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Australian Primary School Students' Knowledge of the Agricultural Industry

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Abstract: The teaching of agriculture is critical to ensure students understand where their food and fibre originate, as well as the industry's contribution to the economy. This research examines the agricultural knowledge of Australian primary school students. Grade 4–6 students (n = 2392) from 75 schools were surveyed in 2021. The students' mean knowledge score was 8.7 out of 13 (SD = 2.1). The students exhibited a reasonable understanding of animal-derived products compared to plant-derived products, particularly when the plant product has undergone substantial processing. However, the students lacked an understanding of modern animal production systems, including the use of technologies on farms. This research identifies the gap in students' agricultural knowledge and provides insight to the industry to design and implement programs to improve their understanding.

Keywords: agriculture; agricultural production; quantitative research; student surveys; technology; technology curriculum

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1. Introduction

As the world becomes increasingly urbanised and the disconnect between metropolitan and rural communities continues to widen, knowledge of agriculture and farming process are on the decline [1,2]. While 55% of Australian land is used for agriculture, only 2.5% of Australians are employed in the sector as of 2020–2021 [3]. Comparatively, 9.8% of the population was engaged in agricultural or pastoral pursuits in the 1911 census [4], although this is expected to be an underestimation due to the number of First Nation agricultural workers that were not accounted for at the time. This trend is not uniquely Australian. Powell and Agnew [5] observed that "Americans are two to four generations removed from the farm, and a majority of Americans, even in rural agricultural states have no direct link to agriculture" (cited in Brandt, Forbes and Keshwani [2]). In the United Kingdom, "for 99% [of the population], farming is neither a livelihood nor a way of life" [6]. As food security continues to be an issue globally [7], the need for increased agricultural productivity and sustainability has never been higher. This can primarily be achieved through adequate agricultural education, which is essential both for consumer purchasing decisions that support the industry, and for continued industry development through a skilled workforce.

Today's students are tomorrow's consumers, and while not everyone will be directly associated with agriculture day to day, the industry is still fundamental for human society in that it provides the raw materials required for items such as food and clothing. Adequate education of today's students is, therefore, imperative to support future purchasing decisions. Food literacy education can help students to establish healthier eating habits, with some industry professionals advocating that exposure should begin in primary school and continue throughout their secondary years [8]. Education is also important to encourage social acceptance of agriculture, and to ensure the industry continues to operate under social license. This acceptance is becoming increasingly difficult and important as resources dwindle and societal expectations become more demanding and variable [9]. Finally, knowledge of an industry is an important factor in making career decisions, including the perception of agriculture as a viable and attractive future field of employment [10–12]. Attraction of skilled workers has been identified as one of the key requirements to accelerate the growth of Australian agriculture [13], particularly as the industry becomes increasingly professionalised [14].

In a systematic review of agricultural literacy research in the United States from 1988 to 2011, Kovar and Ball [15] concluded that while educational programs could increase agricultural literacy in the short term, "many populations were still agriculturally illiterate". Building on these findings, Cosby, et al. [16] conducted a similar systematic review, using international agricultural literacy research from 2000 to 2020. In that paper, Cosby, Manning, Power and Harreveld [16] noted that the definitions of agricultural literacy have evolved from "mere knowledge or awareness ... [to a] deeper understanding of the economic, social, science and technology aspects of the industry". The authors also state that while agricultural knowledge may be gained through social interactions (e.g., family or friend links to agriculture) or the media, the development of agricultural knowledge through formal schooling is critical to ensure a complete understanding of the "breadth and influence of agriculture's production processes" [16].

Australian school students are introduced to agriculture at different stages during their schooling career. Under the national curriculum [17], agriculture, or 'food and fibre' is predominantly taught in primary school in Design and Technologies and Humanities and Social Sciences (Geography sub-strand) subjects. A connection to Science and Mathematics is also common [17]. However, while these concepts are included in the curriculum, they are generally not considered a major focus. Implementation of these concepts is also not usually mandated, and each state and territory are responsible for how they implement the national curriculum. Australia also lacks a formal framework for assessment of agricultural literacy, making benchmarking and comparison of students of different ages or different backgrounds extremely difficult. This contrasts the United States, which has the National Agricultural Literacy Outcomes (NALOs) that detail the expected development of knowledge for each school grade [18]. Since the NALOs conception, Longhurst, et al. [19] developed the Longhurst Murray Agricultural Literacy Instrument (LMALI; Longhurst, et al. [20]), a valid and reliable instrument to assess primary students' understanding of the NALOs. In the absence of a formal assessment framework in Australia, research on Australian primary school students is limited. A single industry report [21] has been published that examines the agricultural knowledge of Grade 6 students (n = 213) and Year 10 students (n = 687). Though this report was updated in 2020 [1], primary-aged students were not represented in the update.

This research examined Australian primary school students' (Grades 4–6) knowledge of the agricultural industry. Using similar survey questions to the Hillman and Buckley [21] and PIEFA [1] reports, as well as the LMALI [20], the research question to be addressed is: What is the current level of knowledge of food and fibre industries in Australian primary-aged students? The results of this work are expected to provide insight into the current agricultural knowledge of Australian primary school students and identify potential areas of improvement. It is also expected that these findings could be used to develop a formal assessment framework for Australian primary students.

2. Materials and Methods

2.1. Survey

Australian primary school students in Grades 4 to 6 were surveyed in 2021 to determine their level of agricultural knowledge. All schools in Australia were emailed inviting them to participate, and a social media advertisement also invited parents, teachers, and community members to nominate a school to participate. Students were selected by their principal and/or teacher to participate in the research and completed the survey in either an electronic or written format.

The surveys were developed using similar survey questions to the Hillman and Buckley [21] and PIEFA [1] reports, as well as the LMALI [20]. A small number of questions (n = 4) were newly developed for this research based on common misconceptions about food and fibre production that the agricultural industry is actively trying to dispel through education and communication strategies.

The surveys were extensively tested for content validity with classes of school students from private and public schools from two states (New South Wales (NSW) and Queensland). Teachers, parents, and the NSW Department of Education staff were also consulted to ensure that students with average literacy skills would be able to read and comprehend what each question was asking them. Images to visually represent answers to each question were also utilised to assist students to interpret and choose their answers.

The final survey consisted of 16 closed-response questions and one open-response question. Most closed-response questions were multiple choice, with either one (n = 8) or multiple (n = 5) possible correct response(s) (i.e., 'select all that apply'). There were also two true/false questions and one match-the-items question. In addition to text, images were used to visually represent answers in five questions. Of the 16 closed-response survey questions, three were used to gather demographic data (gender, age, and farm exposure) and 13 were knowledge-based. This paper reports on the results from selected knowledge-based questions (n = 8).

This research was approved by the CQUniversity Australia Human Research Ethics Committee (approval number 21738). Approval was also granted by each state education department (except Western Australia), respective Catholic dioceses, or independent schools, relevant to each school type (government, Catholic or independent).

2.2. Analytic Strategy

A total of 2477 surveys were collected. After survey completion, electronic responses were exported into a spreadsheet program. Written responses were then transcribed into a spreadsheet and merged with the electronic responses. Thirty-one surveys were immediately discarded due to students being outside of Grades 4–6 (n = 29) or because the survey was illegible (n = 2). The remaining 2446 surveys were then examined and excluded if they: (i) Did not include their grade (n = 9); (ii) Left all questions blank (n = 24); or (iii) responded with all possible answers (including 'I don't know') to three or more 'select all that apply' questions (n = 5). This threshold was chosen based on students having responded with all possible answers to more than half of the five 'select all that apply questions'. Additionally, if students had attempted three or fewer knowledge questions they were excluded (n = 15). For this final criterion, an 'attempt' was defined as any response other than 'I don't know' and the threshold was selected based on students attempting more than 25% of the survey.

For the remaining 2392 surveys, student responses were coded for analysis using Microsoft Excel. Frequency statistics were calculated for all demographic variables. To assist in this, a location variable was generated based on school location and defined by the Australian Statistical Geography Standard Remoteness Structure [22]. The structure defines five areas of relative remoteness across Australia: major city, inner regional, outer regional, remote, very remote. In this study, outer regional, remote and very remote were amalgamated into a single 'remote' group. Descriptive statistics were calculated for agricultural knowledge questions. Correct response options for 'select all that apply' items were weighted based on the total number of selections required for a fully correct answer. For example, for a question with four correct responses, students were given a score of 0 for no correct response, 0.25 for one correct response, 0.5 for two correct responses and so forth. The total correct scores per student were then calculated out of a total of 13.

3. Results

3.1. Participants

The overall sample consisted of 2392 students attending Grade 4 (n = 713), Grade 5 (n = 798) or Grade 6 (n = 881) at 75 schools located across Australia. Participant demographics are presented in Figure 1. Regarding the agricultural knowledge scores, the highest score achieved was 13 out of 13 and the lowest was 0.5 (range: mean = 8.7; SD = 2.1).

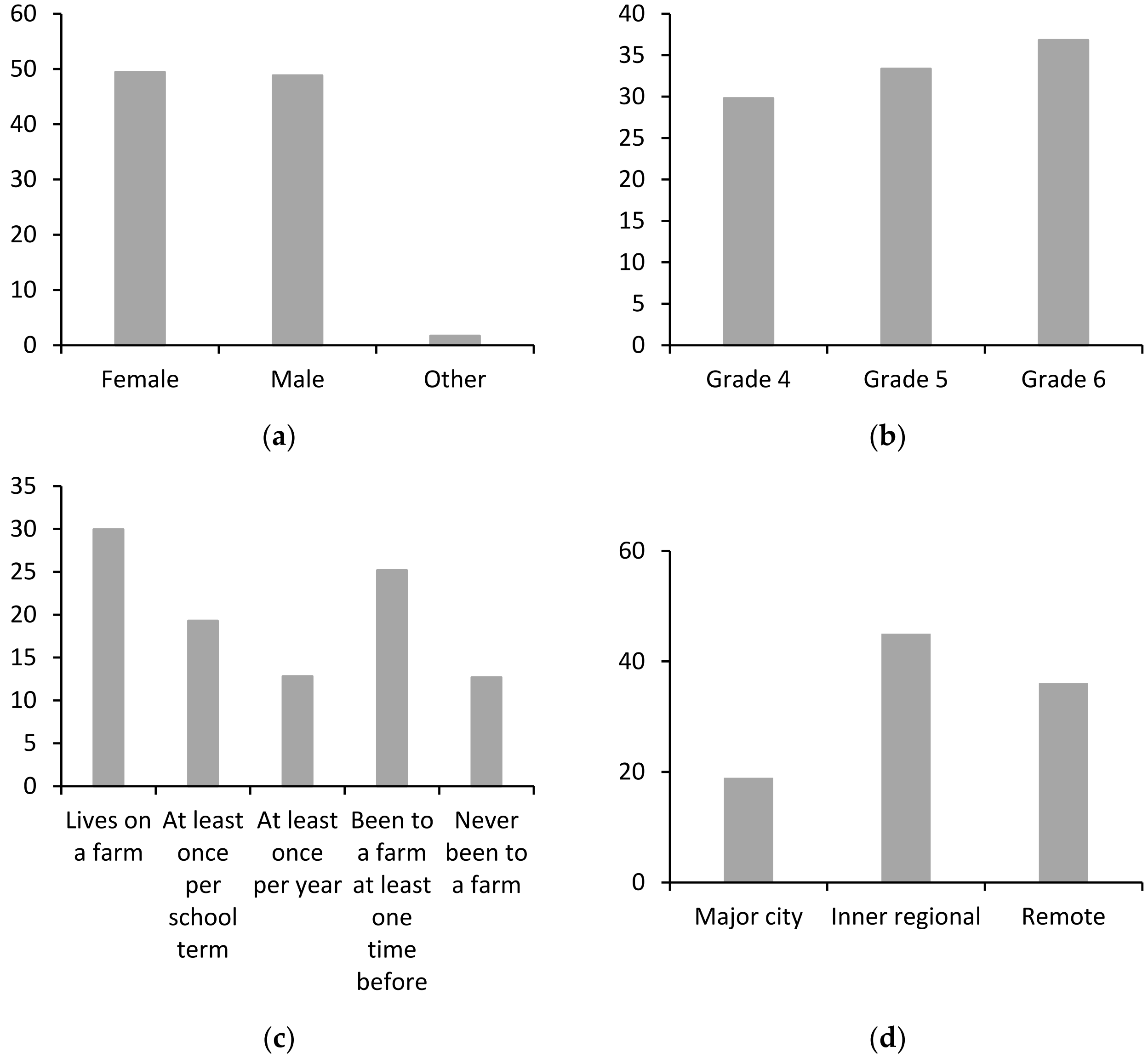

Figure 1. Participants demographics including: (**a**) Gender; (**b**) Grade; (**c**) Level of farm exposure; and (**d**) School location based on Australian Bureau of Statistics [22]. Data presented as a percentage of the total number of survey participants.

3.2. Agricultural Knowledge

Table 1 displays the results for the natural fibre question. Over half of primary students (53.8%) recognised that cotton comes from plants. Nearly 40%, however, believed either cotton came from animals (19.2%) or a combination of plants and animals (19.6%). Very few students stated that they thought cotton was man made (3.2%) and 4.1% indicated that they did not know the correct response or left their response blank.

Table 1. Valid response frequency and percentage for the natural fibre question. Correct response is shown in bold.

Simon Got a New Pair of Cotton Socks for Christmas. Cotton Is a Fibre Used in Many Types of Clothing. Where Does Cotton Come From?	n	%
(a) Animals	460	19.2
(b) Plants	**1288**	**53.8**
(c) Animals and plants	469	19.6
(d) It is man made	77	3.2
(e) I don't know/blank	98	4.1

The responses to the question regarding lunchbox foods are shown in Table 2. Less than half of primary students correctly identified that all the items came from a farm (43.6%). Almost a third recognised that cheese (32.3%) or apples (32.0%) come from farms (either in isolation or in combination with one other product). However, only 10.6% selected an option that specified bread. Some students who completed the survey in written format also selected cheese and bread, but this accounted for only 1.0% of the responses.

Table 2. Valid response frequency and percentage for the lunchbox foods question. Correct response is shown in bold.

Ben Has a Cheese Sandwich and an Apple in His Lunchbox. Which Foods in His Lunchbox Are Produced from Ingredients That Came from a Farm?	n	%
(a) The apple	241	10.1
(b) The cheese	373	15.6
(c) The bread	82	3.4
[1] (b) and (c)	25	1.0
(d) The apple and cheese	376	15.7
(e) The apple and the bread	147	6.2
(f) All of the items came from a farm	**1043**	**43.6**
(g) I don't know	105	4.4

[1] Some students who completed the survey in written format circled both cheese and bread.

Table 3 shows responses to the question about farm products. Almost all primary students were able to correctly identify the origin of each farm product (97.7%) inclusive of beef (97.3%), orange (97.9%), bacon (97.2%) and wool (97.9%). There were very few incorrect responses with pig for beef (1.2%) and cow for bacon (1.1%) being the most frequent errors.

Table 3. Valid response frequency and percentage for the farm product question. Correct response(s) are shown in bold.

	Draw an Arrow to Match the Farm Products to Their End Use							
	Beef		Orange		Bacon		Wool	
	n	%	n	%	n	%	n	%
(a) Pig	29	1.2	5	0.2	**2325**	**97.2**	8	0.3
(b) Cow	**2327**	**97.3**	6	0.3	27	1.1	3	0.1
(c) Sheep	4	0.2	8	0.3	8	0.3	**2342**	**97.9**
(d) Tree	3	0.1	**2342**	**97.9**	6	0.3	9	0.4
Blank	29	1.2	31	1.3	26	1.1	30	1.3

Table 4 shows the results for all true or false question items. While a high proportion of primary students were able to identify that not all farm animals are kept in cages (87.2%), most students indicated that they did not know if all chickens are given hormones (42.9%). Accordingly, only 38.1% responded correctly, and 19.0% selected the incorrect response.

Table 4. Valid response frequency and percentage for the true or false question items. Correct response(s) are shown in bold.

	True		False		I Don't Know/Blank	
	n	%	n	%	n	%
All farm animals in Australia are kept in cages.	143	6.0	**2086**	**87.2**	163	6.8
All chickens in Australia are given hormones to grow.	454	19.0	**912**	**38.1**	1026	42.9

The responses to the question about knowledge and perception of dairy farming are shown in Table 5. While many primary students correctly identified that milking machines are used to collect milk from cows (n = 1873), a smaller number recognised that milking also occurs in robotic dairies (n = 638). Conversely, a high number of students believed that milking happens by hand on commercial dairy farms (n = 1865). In total 17.4% selected all the correct responses, 60.2% selected at least one correct response and 17.4% did not select a correct response. Interestingly, 340 students (14.2%) thought that milking by hand was the only method used.

Table 5. Valid response frequency for the dairy farming item. As multiple responses were allowed, the numbers presented do not total the number of students. Correct response(s) are shown in bold.

Amy Is a Dairy Farmer. Circle All the Methods That Farmers Use to Collect Milk from Cows on Commercial Dairy Farms in Australia to Sell to Customers (You May Choose More than One Answer).	n
(a) With milking machines	**1873**
(b) By hand into a bucket	1865
(c) In a robotic dairy	**638**
(d) I don't know/blank	76

Table 6 shows responses to the question about technology use on farms. Most primary students correctly identified that drone (n = 1514) technology is used on farms. A large number also recognised that iPads (1305) have been implemented. However, many students believed that cattle yards (n = 1147), as well as taps and hoses (n = 777) were among the new technologies being used. Nearly half of the students were able to identify the two correct responses (44.6%). Similar proportions identified one correct response (28.6%) or did not select any correct response (26.8%).

Table 6. Valid response frequency to the technology use question. As multiple responses were allowed, the numbers presented do not total the number of students. Correct response(s) are shown in bold.

Farmer Ted Uses His Computer to Keep Track of His Business Records. What Other Kinds of New Technology Can a Farmer Use? Circle All That Apply (You May Choose More than One Answer).	n
(a) Tap and hose	777
(b) iPad	**1305**
(c) Cattle yards	1147
(d) Drones	**1514**
(e) I don't know/blank	161

The results for the question about fruits and vegetables traditionally eaten in different parts of the world are presented in Table 7. A high proportion of primary students were aware that people in different parts of the world eat different fruits and vegetables because they grow better in certain areas (78.9%). While some students thought that the main reason was because of differences in food preferences (10.7%), very few believed the reason was because their school tells them what to eat (1.8%).

Table 7. Valid response frequency and percentage for the item about why people across the world eat different fruits and vegetables. Correct response is shown in bold.

Farah Lives in Malaysia and Takes Starfruit to School. Jane Lives in Australia and Takes an Apple to School. Why Do People in Different Parts of the World Eat Different Fruits and Vegetables?	n	%
(a) Because Farah likes star fruits and Jane likes apples	255	10.7
(b) Because some fruits and vegetables grow better in certain areas of the world	**1887**	**78.9**
(c) Because their school tells them what fruit they can bring	44	1.8
(d) I don't know/blank	206	8.6

4. Discussion

This paper reports on Australian primary school students' (Grades 4–6) knowledge of the agricultural industry. Overall, the knowledge of aspects of the industry was moderate (mean = 8.7 out of 13; SD = 2.1), though some students lack knowledge of several key areas. These will be discussed in further detail below.

Regarding the knowledge of farm products, understanding varied for plant- or animal-derived products. For example, while over half of primary students, recognised that cotton comes from plants, a large number believed that cotton is derived from animals or a combination of plants and animals (Table 1). Similarly, under half of primary students correctly identified that cheese, apples, and bread all come from a farm (Table 2), with a greater proportion identifying the cheese product, either in isolation (15.6%) or in combination with a plant-product (16.7%), compared to bread (3.4% in isolation, 6.2% in combination with the apple). In contrast, almost all students correctly identified the source of beef, bacon and wool as animal-derived products (Table 3). Of note, while identification of bread and cotton was lower, most students were able to identify that apples (75.6% in total; Table 2), and oranges (97.9%; Table 3) are produced on farms, with the discrepancy between the two fruits likely to reflect the survey questions themselves and the possibility that students could simply not select apple in the first instance, while they had to match the orange to the tree in the second, potentially by a process of elimination. Nevertheless, these findings suggest that students are more proficient in identifying animal-derived products compared to plant-derived products, especially when the plant product has undergone substantial processing from the farm product itself (i.e., cotton plant to produce cotton socks, and grain to produce bread).

In research conducted by Hillman and Buckley [21], over 60% of Australian Grade 6 students could recognise that natural fibres come from both plants and animals. However, when asked about specific products, only 25% of Grade 6 students correctly identified cotton socks as a plant product, compared to 95% that correctly identified a woollen rug as an animal product. In a similar question regarding product origins, 99% and 92% of Grade 6 students correctly identified that wool and cotton were 'grown' rather than 'made', with a smaller proportion also identifying cooking oil (63%) and cardboard (15%). Again, the results of Hillman and Buckley [21] are similar to the current research, suggesting that students are more familiar with animal-based products (i.e., wool) than plant-based products (i.e., cotton), particularly if the product has undergone higher levels of processing (i.e., bread, cooking oil, and cardboard). The results may also reflect increased knowledge of food products compared to fibre, potentially due to learning outcomes from other educational programs such as Healthy Harold, which introduce students to concepts such as healthy eating [23].

Students reported moderate levels of understanding of farm animal production systems. While most were able to identify that not all farm animals are kept in cages, almost half of the surveyed students were unsure if chickens are given hormones to grow (Table 4). The administration of hormones in the Australian poultry industry has been banned for over 60 years [24]. However, this uncertainty of students is representative of the misconception that chickens are routinely fed hormones to increase their muscle production. In research by Umberger and Malek [25], 40% of Australian adult consumers still believe that hormones can be used in poultry production. Although the Australian Chicken Meat Federation has attempted to dispel this belief [24,25], it remains widely accepted, partially due to misleading product marketing such as the common promotion of "no added hormones" (e.g., Lilydale Free Range, Steggles, Woolworths Macro). This suggests a wider problem for the industry and the need for continued consumer education, not just at a school level, but for adult consumers as well.

For a similar question regarding farm animal production systems, almost four in five students reported that commercial milking of dairy cattle occurs by hand (Table 5), including 14.2% that believe this was the only method of milking used. The dairy industry is one of the greatest adopters of agricultural technologies [26]. 'Technology and data-enabled dairy farms' is one of seven strategic priorities for Dairy Australia for 2025, with a goal of "greater use of high-value technology on farm [and] connected dairy production systems utilising multiple data sources to enhance decision making" [27]. Digital agriculture is also revolutionising other parts of the sector, including improved innovations for monitoring and management of animals [28], and automation of various cropping processes [29]. Yet, the finding of the current study suggests this 'modernising' of agriculture is not being adequately portrayed to Australian primary students. This was further supported when asked about new agricultural technologies (Table 6), with over half of the students, and almost one-third of the students identifying 'cattle yards' and 'taps and hoses' as new technologies, respectively.

In previous research by YouthInsight Australia [30], secondary and early university students' perceived agriculture as "hard manual labour" and "practical and hands-on". This perception was said to be impacted by the representation of farming in popular culture, rather than through personal experience with agriculture. This finding, and the results of the current study, may reflect limitations in common school-based agricultural activities, including school vegetable gardens, farm visits or attending local agricultural shows [21]. Except for perhaps the farm visit, these activities are generally on a small scale or used for demonstration and are unlikely to reflect real examples of farm life. It may also be reflective of a general lack of agricultural technology taught in the classroom [31]. This may lead to potentially negative consequences for the industry later, with research finding that a limited understanding of the scope of possible industry careers can impact students' decisions to pursue further study in this area [32,33].

One final aspect of primary student knowledge that was relatively high was the reasons why different fruits and vegetables are consumed in different parts of the world (Table 7). A similar question is asked in the LMALI, where students are required to identify that language does not impact cultural food selection, but rather different religions, holidays, climates or soil types [20]. In that instrument, the selection of the correct answer is thought to reflect 'literacy' (compared to a lower proficiency level of 'exposure' [19]) regarding the NALO theme of 'Culture, Society, Economy and Geography' [18]. Outcomes in this theme are considered relative to social studies; one of three academic content areas aligned with the NALOs: science, social studies and health. NALO themes are also identified as 'cross-disciplinary' and said to encourage content integration with other subject areas [18]. Thus, while in the current research the apparent knowledge in this area is positive, it does not necessarily indicate knowledge of agriculture per se, but could also be the result of related learning in subjects such as geography or cultural studies. The result could also reflect out-of-school learning, for example, through exposure to other cultures on an international holiday. Nevertheless, regardless of how these students are introduced to this concept, cross-discipline learning is thought to facilitate long-term understanding [18], which is overall encouraging for student agricultural knowledge development.

Limitations and Future Research

One limitation of this research is the potential impact of student selection by principals or teachers and the assumption that the selected students have adequate literacy to comprehend the survey. According to the 2021 National Literacy and Numeracy report [34], approximately 5% of Grade 5 students across the country have reading comprehension that is below the national minimum standard. This varies by many factors, including state to state (31.5% in the Northern Territory to 3.7% in the Australian Capital Territory) and location (47.4% in very remote areas to 3.8% in major cities). A similar result was also reported for writing, with almost 7% of students below the national minimum standard. Though the current survey was trialled with students of different abilities and ages, it is possible that some students were unable to comprehend all questions, e.g., understanding the word 'hormone' when asked about chicken production. Conversely, it is also possible that principals or teachers selected students of higher reading and writing comprehension to complete the survey. The impact of student literacy was potentially mitigated by the inclusion of the 'I don't know' option throughout the survey, although minimal selection of this response was evident. Further consideration of this is required in future research, including, for example, the random selection of student participants to ameliorate this issue.

A further limitation of this research is that it only explores the agricultural knowledge of primary-aged students, with no further discussion of whether this level of knowledge is sufficient for the age of the students surveyed. Unlike the United States, Australia does not have a formal framework for the assessment of agricultural literacy. This makes benchmarking and knowledge assessment difficult. In contrast, the NALOs provide a prescriptive list of outcomes that "an agriculturally literate person should know and be able to communicate about agriculture at the end of a grade level band (K-2, 3-5, 6-8, 9-12)" [18]. The assessment of these is facilitated by the use of purpose-made instruments, such as the LMALI, for the assessment of primary-aged students' (Grade K-5) agricultural literacy [19,20]. Until a formal framework has been developed for Australian students, formal assessment and benchmarking will not be possible. In the meantime, the use of existing frameworks and accompanying instruments such as the NALOs and LMALI could be a valid substitute. Future research should be conducted in this area to determine if the level of agricultural literacy of Australian students is appropriate for their year level. In combination with the results in the current study, this could be used to identify potential areas of improvement, either through formalised curriculum changes or professional development support of teachers. Resource development is recommended to be as industry relevant as possible [35], with a broad aim to benefit the industry, either through the general knowledge development of future consumers or the attraction of future workers in to the industry. Additionally, these findings can be used to evaluate existing educational programs running through industry bodies, agricultural shows, etc., and to measure the impact of these programs on students' knowledge of agricultural concepts, not just engagement.

5. Conclusions

Education is key to ensuring future consumers; today's students, can make the best decisions regarding animal welfare, environmental sustainability, and healthy food choices. This research has explored the current levels of agricultural knowledge among Australian primary-aged students. Overall knowledge levels were moderate, though some aspects of education, including farm-product origins and agricultural technologies can be improved. This research has provided a strong understanding of the current agricultural knowledge of Australian primary students and potential areas of improvement. These findings should be used by Government agencies to help improve formal curriculum programs and develop formal assessment frameworks that allow benchmarking student knowledge. Industry, educators, and schools can also use these findings to improve current professional development opportunities for teachers to support improved agricultural education. This will in turn ensure that next-generation consumers are best placed to support the industry in the future.

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