., 2007).

Users are generally more comfortable communicating with a chatbot that can mimic human interactions (Purington et al., 2017). According to Svenningsson and Faraon (2019), building human attributes in a chatbot is a good way to improve user engagement and emotional connection with a brand. A chatbot that has a social presence, like a virtual avatar, or smart voice-assistant system, with a natural tone of voice, is considered more enjoyable, co-operative, and capable of providing good solutions than those that do not (Sensuse et al. 2019). However, Duijst (2017) argues that personalisation aspects like emotion do not have a remarkable impact on user experience, especially in situations of urgency. Some clients are even negative about a chatbot that shows empathy and emotion (Duijst, 2017). For this customer group, the main consideration is about a chatbot's productivity level in providing help and information free of identical responses or bias (Meyer-Waarden et al., 2020; Brandtzaeg & Følstad, 2017). These differences in customer perceptions suggest there is one category of customer who prefers human cues in a chatbot, while another customer group focuses on the task and may not see the lack of human cues in a chatbot as a disadvantage. To summarise, task-oriented customers prefer a significant level of support in a chatbot to improve their productivity rather than spending time on engaging with a bot's personality for entertainment. Likewise, emotionally driven clients prefer human cues in the bot more than informative ones, to build a brand relationship (Følstad & Skjuve, 2019). One other factor for the increased usage of chatbot technology is the degree of customer motivation to use new technology in this context; consumer perceptions and attitudes determine customers' willingness to adopt new technology (Jain & Sareen, 2014). People who perceive chatbot technology positively are motivated to use the chatbot service (Fink, 2012; Adam et al., 2020; Čaić et al., 2019). Likewise, negative perceptions influence customers' reluctance to use chatbots in customer service (Um et al., 2020).

Satisfaction with chatbots

The intense competition among airlines makes it imperative that an airline brand aims for high levels of customer satisfaction (Clemes et al., 2008), because customer satisfaction is the precursor to customer loyalty and repurchase behaviour. Customer satisfaction for business arises from the contexts of overall customer satisfaction and transaction-specific satisfaction (Keiningham et al., 2006). To attain high overall satisfaction, a business must be perceived to provide high levels of support at every touchpoint in the customer purchase journey (Bodet, 2008). It is suggested that high satisfaction ratings for a business provide the basis to retain customer loyalty (Bodet, 2008). In addition, satisfied customers support the creation of goodwill by generating positive word-of-mouth based on good customer experiences (Chan & Yazdanifard, 2014). Overall satisfaction can be defined as customers' evaluation

of the company according to their experience, and it is achieved when customers are provided services or products that meet their expectations (Deng et al., 2010; Omisakin et al., 2020; Veloutsou et al., 2005). Overall satisfaction also is found to be a significant determinant of customer loyalty (Gures et al., 2014).

Transaction-specific satisfaction arises from individual episodes of customer interaction with the business or service provider during the customer journey. For an airline customer journey, a customer may experience various interaction episodes of service, from baggage handling, on-time performance, food quality, check-in service and customer service for evaluating airline service quality (Ban & Kim, 2019). Thus, transaction-specific customer satisfaction may vary from one episode to another. Therefore, a customer chatbot interaction is an example of an episodic interaction with the business. A good chatbot customer experience will have positive-transaction customer satisfaction, while a negative experience might mean a poor rating on transaction-specific satisfaction. Each episode of transaction-specific satisfaction will contribute to the customer's perception of the overall satisfaction rating (Bodet, 2008; Veloutsou et al., 2005). We reason that chatbot customer-service is an example of a customer episode, and the customer's chatbot experience will have an influence on their overall satisfaction rating, based on the combined customer evaluation of customer-satisfaction individual ratings from the episodes of interactions experienced in the customer purchase journey. We contend that if the chatbot service delivers good customer service, this will positively influence overall customer satisfaction (Clemes et al., 2008).

RESEARCH AIM AND QUESTIONS

Air New Zealand's driving purpose is a 'customer-first culture' which means customers lie at the core of everything they do, and they strive to provide meaningful connection and excellent standards for every customer (Air New Zealand, 2021). To support this objective, in 2017 the airline developed a customer service Chatbot named Bravo Oscar Tango (Oscar), powered by AI, across multiple channels, including mobile apps, collaboration apps like Facebook Messenger, and the web.

The aim of this study is to assess customer perceptions of how Air New Zealand is adopting the chatbot for customer service and its effect on customer satisfaction.

From this overall research aim we draw out two research questions:

- Is the human-to-chatbot interaction perceived as equal to human-to-human interactions?
- Does customer interaction with the chatbot affect transaction-specific and overall customer satisfaction?

METHODS

This is a qualitative study that used semi-structured interviews and open-ended questions based on the issues identified in the two research questions. One advantage of qualitative research is that it has the potential to provide rich, detailed insights for studying a phenomenon (Lee & Krauss, 2015). Therefore, qualitative data is appropriate to tease out underlying meanings, opinions and feelings embedded in customers' chatbot experiences by analysing their statements to investigate the issues for this study (Given, 2008). A convenience–purposive sampling method was used to select participants for the study (Etikan et al., 2016). A purposive sample identified participants who had previous experience in using the Air New Zealand chatbot to provide responses to interview questions (Andrade, 2020). Data-collection interviews were conducted in the second half of 2021. All participants were over 18, and the interviews focused on collecting information on participant perspectives, perceptions and feelings regarding the Air New Zealand chatbot. By using the filter question "Have you used the chatbot from Air New Zealand before?" the researchers initially eliminated those who had not from the interviews. As this is an exploratory study, the primary data was collected from a small sample of 11 participants, hence the results in this study should not be generalised (Etikan et al., 2016).

Ethics approval for primary data collection was given by Otago Polytechnic Research Ethics Committee (OPREC) on 17 June 2021, Reference # AIC84, prior to data collection. We used 13 open-ended questions to tease out insights for the research questions. Appendix A lists the specific interview questions for the study. The open-ended questions related to the contexts of each of the research questions. Additionally, the conversational flexibility of a semi-structured interview allowed both the researcher and the participant to explore participants' thoughts and perceptions with follow-up questions (DeJonckheere & Vaughn, 2019; Turner, 2014).

Braun and Clarke's thematic analysis technique was employed to generate common themes and patterns for this qualitative research (Clarke et al., 2015). Thematic analysis identifies the frequency of a theme in a whole content and uses those themes to address an issue (Maguire & Delahunt, 2017). Data collected from the interviews was analysed based on six stages: data familiarisation, generating initial codes, theme development, theme revision, defining themes and writing up (Braun & Clarke, 2012). The interview recordings were transcribed and the transcription was verified by the second author to check for the accuracy of transcription. Next, the data was transferred to an Excel file to analyse text data by looking for similar keyword or phrases and patterns of meaning. In the next stage, the researcher reviewed preliminary themes and refined them to the final patterns.

RESULTS

This section reports the findings collected from the data analysis of the semi-structured interviews. These findings are reported along three themes, Themes 2 and 3 mirroring the research questions for the study. The first theme reports on the types of issues the chatbot resolves, the second reports on customer perceptions of the human-like qualities of the chatbot, and the third theme presents findings on customer satisfaction with the chatbot facility.

Theme 1. The type of issues participants used Oscar for

> *… search for anything that you like … it is the first-line customer-service support …* (Participant 7)

> *… enquiry or [something] I cannot find on the website …* (Participant 8)

> *… use the chatbot to … detail information about my travelling, such like … my seats for the travelling, confirming my allowance for the baggage, or what are the movies that came during my flight journeys, and taking my points and also confirming my booking tickets.* (Participant 5)

> *… to make booking inquiries, to check flight schedules, in the future I will certainly use it to book flights.* (Participant 6)

> *… available 24 by 7… give me instant feedback … make my work very easy… make my process [easier] for booking and planning my journey.* (Participant 5)

> *Generally we use the chatbot just to [look] for some common information … more detailed question, then we don't get answers, … just directing us towards … the website pages … not giving me some better kind of solution that I need …* (Participant 2)

Summary of findings: Theme 1

Oscar, the Air New Zealand chatbot, is considered front-line customer-service, or a substitute for a customer representative to initially connect with Air New Zealand. Most customers used Oscar when they could not find general information, common questions (FAQs), or terms and policies on the website. For these kinds of information, Oscar was useful and acted in the best interests of the customers during their purchasing journey. Despite Oscar's limited problem-solving capabilities, our findings suggest that for basic informational customer enquiries, chatbot customer-service provides relative ease of use, convenience and faster accessibility for customer enquiries.

Theme 2. Participants' perceptions of the human-like qualities of Oscar

> *… doesn't pick up informal language … does not have any other languages … needs to be more streamlining or improvement with the composition of the sentences.* (Participant 4)

> *… felt very monotonous, didn't have any feelings …* (Participant 4)

> *… cannot find the solution to my query … more complex questions where there's one or two things that are combined …* (Participant 4)

> *… talk to human to solve the problems that the bot can't help.* (Participant 10)

> *[Human agents] … get a sympathy, undertaking your situation, give a practical judgment and give practical outcomes … giving you a suggestion, which will be reliable, very useful…* (Participant 5)

> *… chatbot so far doesn't make a mistake, so there's no more no error. A human could give incorrect information, or not be precise…* (Participant 6)

> *[When having] … specific things that you really need to discuss … get to an agent.* (Participant 11)

> *… basic information … use chatbot … it will save time … If you have plans, specific questions and details … not really usual … having any problem … … call an agent to get an update …* (Participant 11)

> *… pick a chatbot first. And then human agents kind of follow up action.* (Participant 8)

Summary of findings: Theme 2

Findings suggest that customer–chatbot interactions lacked emotional or anthropomorphic attributes in contrast to human-to-human conversations. Additionally, participant perceptions are indicative that Oscar has diminished capabilities for understanding contextual nuanced meanings in customer conversations. Participants also pointed to a lack of an emotional connection when using Oscar. However, customers are generally prepared to use chatbots as a first-line customer support and consider human customer-service agents as the second-line customer support.

Theme 3. Participants' satisfaction with Oscar

> *Not satisfied … sending you the same question over and over again until you figured out your answer …* (Participant 7)

> *Satisfied, because they can provide basic information, give out … some other contact or follow-up action that I can do …* (Participant 8)

> *Not really … only addressed one of my current problems and only if it's identified. The more specific the problem I have, the less useful the robot's gonna be …* (Participant 9)

> *… this is a whole package and chatbot is one of the … reason that I will repurchase.* (Participant 8)

> *… would try it if they change the system: the system is very traditional and it's very slow, it's not clever.* (Participant 1)

> *Yes … it supports every concern of your journey, and it's been a great help.* (Participant 5)

> *Air New Zealand I'm satisfied … very responsible … no other better airlines in the country … flagship airlines company in the country …* (Participant 4)

Summary of findings: Theme 3

The findings for satisfaction with the quality of Oscar's service in resolving customer-service issues were mixed: 6/11 were satisfied and 5/11 were not satisfied with the chatbot's resolutions. Despite mixed views, participants

also indicated that they were willing to use Oscar in the future and would recommend it to others. The mixed perceptions of Oscar's performance did not appear to be a key driver for customers to leave Air New Zealand.

DISCUSSION

Chatbot usage

As noted previously, this is an exploratory study carried out with a small number of participants. The summary of findings for Theme 1 shows that participants in this study found that Oscar, the Air New Zealand chatbot, is a convenient facility to support them in their purchasing journey. Oscar acts as a frontline customer-service encounter to provide real-time customer enquiry support. In these contexts, participants found Oscar to be an efficient digital application to support customers, even for those with disabilities, who can communicate with relative ease by chatting or through the button options. This finding is consistent with previous studies (Kasinathan et al., 2020; Bradley, 2017), which report that chatbots are designed to handle standard questions and more singular tasks, but are not as well suited to resolving complex customer enquiries. The participant findings also show the chatbot service is beneficial for customers, in that the chatbot customer-enquiries provide quick resolutions with consistent information, aligning with the findings in some recent studies (Adamopoulou & Moussiades, 2020; Winkler & Soellner, 2018; Ukpabi et al., 2019; Ubisend, 2021; Brandtzaeg & Følstad, 2017).

Perceptions of human–chatbot and human–human interactions

The findings from the participants in our study suggest that Oscar demonstrates a reduced level of human-like qualities in the context of its avatar and limited language capabilities. The avatar is not a human face, but just a little cartoon face in a pilot's cap, which does not resonate with customer users on first impression, leading them to perceive lower connections or engagement (Nowak & Rauh, 2005). These findings show the relevance of humanising Oscar to enhance customers' engagement, especially for emotionally driven people, as observed in a previous study (Svenningsson & Faraon, 2019). When users feel a relationship or emotional connection with a chatbot, they might be committed to using it more frequently, which is in line with findings reported by Meng and Dai (2021). The participants in our study state that Oscar has some way to go to improve its ability to simulate emotional qualities like humour, empathy and gratitude; this can contribute to negative attitudes towards a chatbot, as suggested in the study by Carter and Knol in 2019. A caveat to note is that not all customers like or prefer the use of chatbot technology in customer-service interactions, even when a chatbot shows empathy and emotion (Duijst, 2017). Further, the literature points to emotionally driven customers who prefer human cues in chatbot technology, while task-oriented customers are focused on productivity (Meyer-Waarden et al., 2020; Brandtzaeg & Følstad, 2017). These different preferences are reflected in our findings in this study. The evidence of differing customer preferences suggests a need for service providers to understand the multiplicity of customer perceptions and behaviours for the successful adoption of chatbot technology in customer-service interactions. Therefore, providers must consider the differing customer groups in the adoption and implementation of chatbot technology.

Our findings also suggest that human–chatbot interactions have noticeable differences regarding word-pattern quality and behaviour compared to human–human discussion. Although supported by a lot of artificial intelligence (AI) and neuro-linguistic programming (NLP) technology, which allows a bot to understand complexity in human language and to provide similar complex responses, Oscar does not understand 100% of customers' inquiries and human tonality. Oscar is equipped with English only, and is weak in catching everyday language. People must make sure their language is concise and exact to allow Oscar to understand and deliver precise answers, which is consistent with the findings of Hill et al.'s (2015) and Bradley's (2017) research.

Customer satisfaction

Oscar is a first touchpoint for Air New Zealand customers. Fifty-five percent of participants in our study stated that they were satisfied with Oscar's service quality to solve their questions or problems. For our participants, Oscar's human cues, usefulness, and ease of use had a considerable influence on their customer experience and were critical factors in how positively or negatively they perceived human–Oscar interaction. However, participants in our study suggested that the lower-quality customer experience of Oscar on its own would not make customers leave Air New Zealand. For our participants, the quality of Oscar in itself did not have a significant influence on their repurchase intentions and loyalty, which is supported by the work of Jones & Suh (2000) on the relationship between overall satisfaction and transaction-specific satisfaction, and their influences on repurchase intention.

CONCLUSION AND RECOMMENDATIONS

Limitations and further research

This an exploratory study using a small sample of 11 participants. Hence, these results should not be generalised (Etikan et al., 2016). In the context of future research, we suggest that this is an important area, which is set to grow in the near future. We suggest that future studies adopt a larger sample and mixed-methods research to expand the knowledge-base for the application of chatbots in business (Tongco, 2007; Etikan et al., 2016).

Chatbot capability

To increase Oscar's uptake with customers, its capability might be improved by greater resolution accuracy for routine customer issues, as well as adding capabilities to resolve moderately complex customer enquiries as the next step in Oscar's capability development. As an example, AirAsia builds actionable customer segments with an effective implementation of machine learning. With data integration, the AirAsia chatbot can access customers' history, so it can suggest solutions based on past interactions or even website browsing activity, to proactively suggest relevant content and solutions related to what the customer has accessed in the past (Ada, 2021).

Making Oscar more empathetic

From the findings, customers feel Oscar lacks the capability of empathy. Injecting a human touch into Oscar, such as humour, sympathy or gratitude, through wording options, could resolve that problem. For example, Blue Bot, the KLM airline chatbot, performs very well in providing a conversational experience for customers. Blue Bot has strong natural-language understanding, human-like speech synthesis and deeply conversational communication, which gives users an easier and more comfortable communication experience (Wavyr, 2019). The Norwegian Airlines bot is equipped with five languages to increase personalisation of discussions (Kindly, 2021). In 2019, the low-cost carrier AirAsia launched its chatbot AVA, which speaks eight languages (AirAsia, 2019).

Chatbots were originally configured purely for text-based conversations, but thanks to technological innovations and advanced NLP, there are now chatbots that can conduct speech-to-text and speech-to-speech conversations (e.g., Siri, Alexa, etc.). Therefore, a suggestion is for the provision of voice options in Oscar to deliver faster resolution compared to engaging in a text conversation only, also offering a more natural way of functioning for humans than texting. A voice bot is helpful for people who are not good at typing, because it enables them to accomplish tasks hands-free. For example, Indian airline SpiceJet has launched a voice bot named Pepper on an AI platform to address customer needs or connect employees to co-ordinate customer requests (PTI, 2020). Emirates has introduced a team of four virtual assistants with human names: Leo, Emma, Tom and Lara. Two are male and two are female, and they all have 2D human faces with different skin tones and hairstyles, as a means of presenting different ethnicities (Emirates, 2021).

In conclusion, by drawing on understandings of customer insights about chatbot service quality, Air New Zealand can improve the quality of Oscar's customer service, which will influence and enhance customer satisfaction, retention and loyalty for the Air New Zealand brand.

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APPENDIX

Interview questions

1. What do you think you would personally use a chatbot for?
2. When would you find a human agent to support your problems/questions?
3. What factors do you consider most when you seek support from a chatbot or a human agent?
4. Please list any benefits and challenges in using the chatbot to support your questions/problems?
5. Would you prefer to converse with a chatbot or a human for your customer-service needs?
6. In your experience, would you be able to pick up any differences between dealing with a chatbot or a human? (E.g., word pattern, behaviour, etc.)
7. What are your feelings or concerns toward the use of chatbots in customer service for solving your questions/problems?
8. What are your feelings or concerns toward human agents for solving your questions/problems?
9. Are you satisfied with the chatbot service quality to solve your questions/problems? Why or why not?
10. Is the chatbot a reason for you to repurchase or leave the organisation?
11. What can Air New Zealand do to improve its chatbot services in customer service?
12. Are you satisfied with the purchase experience using the chatbot with Air New Zealand? Why or why not?
13. Would you use the chatbot in the future? Why or why not?

NEW ZEALAND PUBLIC-HOUSING PROJECT TENDER PRICE FORECAST: PRELIMINARY FINDINGS

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https://doi.org/10.34074/proc.2206012

Business and Infrastructure

This publication may be cited as:

Chen, A., Domingo, N., and Rotimi, J. O. B. (2022). New Zealand Public-Housing Project Tender Price Forecast: Preliminary Findings. In E. Papoutsaki and M. Shannon (Eds.), *Proceedings: Rangahau Horonuku Hou – New Research Landscapes, Unitec/MIT Research Symposium 2021, December 6 and 7* (pp. 177–188). Auckland: ePress, Unitec, Te Pūkenga. https://doi.org/10.34074/proc.2206012

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ISBN 978-1-99-118340-8

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ABSTRACT

To make house prices affordable to first-home buyers on low-to-medium incomes, one of the solutions is the capped cost of public-housing projects. The accepted tender price forms the major portion of final project cost, and the level of the accuracy of the project's tender price determines the possibility of achieving the cost cap. Hence, exploring and developing effective tender price forecasting tools is worth researching. To achieve this goal, the literature suggests that an understanding of the tools and factors affecting the accuracy of public-housing tender price is crucial. There is little to no research into tender price forecasting tools and the factors affecting the accuracy and efficiency of public-housing tender prices in the context of Tāmaki Makaurau Auckland, Aotearoa New Zealand. This research aims to fill some of this gap. It is a first step in an ongoing programme of research that aims to develop a public-housing project tender-forecast tool.

The research aims to identify the possible tender price forecasting tools and the factors significantly affecting the accuracy of public-housing project tender prices in the context of Tāmaki Makaurau Auckland, Aotearoa New Zealand. Preliminary interviews were carried out. The sample was limited to experts with at least five years' public-housing tender experience in the Aotearoa New Zealand context. The frequency method was adopted to carry out data analysis.

All preliminary interview participants agreed that material cost, labour cost and quality of design information were the top three factors significantly affecting the accuracy of the tender price. The research identifies loopholes in the current public-housing project tender practices in the context of the Tāmaki Makaurau Auckland public-housing sector. The main contribution of this research is providing insights for public-housing project cost estimators who aim to balance the accuracy of tender price and the efficiency of tender process, by using the research findings to select the appropriate tendering forecast tools. The research also provides a base for future research to develop tender forecasting tools by using information gaps and current industry practice findings.

The data collected from this preliminary research are subjective; participants measured the importance of factors based on their own subjective opinions. There is no guarantee that the data collected fully reflect the opinions of the whole public-housing sector in the context of Tāmaki Makaurau Auckland. To overcome this limitation, the researchers will develop a questionnaire, and invite more eligible experts to complete the questionnaire as the next research step.

KEYWORDS

Accuracy of cost estimate, public-housing tender, tender price prediction

INTRODUCTION

All participants in the construction industry are concerned with pre-construction cost estimate. This is the first effort to estimate the cost of a project and is crucial during the initial decision-making processes for construction projects (Flanagan & Tate, 1997). The accuracy of the pre-construction cost estimate significantly affects the destiny of many projects and critically contributes to the successful project delivery. The process starts from the initial determination

of project viability and client feasibility, by setting up the cost limit, the cost budget and the cost target, then moves to the cost check and remedial actions (Smith et al., 2016).

The tender price established at the pre-contract stage forms the basis of the contract sum – it is the amount set up for the entire project and it is expected not to be overrun (Ashworth & Hogg, 2002). Those cost estimators working with public-housing projects are aware of these issues; further, to ease the housing-affordability crisis in Tāmaki Makaurau Auckland, public-housing projects in the area are cost capped (Kāinga Ora, 2021). Although cost overruns are not permitted, it is very difficult to find a project in which the final project cost is equal to or less than the tender price (Akintoye, 2000; Ashworth et al., 2013; Odeyinka et al, 2009). Hence, the cost cap creates the requirement for accurate tender price prediction.

Because of the importance of the accuracy of the tender price, exploring and developing effective forecasting tools is a worthwhile field for research. The first step in this study is to understand the factors affecting the accuracy of public-housing tender prices; the ultimate objective of this research is to identify factors and the extent of their impact on the accuracy of cost estimate in public-housing projects.

LITERATURE REVIEW

Tender price forecast methods

The tender price forecast can be achieved via either rate methods or price-index methods.

Rate methods

Dysert (2003) states that the tender price is formed from trade package items, which are identified from a construction project's scope statement, and are quantified and priced by the application of unit prices. Ashworth and Perera (2015) further point out that rate methods are highly dependent on the availability of cost data developed during different design stages. The detailed level of cost estimates developed throughout the whole design stage, from the single-rate method to the multiple-rate method, is illustrated in Figure 1. Each construction project is unique. When establishing the rate, the accuracy and completeness of design information, building functions, expected quality standards, quantities of the elements, site conditions and contingency are all items to be considered (Smith et al., 2016).

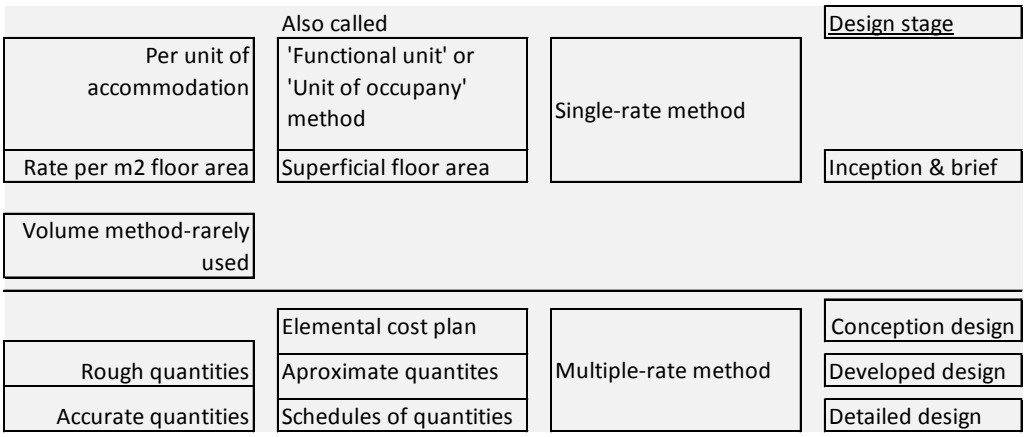

Figure 1. Summary of rate methods.

Price index methods

Price index methods rely heavily on cost information and the trend of cost movement over a period of time, because building costs, market conditions and inflation, etc., will change during this period of time. The collected data, therefore, must be converted to a current date or appropriate future timescale. Under the price index method, the conversion process is achieved by means of index numbers, which measure the change that has occurred from one period to another. Ashworh and Perera (2015) state that the tender index includes weighted items (factors affecting tender price) in the order of their importance within the index, based on the 'basket of goods' principle. Figure 2 indicates the most prominent indices available in the global context.

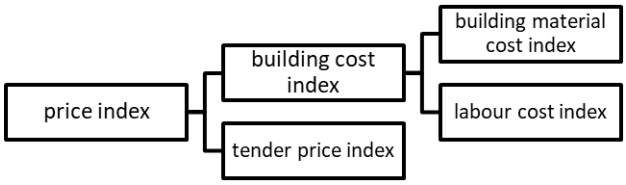

Figure 2. Summary of price index methods.

The building cost index measures the change in contractor's costs. It is built on a combination of labour costs, material costs, plant/equipment and overhead expenses (Smith et al., 2016). Some countries may not have a building cost index; in that case, only a material cost index and a labour cost index are available. Compared with a building cost index, a material cost index and a labour cost index can only measure the trend of material costs or labour costs, they can't provide the pattern of overall changes in contractors' costs.

The tender price index is based on what the client is prepared to pay for the building. Therefore, besides all the items covered by the building cost index, it also considers the allowance of market conditions and profit margins, and the reflection of cost fluctuations. From a client's perspective, the tender price index focuses on the tendering market, and hence is much more useful in updating the prices in a design budget (Fleming & Tysoe, 2007).

Factors affecting tender price accuracy

Many researchers have studied the factors influencing tender price and have tried to categorise and rank them. The discussion below covers the main groups of factors that could affect the tender price.

Factors related to project characteristics

It is widely accepted that this group of factors has a strong impact on the accuracy of the tender price. The factors in this category could include, but are not limited to, buildability, scale of project, construction techniques, location, programme, access and structural type (Ji et al., 2014). Most researchers have identified project scale and scope, location and buildability as the top three factors affecting the accuracy of tender price (Akintome, 2000; Dysert, 2006; Elhag et al., 2005). The project's scale and scope determine the project's size, complexity, duration and construction methodology, and inevitably affects the project's cost (Ashworth & Perera, 2015). In addition, the more complicated and the larger a project is, the longer the project's duration will be, which increases the risk of onsite and offsite expenses going over budget (Akintoye, 2000). Location is tightly linked to delivery cost (Ji et al., 2014). However, this research only studies the Tāmaki Makaurau Auckland market, hence location does not provide too much variability.

Factors related to client characteristics

The client is the core of a construction project, and determines each element of the project's delivery. Research into the impact of client characteristics points out that every client is unique; hence, clients can be categorised into different groups, as shown in Figure 3. The client's attitude towards the project will depend on the category that they belong to (Masterman, 2001).

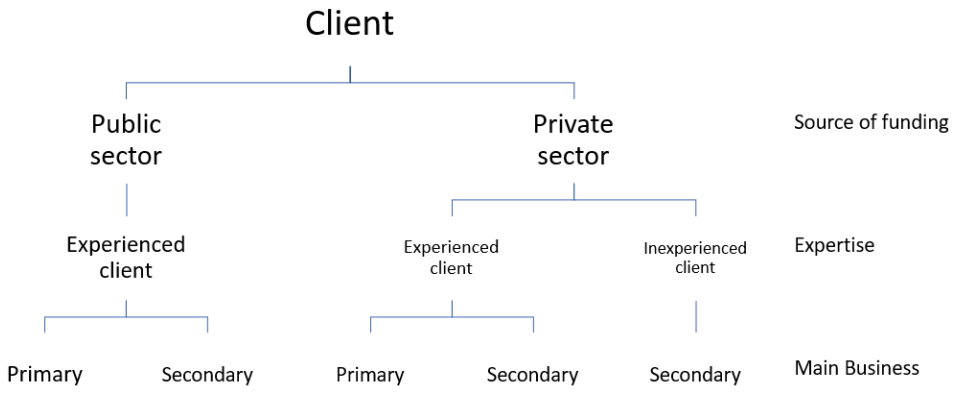

Figure 3. Client categories.

Besides the client category as discussed above, the client's experience and expertise, the budget that they can afford, the functionality requirements, quality expectations and the time allowance of the construction project are factors that need to be considered carefully (Akintome, 2000; Ashworh & Perera, 2015; Dysert, 2006; Elhag et al., 2005; Masterman, 2001).

The proposed research focuses on clients from the public sector. These clients, whose primary business is construction, are always experienced. They have detailed knowledge and understanding of the construction-project delivery process, they have sufficient expertise in managing and controlling construction projects, and they are highly likely to have in-house construction managers and/or designers. As a result, they have the ability to "produce a comprehensive initial brief incorporating prioritized objective for the project's time, cost, quality and functionality" (Masterman, 2001, p. 7).

Factors related to design parameters

The factors in this category include, but are not limited to, completeness and comprehensiveness of the design information, accuracy of the design information, the designer's experience and expertise, availability of historical data, the procedure of updating information, and the time allowance for preparing the design (Dysert, 2006; Elhag et al., 2005). The completeness, comprehensiveness and accuracy of the design information are the crucial factors in this category (Ashworth & Perera, 2015). Poor design or insufficient design information could significantly affect the accuracy of the tendering price, as the estimate of this price must be based on the available information; vague or incorrect design parameters mean the estimator is unable to retrieve accurate data from the design documents (Akintoye, 2000; Hastie et al., 2017; Liu et al., 2016; Urquhart et al., 2017). Poor design could lead to more project variations, since there is greater potential for design changes at the construction stage (Adafin et al., 2016; Ji et al., 2014). Meanwhile, poor quality of design information can lead to additional administrative costs (i.e., costs relating to requesting extra information, and dispute-resolution costs). Therefore, poor design information is likely to hinder the reliability of the tender price (Laryea & Lubbock, 2013; Love et al., 2019).

External factors and market conditions

This group of factors includes cost, availability and supply of materials, labour and equipment, stability of market conditions, labour productivity, government policies and level of competition (Akintoye, 2000; Dysert, 2006; Odusami & Onukwube, 2008). The authors acknowledge that the first three factors are the key ones in this group and have higher impact on tender forecast accuracy.

The findings are supported by survey studies undertaken in other countries. Elhag et al. (2005) carried out a study in the United Kingdom and examined factors affecting tender price accuracy from the standpoint of quantity surveyors who were members of the Royal Institute of Chartered Surveyors (RICS). Odeyinka et al. (2010) also produced a similar study from the standpoint of project type. A two-dimensional scaling was used to rank the factors' importance. The top-ranked factors were design parameters, material cost and labour cost.

Ahmad et al. (2012) studied construction costs influencing factors for Industrialized Building System (IBS) projects in Malaysia. They applied the Relative Importance Index (RII) to rank the importance of factors, and found that unforeseeable fluctuation of material and labour cost was higher than other factors.

Ji et al. (2014) and Adafin et al. (2016, 2020) investigated the whole Aotearoa New Zealand construction market by computing the mean rating of all responses to a particular variable to measure respondents' level of agreement. Their studies found that unforeseeable material and labour cost escalation, quality and comprehensiveness of design information, and the client's characteristics were the top three factors affecting tender-forecast accuracy.

Knowledge gap in the existing literature

Although there are studies of the factors affecting the accuracy of tender pricing in overseas contexts, studies about public-housing projects in Aotearoa New Zealand are scarce. How these tender-forecast methods work in the Tāmaki Makaurau Auckland market, how these factors influence tender-forecast accuracy still needs investigation. To develop a tender forecast tool with a balance of tender accuracy and tender efficiency, current industry practices and requirements need to be tested, especially from the view of public-housing project clients. It is in this gap that our study finds its significance.

RESEARCH METHODOLOGY

This is a preliminary study in a research project. The aim of this study is to establish the perceptions about the current circumstances of tender price forecasting, and the factors and biases affecting the accuracy of public housing tender prices in Tāmaki Makaurau Auckland, Aotearoa New Zealand. Hence, ontology is the appropriate research philosophy to employ, at it emphasises existing knowledge and the nature of knowledge, and describes what knowledge is (Fellows & Liu, 2022).

Ontology can be characterised as objectivist or constructivist. In accordance with Bryman and Bell (2011), objectivism means social phenomena and their meanings are independent of human observation, while constructivism refers to reality being determined by social factors. This study requires an ontological constructivist approach, as the researchers need to understand the social factors affecting the accuracy of tender price forecast and the data are experts' opinions, which are subjective.

Because this research requires a constructivist approach, the data collection of current industry practices of public-housing project tender forecasting was required, as the basis of future theoretical development. Therefore, a deductive approach was applied in this study. As illustrated in the figure below, the researcher first determined the research topic, then a three-step approach was applied: the researchers conducted a literature review, interviews and data analysis to get preliminary findings.

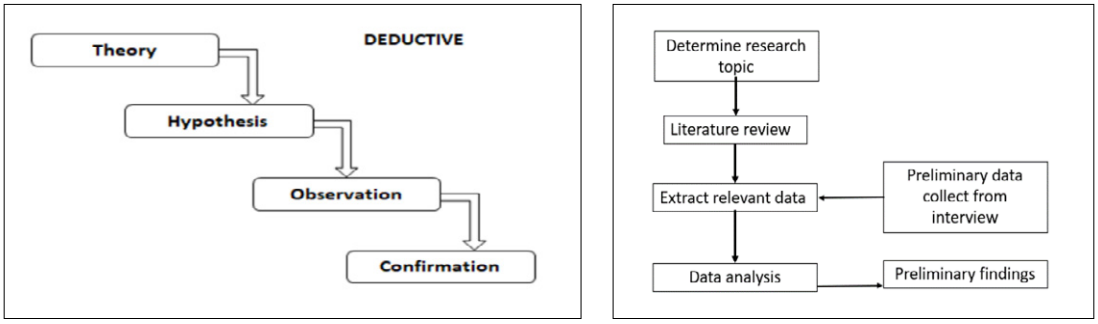

Figure 4. Research approach.

Firstly, the researchers reviewed literature sources, and identified tender price forecasting approaches, tender price indexes, and the key factors that could affect tender price accuracy. Secondly, interviews were conducted with experts who had at least five years' public housing project tendering experience. Lastly, the researchers used the percentage method to analyse the data.

The interview method is used to establish the perceptions of a targeted group. This is especially applicable to this research topic as the data collected are expected to reflect the industrial insights and opinions of the clients of public-housing projects. An interview generates standardised answers from pre-written questions, and allowed the participants in this study to provide information about the tender price prediction approaches they use, or have never used, and to describe the factors that could affect tender price accuracy. A further benefit is each interview participant answered the same questions, which adds to the validity of the results.

The interview questions were grouped into three manageable themes. The first part focused on the participants' activities of reviewing and monitoring tender price trends. The second part collected information on the tools the participants use to forecast public housing project tender prices. The last part concentrated on the participants' opinions of the factors affecting the accuracy of public-housing tender prices. Below is the full list of interview questions.

TABLE 1. PRELIMINARY INTERVIEW QUESTION LIST.

Question No.	Questions
1	Do you monitor tender price movement?
2	How often do you monitor the trends in tender-price movement?
3	How many quarters ahead do you forecast tender price?
4	Do you have a specific model(s) to forecast tender price?
5	If not, what forms the basis of your tender price forecast?
6	Is your tender price forecast model publicly accessible?
7	Do you monitor the accuracy of your tender price forecast?
8	What are the major determinants of the accuracy of the tender price forecast?

Non-random purposive sampling was used to select the sample, to ensure the appropriate candidates were interviewed (Denscombe, 2007). The participants were quantity surveyors with at least five years' public-housing project tendering experience in Aotearoa New Zealand. A convenience sampling approach was used to collect participants' responses: the researcher invited colleagues and clients with at least five years' public-housing project tender experience to be the interview participants. Considering the experience of the participants in public housing projects, the researcher expected that they had connections with other potential respondents, therefore some of the them were asked to distribute the interview as well.

To reflect how often the interview participants selected a response, data was analysed by calculating the percentage of each response's frequency. The individual formula was:

(Frequency of the response /number of interview participants) x 100%

FINDINGS AND DISCUSSION

Years of public-housing project tendering experience

All 11 respondents are quantity surveyors with at least five years' tendering experience for public-housing projects. As shown in Table 2, 9% of the respondents have 6–10 years' experience; 27.3% of them have 11–15 years' experience; 27.3% of them have 16–20 years' experience; 18.2% of them have 21–25 years' experience; and 18.2% have 25+ years' experience. There is a balance of years of experience among the respondents. The participants' quantity-surveyor and procurement-manager roles, plus their public-housing tendering experience ensured rich and comprehensive data collection.

TABLE 2. YEARS OF PUBLIC-HOUSING PROJECT TENDERING EXPERIENCE.

Years of experience	**0–5 yrs**	**6–10yrs**	**11–15yrs**	**16–20yrs**	**21–25yrs**	**25+ yrs**
Number of participants	0	1	3	3	2	2
% of participants	0	9%	27.3%	27.3%	18.2%	18.2%

The research data were analysed by using the percentage method. The researchers calculated the percentage of respondents' answers to recognise the general practices in tendering for public-housing projects.

Tender price reviewing and monitoring

Questions included in this part ask for respondents' frequency of tender price monitoring. Their overall responses are identified in Table 3.

TABLE 3. FREQUENCY OF TENDER PRICE MONITORING.

Do you forecast tender price movement?					
Answer	Yes	No			
Number of participants	10	1			
% of participants	91%	9.1%			
How often do you monitor the trends in the tender price movement?					
Answer	Never	Rarely	Quarterly	Annually	Bi-annually
Number of participants	1	1	2	6	1
% of participants	9.1%	9.1%	18.18%	54.55%	9.1%
How many quarters ahead do you forecast tender price?					
Answer	None	2 quarters	3 quarters	4 quarters	4+ quarters
Number of participants	1	4	2	4	0
% of participants	9.1%	36.4%	18.18%	36.4%	0.0%

Ten out of 11 participants do review the tender price trend. However, over 50% of the participants review the trend annually or even biannually. When predicting the future tender price trend, the participants only focus on up to one-year short-term forecasting. This means an insufficiency of quarterly-based review and monitoring activity and the absence of long-term tender price forecast activity.

Tools of public-housing project pender price forecast

The aim of these questions was to explore whether the interview participants adopted tender-forecast model(s) to predict the tender price trend. Their overall responses are identified in Table 4.

TABLE 4. METHODOLOGY OF PUBLIC-HOUSING PROJECT TENDER PRICE FORECAST.

Do you have specific model(s) to forecast tender price?					
Answer	Yes	No			
Number of participants	0	11			
% of participants	0%	100%			
If yes, what model do you adopt?					
Answer	Not applicable				
Number of participants	11				
% of participants	100%				
If yes, is your model publicly accessible?					
Answer	Not applicable				
Number of participants	11				
% of participants	100%				
If no, what forms the basis of your tender price forecast?					
Answer	Organistion's historical data	QV Costbuilder labour and cost data	RLB labour index	RLB material index	Stats NZ labour index and material index
Number of participants	11	4	1	1	1
% of participants	100.0%	36.4%	9.1%	9.1%	9.1%

The particpants' answers clearly indicate there is no tender price model used. All participants rely heavily on their own historical cost databases. Of all the participants, 36.4% refer to the QV Costbuilder data occasionally, and very few participants refer to other cost data resources, such the labour index and material index published by Stats NZ or RLB.

The limitation of the client's own historical data is that it is unable to reflect the whole public-housing-sector tender price.

The indexes the participants adopt are not sufficient to form a tender price. All the indexes adopted belong to the building-cost index, which measures the contractor's labour and material costs. However, when a client considers a tender price, besides the contractor's labour and material costs, other important elements of the tender price are plant cost, overheads and profit margin (Fleming & Tysoe, 2007). This information is absent from the labour index and material index. There is no finding of the adoption of the tender price index by any interview participant.

Factors affecting accuracy of the public-housing project tender price

The aim of these questions is to gather information about the key factors that affect the accuracy of public-housing project tender prices. Participants' overall responses are identified in Table 5 below.

As shown in Table 5, labour costs, material costs, plant costs and design information are the factors identified by over 90% of the interview participants. They believe these factors significantly affect the accuracy of the tender price. The findings are similar to the studies of tender accuracy of other types of construction projects (Ashworth & Perera, 2015).

TABLE 5. FACTORS AFFECTING THE ACCURACY OF THE PUBLIC-HOUSING PROJECT-TENDER PRICE.

Do you monitor the accuracy of your tender price forecast?				
Answer	Yes	No		
Number of participants	11	0		
% of participants	100%	0%		
Factors that affect accuracy of tender price				
Answer	Accuracy of labour costs, material costs & plant costs	Accuracy of design information	Project scale and scope	Market stability
Number of participants	11	10	7	5
% of participants	100%	90.9%	63.64%	45.45%

CONCLUSION

Although there are some overseas studies of public-housing tender price forecasting, there has been very little research undertaken in the Aotearoa New Zealand context. It is impossible to draw conclusions based on overseas studies and apply them to the Tāmaki Makaurau Auckland market. This study has investigated the public-housing project tender practice in Tāmaki Makaurau Auckland through a literature review and interviews. The study highlights the industrial circumstances and practice occurring in this market.

The main contribution of this research is providing the insights for public-housing project cost estimators who aim to balance the accuracy of the tender price and the efficiency of the tender process, by using the research findings to select the appropriate tendering forecast tools. The study findings provide a base for the development of future tender-forecasting tools.

This study shows the participants' tender price forecasts only focuses on the short term of less than one year. There's no coverage of long-term tender price forecasting. Secondly, although a construction project's cost estimate can't be 100% accurate (Flanagan & Norman, 1983), a reasonably accurate tender price provides significant value to the quantity surveyor in providing a reasonably realistic construction-project price prediction to help the client to check the public-housing project's feasibility and to ensure the project's cost is within budget. Hence, identifying the factors that could affect the accuracy of costing public-housing projects is an important job. This study has found that the accuracy of tender prices could be significantly affected by labour costs, material costs and the quality of design information.

The researchers have also found a gap in the current public-housing tendering practice, based on the responses to our interviews. The current public-housing project tendering price relies on the actual cost data retrieved from an organisation's own historical database. There's no adoption of the tender index model as a fast and efficient method to forecast the tender price (Fleming & Tysoe, 2007). There is no existing tender price index (TPI) in the Aotearoa

New Zealand context to date. Future research could focus on developing a TPI system to achieve the target of efficiency.

The data of factors affecting the accuracy of tender prices collected from these preliminary interviews are subjective, being the participants' own opinions on the importance of factors. Because of the small sample size, it is not likely that data collected fully reflect the opinions of the whole public-housing sector in the context of Tāmaki Makaurau Auckland, Aotearoa New Zealand. To address this limitation, the researchers will develop a questionnaire, and invite more eligible experts to complete it as the next research step, as the more sampling the researchers collect, the less biased the results will be.

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