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Health literacy of adolescents' responses to a workshop focusing on food, nutrition, climate change and digital technology solutions in Oceania: a multi-site pilot study in Vanuatu

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Abstract

Background Non-communicable diseases (NCD) have become the leading cause of premature death and disability in the Pacific region, with the development of health literacy an important factor for the prevention and control of NCD. Health literacy is an important lifelong asset that can be developed in adolescents through engagement in schooling and curriculum. The aim of this study was to explore Ni-Van adolescents' health literacy knowledge and capabilities regarding food and nutrition, climate change and digital technology solutions.

Methods Two Ni-Van schools participated in the study (one urban (School A) and one rural school (School B)), with 44 students (68% female) comprising 14 small groups participating in one workshop and booklet activities in April 2023. The 14 workshop booklet responses were deductively analysed using Nutbeam's health literacy hierarchy.

Results School A's booklet responses showed that interactive health literacy responses were dominant (54%), followed by functional (34%) and critical learning activities (12%), whereas School B's responses showed that functional health literacy responses were dominant (65%), followed by interactive (28%) and critical (5%).

Conclusion The findings show that students in both schools were less likely to engage in critical, compared with functional and interactive health literacy levels. This is an important consideration for future workshops, as well as curriculum and teacher training in Vanuatu, as Vanuatu (and other PICTs) are more susceptible to the effects of climate change and food sustainability issues.. Without a focus on developing critical health literacy knowledge and capabilities throughout the schooling years, this is a missed opportunity to create enabling environments that reduce youth exposures to NCD risk factors.

Keywords Health literacy, Adolescent, Health education, School, Food and nutrition, Melanesia, Vanuatu

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Introduction

Non-communicable diseases (NCD), principally cardiovascular diseases, cancer, diabetes and chronic respiratory diseases, have become the leading cause of premature death and disability in the Pacific region [1]. In 2011, Pacific Islands Forum leaders and Ministers of Health declared the Pacific region to be in a human, social and economic crisis due to the significant and growing burden of NCD [2]. The WHO estimates that over 80% of all deaths in Pacific Island Countries and Territories (PICT) result from NCD, many of which are premature and preventable [3]. Seven of the top ten countries/territories internationally for prevalence of diabetes are PICT [4]. Life expectancy in several PICT has stalled, and in some cases (e.g. Nauru, Tonga) seems to be falling, due to NCD-related premature deaths [5]. Although most of this research was conducted over ten years ago, many health indicators are not advancing in the PICT as rapidly as elsewhere, primarily due to challenges including inadequate human and financial resources and fragmented implementation [6]. Rates of NCD and child mortality exceed global averages in PICT and the percentage of the population accessing improved water and sanitation facilities is lower than the global average [6]. This is concerning, as NCD affect individuals and families through disability and premature death, caring burdens, health care costs, lost productivity and place a substantial social and economic burden on health systems [5, 7, 8].

Compounding the effects of high levels of NCD is climate change. Climate change has been described as the most important global health challenge of this century [9]. Climate change has been described as a 'risk multiplier', magnifying existing health risks and affecting health both directly and indirectly [10, 11]. The broad health impacts of climate change are increasingly being recognised and brought to the forefront of the climate change and development agendas. These impacts are distributed inequitably, and some vulnerable populations stand to endure a particularly high burden of these effects [11, 12]. The impact of climate change on NCD has been emphasized as a key health risk in several PICT. Assessing the health impacts of climate change in 11 PICT found that the issue of NCD was prominent in the face of climate change [7, 8, 11]. Swinburn et al. [9] reports that severe food insecurity and hunger are associated with lower obesity prevalence, but mild to moderate food insecurity is paradoxically associated with higher obesity prevalence among vulnerable populations. This is due to climate change directly influencing food and nutrition security through adverse effects on agriculture and fisheries and indirectly by exacerbating underlying risk factors for NCD such as water insecurity, dependency on imported foods, urbanization and migration, health service disruption, impaired livelihoods and lifestyle changes [7, 10, 13].

The occurrence of NCD is strongly associated with modifiable factors such as physical inactivity, unhealthy eating, substance use (i.e., smoking), excessive screen time and stress [14]. These behaviours have been observed in Melanesian adolescents from New Caledonia [15, 16], with adolescents in Vanuatu acknowledging that members at all levels of Ni-Van society are ultimately perceived as responsible for improving health, particularly to ensure adolescents have access to positive lifestyle opportunities (sport, community participation), increased protection from the impact of harmful substances and causes of chronic illness, and access to evenly distributed health services [17]. However, the use of digital technologies and media in Oceania are prominent and contribute to increases in sedentariness, physical inactivity, unhealthy eating and screen time [18]. Despite the negative impact of digital technologies on adolescents' behaviours, the widespread adoption of digital technologies indicates an opportunity to leverage digital tools to support the development of adolescents' lifestyles (including the promotion of physical activity and healthy eating) through up-to-date evidence-based health information and personalised guidance [19, 20]. Harnessing adolescents' knowledge and capabilities when it comes to adolescents, digital technologies and health literacy is currently under-explored, particularly in the PICT region.

NCD have also been associated with health literacy [21–23], with lower levels of health literacy more likely to be associated with socioeconomic hardship and those who are living with high exposure to climate change, food and nutrition insecurity, physically inactive environments and other risks, like those experienced in PICT [24–26]. A recent systematic review of health education interventions to promote health literacy in adults with NCD in low- and middle-income countries reported evidence for the potential effectiveness of these interventions for improving knowledge, attitudes and behaviours for health promotion [27]. This was supported internationally by the 2022 WHO report [28], which highlighted the importance of developing health literacy for the prevention and control of NCD, and by Bollars, Sorenson, de Vries and colleagues' [29] study that reinforces that the promotion of health literacy in PICT is largely influenced by culture, suggesting the need to employ participatory and culture-sensitive public health interventions which address family and communities. As the WHO defines health literacy as a critical determinant of health, and as the personal characteristics and social resources needed

for individuals and communities to access, understand, appraise, remember and use information and services to make decisions about health [30]. Health literacy also includes the capacity to communicate, assert and propose solutions and strategies and enact these in context-specific environments [31]. Therefore, health literacy programs and interventions need to respond to the health literacy needs of participants [32], their culture [33] and should be introduced and taught early in the lifespan, first and foremost through school curriculum [34].

Schools have long been identified as appropriate settings for health promotion and health education [35], since they can reach almost all school-aged children regardless of their social, cultural, or economic background. Schools in Australia [36], Finland [37] and more recently Tokelau [33] have included health literacy in the curriculum. However, it is important to note that for Finland, health literacy is an expected learning outcome of health education curriculum, or one of the primary goals of health education [38], whereas health literacy is an underlying proposition of the national curriculum for Health and Physical Education (HPE) in Australia [36]. This means that the programming and planning, teaching and assessment across international health education curricular may take different forms due to the explicit and implicit place of health literacy.

With a focus on PICTs and health literacy embedded in school curricular, the 2022 WHO Western Pacific regional framework on nurturing resilient and healthy future generations [28, 39] recently highlighted the importance of schools providing students with health capabilities and promoting health literacy, with the aim of empowering young people and future generations to make healthy decisions. For this to occur, one of the suggested actions for schools is to develop and enhance curricula that promote health literacy and reinforce health and healthy behaviours, reflecting a life-course approach, and to support ongoing teacher education to enhance teacher capacity to enhance students' health literacy teaching through health education curricula [30]. In this pilot study, the Vanuatu Ministry of Education and Training is responsible for developing, implementing and evaluating curriculum. As curricular changes can take time and fall under the umbrella of the Ministry of Education and Training (rather than the Ministry of Health), Vanuatu's current Family Life Education curriculum for senior secondary schooling years (Years 11–13) has one learning outcome with an explicit mention of HL for Year 12 students: 12FLE3.1.6: Analyse the socioeconomic and cultural barriers that may lead to reduced family planning and unintended pregnancies (e.g., unmet needs of contraceptives, level of income, low health literacy, unavailability of facilities, and religious beliefs [40].

There is no explicit mention of health literacy in Vanuatu's Years 7–10 basic science and agriculture syllabi [41]. Health literacy knowledge and capabilities are implicitly embedded. This not dissimilar to other international health education curricular and health education curriculum in New Zealand [42]. Okan et al. [43] assert that few school programs exist that deliberately focus on health literacy as a learning outcome and surmise that this might be due to crowded curricular and standardised testing, in which other learning is privileged. However, health literacy knowledge and capabilities can be enhanced if curricular outcomes and aims focus on developing young people to become autonomous, empowered and independent citizens, critical thinkers, competent to make (health) decisions, and to reflect on the consequences and ethics of their actions towards themselves and society [43]. Another suggested action for schools in the 2022 WHO Western Pacific regional framework on nurturing resilient and healthy future generations was the need to engage and involve young people in health policy and health education program development and implementation [39]. Using this advice, this research project was based in two Ni-Van schools, to explore adolescents' health literacy knowledge and capabilities regarding food and nutrition, how climate change may be impacting these behaviours, and the suggested technological solutions for promoting healthy eating.

Methods

Design

A multi-site pilot study was used [44]. Mixed methods can provide possibilities for researchers to grapple with the complexity of exploring and understanding adolescents' health literacy in two schools in Vanuatu, and to determine whether the workshops and booklets need adjustment for future use in Ni-Van schools. School variability and diversity are large even within one PICT, thus a robust methodological approach was chosen to consider variability and diversity of different school contexts, to represent a broader understanding of adolescents who reside in Vanuatu and their health literacy knowledge, capabilities and aspirations. This project is part of the European project FALAH (Family Farming Lifestyle and Health in the Pacific, project number: 873185) which has been approved by the Ethics committee of New Caledonia (approval number 2018–06 001 and 2023–10 012) and the University of Sydney (HREC: 2023/453). Informed consent to participate was obtained from the parents or legal guardians of adolescent participants in this study.

Setting

Two schools from Vanuatu participated. One school was located in the capital city, Port Vila (School A) and the other school was located in the northwest (rural) region of Vanuatu (School B). Vanuatu's basic science and agriculture syllabus is scaffolded to allow students to develop knowledge and understanding, problem solving and practical capabilities, and attitudes to explore energy and the transfer of energy, how materials and the reactions of materials, how living things interact with one another and their environment, and the nature of the Earth [41]. The nutrition component is explicit in Year 9 through the nutrition, digestion and excretion strand, and has also been addressed through primary school from Years 1–6 in the strand of healthy living. Therefore, it is likely that Vanuatu's basic science syllabus can lead to the development of students' health literacy knowledge and capabilities. To provide examples of how this health literacy is implicitly embedded in the basic science syllabus, and nutrition is explicitly mentioned and scaffolded, we use curriculum extracts across Year 9 and map it to Nutbeam's [45, 46] three level hierarchical model. Nutbeam's model has been used to underpin health literacy development in school health education curricular internationally [36, 37] (see Table 1). Nutbeam's [45, 46] hierarchical model consists of three dimensions: functional, interactive and critical health literacy. This model characterises health literacy from an asset-based perspective that is developed in phases through health literacy dimensions. These dimensions start with the basic literacy and numeracy skills required to find and understand basic health information (functional), progressing to the ability to interact, communicate and apply learned health information to change behaviour (interactive), and then the ability to evaluate and reflect upon information to make decisions about health at an individual and community level (critical) [46].

Procedure and participant sample

School recruitment

Utilising existing connections with the Family, Farming, Lifestyle and Health (FALAH) network of international scientific teams (https://falah.unc.nc/en), schools expressed interest via email and provided the name and email address of the school principal or the champion teacher. Two schools expressed interest and consented to participate in the study (School A = urban school; School B = rural school). Arrangements were made to visit two schools (one urban and one rural) to talk to the principal and teachers about the study which is in line with convenience sampling methods [49]. A research team travelled to Vanuatu in October 2022 to visit these schools to understand the community and educational context and to build relationships with school personnel and community leaders. During this visit, the workbook scenarios were developed with feedback from the FALAH network, school principals and teachers to meet the needs of the adolescent population. Communication with principals and deputy principals also centred on coordinating a 2-h time slot in curriculum time for the workshop session to be implemented in June 2023.

Workshops

The classes and students were selected based on teacher interest and consent to participate in the study. For both schools, the principal and teachers selected the Year 8 classes. At School A, 23 students (12 girls; 52%) consented to participate in the workshop. Students were asked to group themselves, with 9 groups formed. Each group completed a booklet that focused on food and nutrition. At School B, 21 students (18 girls; 86%) consented to participate in the workshop. Students formed 5 groups. Each group completed a booklet that focused on food and nutrition. In these groups, students were expected to collectively work together to discuss the questions and their responses and decide which

Table 1 Mapping of nutrition and diet in Vanuatu's basic science syllabus and mapping of health literacy

Level of health literacy [45, 46]	Knowledge and capability [47, 48]	Year 9 Basic science and agriculture syllabus [41]
Functional	Understand and describe health information relating to knowledge and services to respond to a question	List the following categories of nutrients, list available sources of each and state the role of each in meeting the nutritional needs of the human body; carbohydrate (sugars and starch), fat, protein, vitamins, minerals, fibre, water
Interactive	Navigate, access and engage with health information to apply new information to a range of situations and circumstances	Construct a balanced diet for one person for one day (three meals) from knowledge of available foods or from tables showing the composition of unfamiliar foods
Critical	Critically analyse a range of health information from a variety of sources to take action to promote the health and wellbeing of themselves and others	Interpret, and explain the value of a growth chart for babies

response/s to write and draw in the booklet. Data collection was anonymous (i.e., students names were not collected).

The role of the research team members in the workshops were to provide instructions for the completion of the booklets. They were also available to answer participant questions if they did not understand the wording within the booklet or survey. Researchers were careful not to provide examples that may sway the participants' responses, rather, providing definitions of words the participant may not have understood, or rephrasing the question to account for terminology that might not have been clear.

Booklets

The methodology to create the booklets used in the workshop was a participatory design with researchers from the FALAH program (https://falah.unc.nc/en), school Principals and teachers, as well as trauma-informed methodology. The booklets centred around relatable stories for Vanuatu adolescents and were used in a way to bring together health information using appropriate narratives. The insights from the FALAH network and local teachers ensured that the stories were relevant (i.e., culturally and contextually appropriate) and importantly minimised any risk of causing direct distress. The stories were articulated through scenarios and questions using a trauma informed approach [50] that framed scenarios that were relevant to adolescents (and their family and culture) and were consistent with the age and location to those of the participating students but were one step removed to minimise the students providing personal responses and experiences.

The purpose of the booklets was to allow adolescents to show their health literacy knowledge and capabilities through providing advice, suggestions and solutions through responding to the scenarios and questions, to showcase their ability to make decisions around food and nutrition and to determine the effects climate change is having on food and nutrition security and consumption. In addition, adolescents were challenged to provide technological solutions to minimise these impacts. Students were provided with the opportunity to write their responses and to provide drawings as a visual representation of their responses. Written in both English and French (which is likely to be the Ni-Van students second or third language after Bislama), the students had choice which language they wanted to complete the booklets in, with the booklets using the same format of starting with a scenario followed by eleven questions. The eleven questions were drafted and finalised with the research team over a period of 6 months, with the questions scaffolded to allow participants to demonstrate health literacy according to Nutbeam's [45, 46] hierarchal model (see Table 2).

Data analysis

Using the workshop booklets and questions, we deductively analysed each group of students' responses [51] according to Nutbeam's [45, 46] health literacy hierarchy (i.e., functional, interactive, or critical). Following initial conceptualisation discussions with all authors, two groups of authors (LP, RF and KA, JC) analysed the booklet responses independently of the other group, according to the hierarchy of functional, interactive, and critical. If the development of critical literacy was evident in the

Table 2 Level of health literacy promoted through booklet scenarios and questions

Workshop booklet questions	Level of health literacy
Scenario	
Question 1. Where do you think [scenario character name] got the information on food and nutrition guidelines from?	Functional
Question 2. What do you think [scenario character name] friends say about these nutrition guidelines?	Interactive
Question 3. Where do [scenario character name] and her friends go to buy the food?	Interactive
Question 4. What food do they buy?	Interactive
Question 5. What does guide their choice when buying this food?	Critical
Question 6. What makes it easy (facilitators) or difficult (barriers) for [scenario character name] and her friends to access a healthy and enjoyable diet and follow recommendations? List all that come to your mind	Critical
Question 7. Which barriers must be removed as a priority? Which facilitators must be amplified?	Critical
Question 8. [Scenario character name] decides to use digital technologies to adopt a healthy and enjoyable diet consistent with the dietary guidelines. Which digital tools support this and how does she use them? List as many solutions as you can think of!	Critical
Question 9. Decide which digital technology would be best and draw it!	Critical
Question 10. How can [scenario character name] maintain this diet in the new environment (climate change)?	Critical
Question 11. How can digital technologies help [scenario character name] adjust and maintain her diet?	Critical

response, along with interactive health literacy, the activity was coded as critical literacy. If there was no response from the workshop groups for a question, the response was coded as no response. Hence, the highest level evident was the code assigned to that activity (see Table 3). Each booklet took the independent reviewers between 5–10 min to analyse. Once the authors had coded for all workshop booklet responses, they sent their coding independently to another author (CC), who was blinded to the analytic process. This co-author performed an inter-rater reliability check on the accuracy of coding by comparing their assessment with the initial coding results. Inter-rater reliability checks led to an overall 80% agreement on coding allocation. Previous qualitative studies have identified 70% as the minimum acceptable level of agreement [52]. Discrepancies in coding were then discussed and refined in successive meetings before finalisation of the codes.

Table 3 Workshop booklet responses and demonstration of health literacy

Workshop booklet questions	Level of health literacy that could be demonstrated	Level of health literacy demonstrated (%, number of responses)	
		School A (urban) ($n=23$) 5 booklets	School B (rural) ($n=21$) 9 booklets
Question 1. Where do you think [scenario character name] got the information on food and nutrition guidelines from?	Functional	F: 100, 5	F: 100, 9
Question 2. What do you think [scenario character name] friends say about these nutrition guidelines?	Interactive	F: 100 5	F: 100, 9
Question 3. Where do [scenario character name] and her friends go to buy the food?	Interactive	F: 100, 5	F: 100, 9
Question 4. What food do they buy?	Interactive	F: 60, 3 I: 40, 2	F: 100, 9
Question 5. What does guide their choice when buying this food?	Critical	I: 80, 4 C: 20.0 1	F: 100, 9
Question 6. What makes it a) difficult (barriers) or b) easy (facilitators) for [scenario character name] and her friends to access a healthy and enjoyable diet and follow recommendations? List all that come to your mind	Critical	6a I: 100, 5 6b I: 80, 4 C: 20, 1	6a F: 22, 2 I: 56, 5 C: 22, 2 6b F: 78, 7 I: 22, 2
Question 7. a) Which barriers must be removed as a priority? b) Which facilitators must be amplified?	Critical	7a F: 40, 2 I: 60, 3 7b F: 20, 1 I: 60, 3 C: 20, 1	7a F: 11, 1 I: 67, 6 C: 22, 2 7b F: 56, 5 I: 33, 3 C: 11, 1
Question 8. [Scenario character name] decides to use digital technologies to adopt a healthy and enjoyable diet consistent with the dietary guidelines. Which digital tools support this and how does she use them? List as many solutions as you can think of!	Critical	F: 20, 1 I: 80, 4	F: 22, 2 I: 67, 6 C: 11, 1
Question 9. Decide which digital technology would be best and draw it!	Critical	I: 100, 5	F: 44, 4 I: 44, 4 N: 12, 1
Question 10. How can [scenario character name] maintain this diet in the new environment?	Critical	I: 40, 2 C: 60, 3	F: 56, 5 I: 33, 3 N: 11, 1
Question 11. How can digital technologies help [scenario character name] adjust and maintain her diet?	Critical	1: 60, 3 C: 40, 2	F: 56, 5 I: 44, 4
Total % and number of responses at each health literacy level		F: 34, 22 I: 54, 35 C: 12, 8	F: 65, 75 I: 28, 33 C: 5, 6 N: 2, 2

Qu question, *F* Functional, *I* Interactive, *C* Critical, *N* no response

From this analysis, we attributed a score for each group in each level of health literacy (i.e. functional, interactive and critical) by counting the number of answers that the students provided corresponding to the level of health literacy. From this score, a principal components analysis (PCA) followed by a hierarchical ascending classification (HAC) were conducted with R 3.5.1 and its library Factoshiny 2.2 [53, 54]. The PCA was computed with the scores of the level of health literacy. Place of living, the number of students in a group as well as the male proportion in the group were set as supplementary variables.

Results

The results report on the analysis of the 14 booklet responses, completed by 44 students, across the two schools ($n=5$ booklets/$n=21$ students at School A; and $n=9$ booklets/$n=23$ students at School B). As displayed in Table 3, many responses were categorised as interactive for School A (54%) and functional for School B (65%). For both schools, a much smaller number of responses were categorised as critical (School A: 12% and School B: 5%). This is despite a concerted effort to ensure that the workshop booklet activities were structured according to Nutbeam's [45, 46] three level hierarchal model and provided opportunities for students to start with functional level activities and move through to interactive and critical level activities. When an activity allowed for critical health literacy to be demonstrated, School A workshop groups were more likely to respond at a critical health literacy level although the difference was only two responses (School A: 8 responses categorised as critical vs School B: 6 responses).

Figure 1 shows the result of the PCA on scores in level of health literacy and its subsequent HAC that highlighted two groups. The first factorial plan of the PCA enabled to explain 98.85% of the score inertia. The first PCA axis was very strongly correlated with the functional level (cor = -0.99) and with the interactive level (cor = 0.90) whereas the second PCA axis was strongly correlated with the critical level (cor = 0.86). The first PCA axis marked an opposition between groups with a high score in functional level responses and those with a high score in interactive level responses. It seems the number of students in a group was associated with interactive level responses (Fig. 1a). Similarly, rurality was positively associated with a high score in the functional level whereas urbanity was positively associated with a high score in the interactive level (Fig. 1c). The HAC automatically identified two clusters, which were mainly discriminated according to their coordinates in PCA axis 1 (Fig. 1b and c). All the urban groups were in cluster 2 and all the rural groups, except one, were in cluster 1.

Discussion

This research study was based in two Ni-Van schools, to explore adolescents' health literacy knowledge and capabilities regarding food and nutrition, how climate change may be impacting these behaviours, and the suggested technological solutions for promoting healthy eating. In this multi-site collective case study design, differing levels of health literacy were found across the two schools in two different regions of Vanuatu (School A: urban; School B: rural). Lower levels of literacy were found in School B compared with School A with a greater number of responses at the functional, rather than the interactive level. However, responses categorised at a critical health level were low in both schools.

Workshop booklet activities used in this study were designed using Nutbeam's [45, 46] three level health literacy hierarchal model with the intention to provide opportunities for students to work towards and use critical health literacy capabilities. There have been no studies that the authors know of that have assessed students' responses to lesson or workshop activities using Nutbeam's model [45, 46] so these results cannot be compared with other studies. However, previous Australian school-based studies focusing on enhancing adolescents' health literacy knowledge and capabilities do show that interactive learning is the level of health literacy that is often prioritised by teachers, through planning and teaching lessons/activities and practiced by students [47, 48], with critical health literacy minimised. The discrepancies in observed health literacy levels between the two Ni-Van schools could be explained by geographical reasons and student grouping sizes, as although there has been evidence to suggest that rurality does influence health literacy levels [55], rurality alone does not explain rural–urban health literacy differences and that sociodemographic factors play important roles [56]. In terms of group sizes, bigger groups of four to five students seemed to promote the use of interactive health literacy knowledges and capabilities, compared with smaller groups of two to three students.

Focusing on geographical location, although both use the same curricular, the pedagogies and approaches for teaching health-related content to enhance students' health literacy may not be the same across urban and rural contexts, schools and classrooms. International research shows that all countries struggle to recruit and retain staff at rural schools or those schools that are further away from urban centres, and as such rural schools are generally staffed with novice teachers, less motivated teachers, less skilled teachers, or contract teachers or face shortages of teachers with expertise in key subjects (such as health education) [55, 56]. Second, rural schools tend to lack amenities, equipment and resources that urban

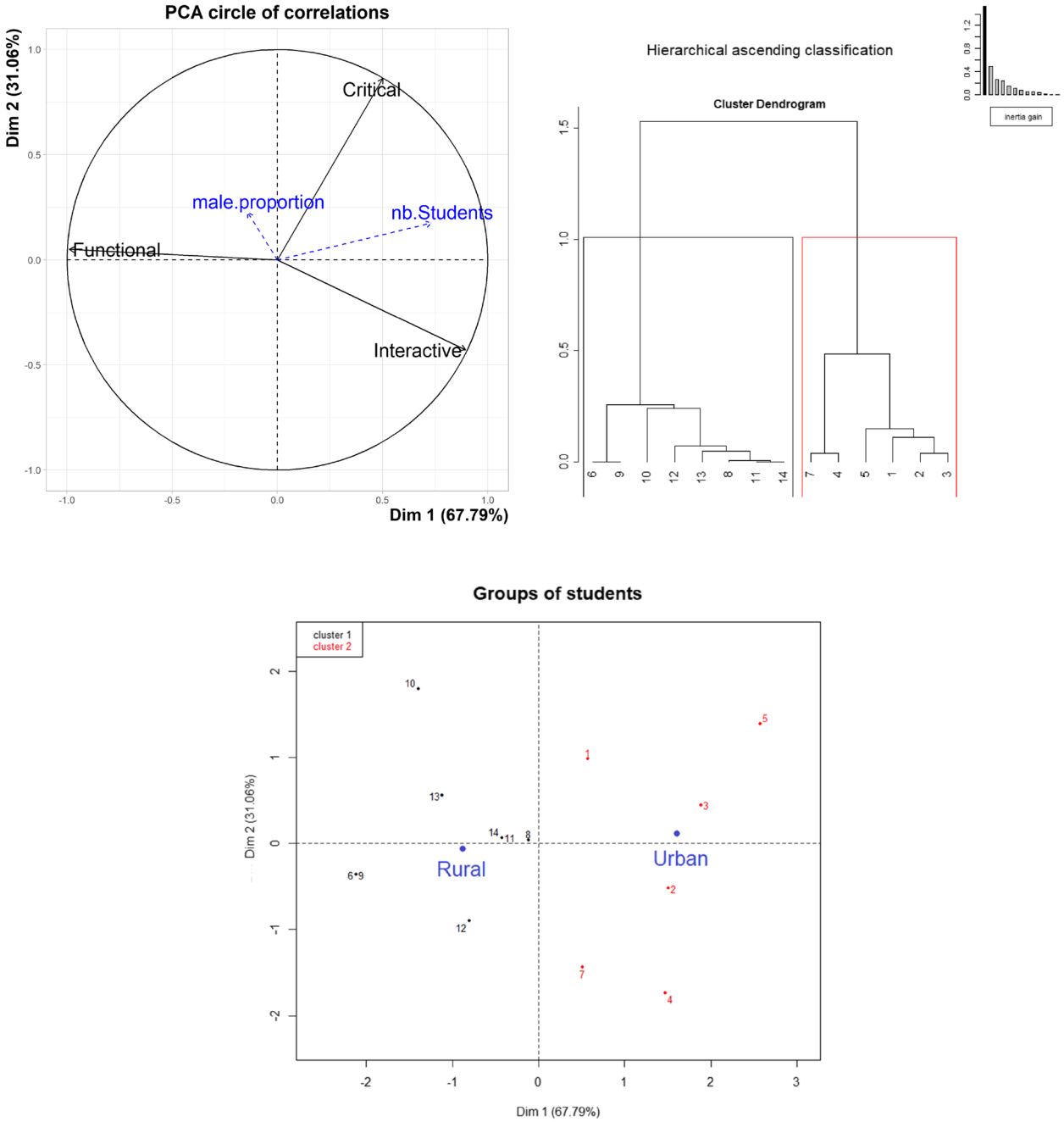

Fig. 1 PCA and HAC analysis of the scores in the level of health literacy: **a** PCA circle of correlations, **b** dendrogram of the subsequent HAC, **c** first factorial plan of the PCA with the HAC clusters (black: cluster 1; red: cluster 2)

schools tend to have, which can limit or minimise high quality and creative teaching and learning experiences, student enjoyment and learning [55]. Third, rural schools and teachers, due to the physical distance between universities, professional associations and rural schools, are less likely to access professional growth opportunities and be engaged in teacher professional development programs [57]. This limits opportunities for teachers in rural schools to enhance their planning, teaching and assessment-related practices. Collectively, these three geographical reasons may explain why School B students were less likely to engage in the workshop booklet activities at an interactive and critical health literacy level, as this may have been the students' first opportunity to

communicate, discuss, develop, design, apply and synthesise new health information in a classroom context. In addition, the grouping sizes may have impacted the ability to respond at a level displaying interactive or critical health literacy levels. School B had smaller groups which may have limited discussions or deeper analysis compared with School A, however there is limited literature to suggest this may be the case. As the responses were a group response, teasing out the other sociodemographic influences was not possible.

Critical health literacy provides a framework for thinking about health as both an individual and as a collective [45, 46], with roots within critical pedagogy [46, 58]. Critical health literacy generally consists of three overlapping and interconnected domains: 1) information appraisal; 2) understanding the social determinants of health; and 3) the abilities that enable actions that can promote health and well-being in a collective [59]. Therefore, those students with these most advanced critical health literacy capabilities can obtain and use information to exert greater control over life events and situations that have an impact on their health and those around them [45, 46]. The findings show that students in both schools were less likely to engage in critical, compared with functional and interactive health literacy levels. School B (rural) students were less likely to engage in critical health literacy compared with School A (urban) students, particularly around food sustainability, climate change, social determinants of health, and digital technology solutions, which is concerning as rural areas in Vanuatu are more susceptible to the effects of climate change and food sustainability. In rural Ni-Van communities there is a heavy reliance on climate-sensitive livelihoods, such as rain-fed agriculture and fishing, and limited capacity for response due to rural underdevelopment and remoteness [60] and therefore critical health literacy is needed to propose community level actions to minimise climate change impacts and risks. Despite community and school input into the workshop booklet activities, perhaps more workshops (e.g., two or three) or more time allocated in each of the workshops (e.g., 3 h) may have been warranted for students to engage at the interactive and critical health literacy level. In addition, explicitly stating to students that local knowledge, that is traditional ecological knowledge, would be appropriate content to draw upon in responding to each of the workshop booklet activities would have been appropriate [61, 62].

As digital technologies are heavily accessed and used by adolescents globally, including in PICTs, enhancing adolescents' digital health literacy (i.e., their ability to apply health literacy knowledge and capabilities to digital contexts and environments [63]) is key for achieving positive lifestyle outcomes. However, the findings show that only 2 of the 14 groups' responses to question 11 were able to evaluate and design a digital technology solution (i.e., demonstrate critical levels of digital health literacy) that could enhance adolescents' health eating opportunities. Digital health literacy, as an extension of health literacy, is essential to optimising health outcomes of adolescents now and into adulthood but at present has very little place in international school health education curricular. Digital health literacy has only been strengthened recently in the current draft of the Australian Health and Physical Education curriculum [36], with little to no teacher professional development to support teachers' knowledge and pedagogy. Future international health curricular needs to focus on promoting adolescents' digital health literacy.

Strengths and limitations

This is the first known study to have assessed adolescents' responses to lesson or workshop activities using Nutbeam's [45, 46] model. The benefit of this approach is that this new knowledge will build upon current evidence that has focused on teachers and health literacy programming and planning. A limitation of this study is that workshop booklet activities were completed by students in groups. Therefore, the responses are an extrapolation of the health literacy levels of the group rather than each individual student. It was also observed during the workshop delivery that students could have had critical level discussions or disagreements with their peers, however once those discussions were translated into responses in the booklets there could have been simplification and generalisation of discussion points rather than an explanation of the many points that were raised. This may have led to the lower health literacy levels demonstrated. Considerations for future research is that this project is currently being undertaken across multiple schools in three PICT. Future analysis could pool the results from rural and urban regions across different PICT to determine similarities and differences in the demonstration of health literacy levels to better inform school curriculum and health education programs.

Conclusion

School A's booklet responses showed that interactive health literacy responses were dominant (54%), whereas School B's responses showed that functional health literacy responses were dominant (65%). Overall, the findings show that students in both schools were less likely to engage in critical, compared with functional and interactive health literacy levels. The piloting of these booklets shows that: 1) more scaffolding, time and workshops may be needed to enhance students' opportunities to engage in critical health literacy; 2) explicitly

stating that local community and cultural knowledge should be used to respond to questions is needed; and 3) smaller sized-groupings or encouraging of multiple responses to questions should be emphasised.

In addition, this research study with Ni-Van adolescents living in both rural and urban areas focus on the importance of Vanuatu curriculum documents to focus on food and nutrition, climate change and other health education content, and explicitly state health literacy in outcomes and content [40, 41]. This will ensure that students are given opportunities to learn health literacy knowledges and capabilities, including digital health literacy in Vanuatu. At the very least, curriculum should scaffold content according to Nutbeam's health literacy model to provide (more) interactive and critical health literacy opportunities. A recent example of this in the PICT region is the Tokelau National Health and Physical Education Curriculum [33], where health literacy promotion is a priority. Using the Tokelau curriculum writing experience will be an important step in determining whether this is a viable option for the Vanuatu Ministry of Education and other associated government bodies (e.g., Ministry of Education) and other PICT education departments who are concerned about the impact of NCD on their communities and the prevalence of NCD risk factors among youth [33]. However, as current evidence suggests that curriculum change and integration of health literacy is often not enough to enhance the programming and teaching of health literacy in health education [47, 48], resources need to be directed to teacher professional development that is accessible for teachers and schools, and preservice teacher education to foster the teaching of health education to enhance students' health literacy [64]. Further, efforts beyond schooling environments (i.e., community strategies) for health literacy development is needed that underpin local and national policy, laws and regulations to create enabling environments that prioritise local wisdom and support whole of school efforts that aim to reduce community exposures to NCD risk factors [28].

Abbreviations

FALAH	Family, Farming, Lifestyle and Health network
NCD	Non-communicable diseases
PICT	Pacific Islander Countries and Territories
WHO	World Health Organisation

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Authors' contributions

CC and OG are the leaders of the research program named FALAH and this research study. LP conceived of the data analysis and wrote the publication. NL and PM organised the data collection sites. NL, PM, RF, KA, CC, OG and GW collected the data. LP, RF, KA, JC, CC, and GW analysed the data. All authors contributed to the drafting of this publication.

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Data availability

The datasets generated and/or analysed during the current study are not publicly available due to ethical reasons but are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

Ethical approval was gained from the consultative committee for ethics of New Caledonia 2018–06 001 and 2023–10 012 and Human Research Ethics Committee (2023/453). Research was conducted in accordance with the National Statement on Ethical Conduct in Human Research (National Health and Medical Research Council, 2018). Written informed consent to participate was obtained from all the participants and their parents or legal guardians of any participant under the age of 16 years.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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References

1. World Health Organisation Western Pacific Region, Government of Samoa, Secretariat for Pacific Community. Towards Healthy Islands: Pacific Noncommunicable Disease Response. Tenth Pacific Health Ministers Meeting 2–4 July. Apia, Samoa: WHO, SPC; 2013a. Available from: http://www.wpro.who.int/southpacific/pic_meeting/2013/documents/PHMM_PIC10_3_NCD.pdf.
2. World Health Organisation. Regional action framework for noncommunicable disease prevention and control in the Western Pacific. Available from: https://www.who.int/docs/default-source/wpro—documents/regionalcommittee/session-73/wpr-rc73-agenda-12-annex-ncd-prevention-and-control.pdf/.
3. World Health Organiaation. Global action plan for the prevention and control of NCDs 2013–2020. Available from: https://www.who.int/publications/i/item/9789241506236.
4. Guariguata L, Whiting D, Hambleton I, Beagley J, Linnenkamp U, Shaw JE. Global estimates of diabetes prevalence for 2013 and projections for 2035. Diabetes Res Clin Pract. 2013;103:137–49.

5. Anderson I. The economic costs of noncommunicable diseases in the Pacific Islands: a rapid stocktake of the situation in Samoa, Tonga and Vanuatu. Washington DC: The World Bank; 2013. Available from: http://www.worldbank.org/content/dam/Worldbank/document/the-economic-costs-ofnoncommunicable-diseases-in-the-pacific-islands.pdf.
6. Matheson D, Park K, Soakai TS. Pacific island health inequities forecast to grow unless profound changes are made to health systems in the region. Aust Health Rev. 2017;41(5):590–8.
7. McIver L, Kim R, Woodward A, Hales S, Spickett J, Katscherian D, Hashizume M, Honda Y, Kim H, Iddings S, Naicker J. Health impacts of climate change in Pacific Island countries: a regional assessment of vulnerabilities and adaptation priorities. Environ Health Perspect. 2016;124(11):1707–14.
8. World Bank. Non-communicable disease (NCD) roadmap report. Washington DC: The World Bank; 2014. Retrieved from: http://documents.worldbank.org/curated/en/534551468332387599/Non-Communicable-Disease-NCD-Roadmap-Report.
9. Swinburn BA, Kraak VI, Allender S, Atkins VJ, Baker PI, Bogard JR, Brinsden H, Calvillo A, De Schutter O, Devarajan R, Ezzati M. The global syndemic of obesity, undernutrition, and climate change: the Lancet Commission report. Lancet. 2019;393(10173):791–846.
10. Friel S, Bowen K, Campbell-Lendrum D, Frumkin H, McMichael AJ, Rasanathan K. Climate change, noncommunicable diseases, and development: the relationships and common policy opportunities. Annu Rev Public Health. 2011;21(32):133–47.
11. McIver L, Kim R, Hales S, et al. Human health and climate change in Pacific Island countries. World Health Organization; 2015. Available from: http://iris.wpro.who.int/bitstream/handle/10665.1/12399/9789290617303_eng.pdf.
12. Costello A, Abbas M, Allen A, Ball S, Bell S, Bellamy R, Friel S, Groce N, Johnson A, Kett M, Lee M. Managing the health effects of climate change: lancet and University College London Institute for Global Health Commission. Lancet. 2009;373(9676):1693–733.
13. Galy O, Frayon S, Goldin M, Zongo P, Wattelez G, Lameta S, Quartermain A, Fotsing JM, Bouard S. Generational issues in linking family farming production, traditional food in diet, physical activity and obesity in Pacific Islands countries and territories: the case of the Melanesian population on Lifou Island. Open Res Eur. 2021;1:135.
14. World Health Organization. Noncommunicable diseases: key facts. 2021. Available: https://www.who.int/news-room/fact-sheets/detail/noncommunicable-diseases.
15. Frayon S, Wattelez G, Paufique E, Nedjar-Guerre A, Serra-Mallol C, Galy O. Overweight in the pluri-ethnic adolescent population of New Caledonia: Dietary patterns, sleep duration and screen time. Lancet Reg Health West Pac. 2020;1:2.
16. Wattelez G, Frayon S, Caillaud C, Galy O. Physical activity in adolescents living in rural and urban New Caledonia: The role of socioenvironmental factors and the association with weight status. Front Public Health. 2021;6(9):623685.
17. Sheridan SA, Brolan CE, Fitzgerald L, Tasserei J, Maleb MF, Rory JJ, Hill PS. Facilitating health and wellbeing is" everybody's role": youth perspectives from Vanuatu on health and the post-2015 sustainable development goal agenda. Int J Equity Health. 2014;13:1–2.
18. Nedjar-Guerre A, Wattelez G, Serra-Mallol C, Frayon S, Galy O. Adolescent screen time and unhealthy food consumption in the context of the digital development in New Caledonia. PLoS ONE. 2023;18(5):e0285374.
19. Gibbs L, Kornbluh M, Marinkovic K, Bell S, Ozer EJ. Using technology to scale up youth-led participatory action research: A systematic review. J Adolesc Health. 2020;67(2):S14–23.
20. Patton GC, Sawyer SM, Santelli JS, Ross DA, Afifi R, Allen NB, Arora M, Azzopardi P, Baldwin W, Bonell C, Kakuma R. Our future: a Lancet commission on adolescent health and wellbeing. Lancet. 2016;387(10036):2423–78.
21. Aaby A, Friis K, Christensen B, Rowlands G, Maindal HT. Health literacy is associated with health behaviour and self-reported health: A large population-based study in individuals with cardiovascular disease. Eur J Prev Cardiol. 2017;24(17):1880–8.
22. Juul L, Rowlands G, Maindal HT. Relationships between health literacy, motivation and diet and physical activity in people with type2 diabetes participating in peer-led support groups. Prim Care Diabetes. 2018;12(4):331–7. https://doi.org/10.1016/j.pcd.2018.02.005.14.
23. Spronk I, Kullen C, Burdon C, O'Connor H. Relationship between nutrition knowledge and dietary intake. Br J Nutr. 2014;111(10):1713–26. https://doi.org/10.1017/S0007114514000087.13.
24. Kessaram T, McKenzie J, Girin N, Roth A, Vivili P, Williams G, Hoy D. Noncommunicable diseases and risk factors in adult populations of several Pacific Islands: results from the WHO STEPwise approach to surveillance. Aust N Z J Public Health. 2015;39(4):336–43.
25. Peralta LR, Cinelli RL, Cotton W, Morris S, Galy O, Caillaud C. The barriers to and facilitators of physical activity and sport for Oceania with non-European, non-Asian (ONENA) ancestry children and adolescents: a mixed studies systematic review. Int J Environ Res Public Health. 2022;19(18):11554.
26. Savage A, McIver L, Schubert L. the nexus of climate change, food and nutrition security and diet-related non-communicable diseases in Pacific Island Countries and Territories. Climate Dev. 2020;12(2):120–33.
27. Heine M, Lategan F, Erasmus M, Lombaard CM, Mc Carthy N, Olivier J, van Niekerk M, Hanekom S. Health education interventions to promote health literacy in adults with selected non-communicable diseases living in low-to-middle income countries: A systematic review and meta-analysis. J Eval Clin Pract. 2021;27(6):1417–28.
28. Osborne RH, Elmer S, Hawkins M, et al. Health literacy development is central to the prevention and control of non-communicable diseases. BMJ Glob Health. 2022;7(12):e010362. https://doi.org/10.1136/bmjgh-2022-010362.
29. Bollars C, Sørensen K, de Vries N, Meertens R. Exploring health literacy in relation to noncommunicable diseases in Samoa: a qualitative study. BMC Public Health. 2019;19:1–2.
30. World Health Organization. Regional framework on nurturing resilient and healthy future generations in the Western Pacific. In: Regional framework on nurturing resilient and healthy future generations in the Western Pacific. 2022. Available from: https://www.who.int/publications/i/item/9789290619741.
31. World Health Organization. Health literacy toolkit for low-and middle-income countries: A series of information sheets to empower communities and strengthen health systems. WHO Regional Office for South-East Asia; 2015. Available from: https://www.who.int/publications/i/item/9789290224754.
32. Beauchamp A, Batterham RW, Dodson S, Astbury B, Elsworth GR, McPhee C, Jacobson J, Buchbinder R, Osborne RH. Systematic development and implementation of interventions to OPtimise Health Literacy and Access (Ophelia). BMC Public Health. 2017;17:1–8.
33. Trask S, Manuele P, Borne L, Galy O, Potter B, Bay J. Developing the Tokelau National Health and Physical Education Curriculum: A case study. Health Educ J. 2024;83(1):78–94.
34. World Health Organization. The mandate for health literacy, 2016. Retrieved June. 2023. from https://www.who.int/healthpromotion/conferences/9gchp/health-literacy/en/.
35. St Leger L. Schools, health literacy and public health: possibilities and challenges. Health Promot Int. 2001;16:197205.
36. Australian Curriculum, Assessment and Reporting Authority (ACARA). Australian Curriculum: Health and physical education; 2023. Version 9. ACARA. https://www.australiancurriculum.edu.au/f-10-curriculum/health-and-physical-education/.
37. Finnish National Board of Education. National Core Curriculum for Basic Education 2014: National Core Curriculum for Basic Education Intended for Pupils Subject to Compulsory Education. Next Print Oy: Helsinki; 2016.
38. Paakkari O, Paakkari L. Health literacy and the school curriculum: the example of Finland. In U. Bauer, O. Orkan, P. Pinheiro, D. Levin-Zamir, & K. Sorensen (Eds.), International handbook of health literacy- research, practice, and policy across the lifespan. Bristol: Policy Press; 2019. pp. 521–534.
39. World Health Organization. Regional framework for reaching the unreached in the Western Pacific (2022–2030). Manila: World Health Organization Regional Office for the Western Pacific; 2023. Licence: CC BY-NC-SA 3.0 IGO.
40. Vanuatu Ministry of Education and Training. National Syllabus Senior Secondary – Years 11–13 Family Life Education. Port Vila: Curriculum development unit; 2014.
41. Vanuatu Ministry of Education and Training. Basic Science and Agriculture Years 7–10. Port Vila: Curriculum development unit; 1997.

42. Dixon R, Abel G, Burrows L. A case for connecting school-based health education in Aotearoa New Zealand to critical health literacy. Curr Stud Health Phys Educ. 2023;14(2):127–42.
43. Okan O, Paakkari L, Dadaczynski K. Health literacy in schools. State of the art. Schools for Health in Europe Network Foundation. 2020. Retrieved from https://www.schoolsforhealth.org/sites/default/files/editor/factsheets/factsheet-2020-english.pdf.
44. Aschbrenner KA, Kruse G, Gallo JJ, Plano Clark VL. Applying mixed methods to pilot feasibility studies to inform intervention trials. Pilot Feasib Stud. 2022;8(1):217.
45. Nutbeam D. Health literacy as a public health goal: a challenge for contemporary health education and communication strategies into the 21st century. Health Promot Int. 2000;15:259–67.
46. Nutbeam D. The evolving concept of health literacy. Soc Sci Med. 2008;67:2072–8.
47. Peralta LR, Cinelli RL, Marvell CL. Health literacy in school-based health programmes: a case study in one Australian school. Health Educ J. 2021;80:648–59.
48. Peralta LR, Cinelli RL, Marvell CL, Nash R. A teacher professional development programme to enhance students' critical health literacy through school-based health and physical education programmes. Health Promot Int. 2022;37(6):daac168.
49. Yin RK. Case study research design and methods. 5th ed. Thousand Oaks, CA: Sage; 2014.
50. Ahmadpour N, Loke L, Gray C, Cao Y, Macdonald C, Hart R. Understanding how technology can support social-emotional learning of children: a dyadic trauma-informed participatory design with proxies. In: Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems. 2023 . p. 1–17.
51. Guerin S, Hennessy E. Pupils' definitions of bullying. Eur J Psychol Educ. 2002;17:249–61.
52. Hsieh HF, Shannon SE. Three approaches to qualitative content analysis. Qual Health Res. 2005;15:1277–88.
53. R Core Team. A language and environment for statistical computing. Vienna: R Foundation for Statistical Computing; 2018. https://www.R-project.org/.
54. Vaissie P, Monge A, Husson F. Factoshiny: Perform Factorial Analysis from 'FactoMineR' with a Shiny Application. R package version 1.0.6. 2017. https://CRAN.R-project.org/package=Factoshiny.
55. Evans DK, Acosta AM. How to recruit teachers for hard-to-staff schools: A systematic review of evidence from low-and middle-income countries. Econ Educ Rev. 2023;1(95):102430.
56. Ingersoll RM, Tran H. The rural teacher shortage. Phi Delta Kappan. 2023;105(3):36–41.
57. Govender S, Ajani OA, Ndaba NH, Ngema T. Making In-service Professional Development Effective in a Rural Context: Enhancing Social Justice for Rural Teachers. In: Contextualising Rural Education in South African Schools. The Netherlands: Brill; 2023. pp. 78–95.
58. Freebody P, Luke A. Literacies programs: Debates and demands in cultural context. Prospect Austr J TESOL. 1990;5(3):7–16.
59. Haugen AL, Riiser K, Esser-Noethlichs M, Hatlevik OE. Developing indicators to measure critical health literacy in the context of Norwegian lower secondary schools. Int J Environ Res Public Health. 2022;19(5):3116.
60. Granderson AA. Value conflicts and the politics of risk: challenges in assessing climate change impacts and risk priorities in rural Vanuatu. Climate Dev. 2018;10(6):481–94.
61. McCarter J, Gavin MC. Perceptions of the value of traditional ecological knowledge to formal school curricula: opportunities and challenges from Malekula Island, Vanuatu. J Ethnobiol Ethnomed. 2011;7:1–4.
62. Ruiz-Mallen I, Barraza L, Bodenhorn B, de la Paz C-A, Reyes-Garcia V. Contextualising learning through the participatory construction of an environmental education programme. Int J Sci Educ. 2010;13:1755–70.
63. Schulenkorf T, Krah V, Dadaczynski K, Okan O. Addressing health literacy in schools in Germany: concept analysis of the mandatory digital and media literacy school curriculum. Front Public Health. 2021;5(9):687389.
64. Kealy-Ashby C, Peralta L, Marvell C. Preservice teachers' health literacy levels and perceptions of teaching capabilities: an Australian case study. Curric Stud Health Phys Educ. 2023;20:1–8.

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