

Agricultural Literacy of First-Year Agriculture University Students in Australia: A Case Study of a Piloted Standardised Assessment

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Abstract

This article explores the level of agricultural literacy of first-year university students undertaking agriculture-related degrees in Australia. First-year university students undertaking their first degree in Agriculture, Agribusiness/Agricultural Economics, Animal Science, Environmental Science or general Science Australia-wide were asked to complete an online survey in 2023 to assess their level of agricultural literacy. This survey is based on the Judd-Murray Agricultural Literacy Instrument (JMALI). In the absence of a relevant Australian framework, JMALI was used as a validated instrument to measure agricultural literacy with slight modifications of the survey questions made to suit the Australian context. The results of the survey were explored through descriptive statistics to determine the frequency of responses and demographically characterise the respondents. Further analysis was conducted to explore the association between having studied agriculture in high school and the level of agricultural literacy. Only half of first-year university students studying an agriculture-related degree demonstrated a high level of agricultural literacy (score over 79.7% of the maximum score). Studying agriculture in high school had no effect on agricultural literacy. More generally, the results identified the need to reinforce and deepen the knowledge of technological, sustainability, market and economic aspects of the agricultural industry for those entering agriculture-related degrees.

Keywords: knowledge, literacy, education, tertiary students, agricultural

Introduction

The agricultural industry is a key driver of the Australian economy (ABARES (2024). However, there is a growing concern that school students do not have an understanding of the importance of agriculture in Australia (Cosby, Manning, Power et al., 2022) which has the potential to impact the supply of qualified labour and increase current workforce shortages in agriculture (Donca, 2018; Pratley et al., 2022). Working in agriculture not only involves roles on farms, but also includes all activities related to primary production, agricultural support, sales and marketing, processing, and distribution (Bassett et al., 2022; Capel, 2024). With a rise in agri-tech tools and utilisation (Rose et al., 2021), training and the development of technology related skills are essential. To enable students to enter the agricultural workforce, it is crucial that they are introduced to data science principles in high school (Manning et al., 2023) with GPS Cows an example of a pilot program (Cosby et al., 2019) proven to be successful in contributing to the development of agri-tech knowledge and skills for the future generation of the Australian agricultural workforce. Furthermore, the knowledge required to ensure students are aware of the diversity of jobs in agriculture comes from various sources,

both informal and formal. Informal avenues include family members or neighbours, where the knowledge transferred is direct. However, it is anticipated that this method will decline over time due to the lower participation of young generations in family enterprises (Wójcik et al., 2019). Additionally, in Australia the number of broadacre and dairy farms has decreased by 33%, which implies a reduction in the total population in the rural area (ABARES, 2025). Although children raised on farms might be the future agricultural workforce, acquiring formal knowledge through further training and education will become increasingly important if rural population decline continues. In Australia, implementation of the formal school curriculum depends on states and territories. For example, agriculture is only compulsory in New South Wales (NSW), as part of the Technology Mandatory subject in high schools (Manning et al., 2023). To reduce the gap between workforce supply and demand in the agricultural sector, formal education and training are key for new generations with limited connection to agriculture who often have less exposure to informal avenues of agricultural education career development. In addition to technical skills, the industry also demands employability skills such as effective time management, flexibility, effective communication, innovation, and initiative among diverse professionals (Hume et al., 2024).

Today's students are also tomorrow's consumers, and improving levels of knowledge about the agricultural industry influences attitudes, purchasing choices (Wierzbiński et al., 2021) and eating habits (Nanayakkara et al., 2017). The social license of animal involvement in agriculture is an ongoing consumer concern, with significant impacts for sectors such as the shutting down of the live export of sheep when societal expectations are not met (Hampton et al., 2020). A thorough understanding of how food is produced (Kuźniar et al., 2021), education and engagement will assist with the social expectations and acceptance of agriculture by young people (Martin & Williams, 2011).

A previous Australian study captured the level of agricultural knowledge acquired by high school students (Manning et al., 2024). Whilst students could easily identify traditional agricultural occupations, such as farming, they could not identify other professions within the agricultural sector (e.g., journalist or researcher). This reinforced that students were not only unable to identify the diversity of careers in agriculture, but were often unaware of the emergence and roles of technology in the agricultural industry (Deloitte Access Economics, 2016). The emergence of these roles has led to more high-paying roles that require technical skills (Azarias et al., 2020). Agricultural technology (agri-tech) offers a solution to address critical challenges, such as environmental sustainability and food security (Ingram & Maye, 2020), however, without a skilled workforce the true value of technology will not be realised. Successfully transforming technology use into transferrable knowledge relies on the end user having the required skills and competencies (Devitt, 2021). To facilitate the transition of new entrants into the agricultural workforce, including the development of essential skills and awareness of current and emerging roles in the sector, commonly starts in formal education environments (Manning et al., 2022). Therefore, educators are crucial to transferring the skills required and fostering paths that continue onto training or formal study opportunities in agriculture (Norris et al., 2024; Weeks et al., 2020). However, this relies on educators having the required agricultural knowledge and skills. Cosby, Manning, Fogarty, McDonald, et al. (2022) found that childhood location, current school location, and having a formal qualification in agriculture influence a teacher's connection to agriculture. School location was also found to have a significant impact on students' knowledge scores, with those from inner regional locations achieving higher scores (Cosby, Manning, Fogarty, Snowden, et al., 2022). Furthermore, teacher perception of agriculture was associated with the identification of job opportunities and the propensity to encourage an agricultural career (Cosby, Manning, Fogarty,

McDonald, et al., 2022). Therefore, the level of agricultural knowledge, location and background of teachers are potentially limiting factors when educating students about careers in the agricultural industry.

The lack of specific agricultural subjects in high schools and the limited availability of teachers qualified in agriculture is prevalent in Australia (Cosby, Manning, Fogarty, McDonald, et al., 2022). It is unreasonable to assume that educators can effectively use a resource in teaching agriculture without sufficient guidance, support or professional development (DiBenedetto et al., 2018). Teachers and career advisors need the opportunity to participate in professional development sessions (Cosby et al., 2024; Smalley et al., 2024) and to be offered a variety of ways to integrate agriculture into the classroom (Cosby, Manning, Power, et al., 2022).

In a systematic review of agricultural literacy in the United States from 1988 to 2011, Kovar and Ball (2013, p. 9) concluded that while educational programs can increase agricultural literacy, “many populations were still agriculturally illiterate”. Building on these findings, Cosby, Manning, Power, et al. (2022, p. 10) conducted an updated review, noting 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”. Australian school students are introduced to agriculture at different stages of their education, but studying the subject of agriculture is not mandatory. Whilst a system exists for the Australian tertiary sector (Botwright Acuña et al., 2014), Australia lacks a formal framework for the assessment of agricultural literacy. This makes assessment and benchmarking of student agricultural knowledge difficult and highlights a major gap in the Australian agricultural education system. This is in contrast to the United States, where the National Agricultural Literacy Outcomes (NALOs) detail the expected development of agricultural knowledge for each school grade (Spielmaker & Leising, 2013). Since the NALOs conception, various instruments have been developed to assess student knowledge, including the Judd-Murray Agricultural Literacy Instrument (JMALI) (Judd-Murray M. Rose, 2019; Longhurst et al., 2020), which is used to assess secondary education students’ understanding of the NALOs. A descriptive summary of how this instrument has been used can be found in Whitaker (2024), with this tool assisting educators in measuring students' agricultural literacy knowledge and improving their assessment determination. One of the most valuable characteristics of this instrument is that it provides real-time formative and summative information associated with demographic variables, which allows for continuous improvements in the planning and delivery of agricultural literacy content across the education continuum. With no formal framework to assess agricultural literacy, it is unknown if students entering into further education have the required background agricultural knowledge. Additionally, students from metropolitan areas who may not have grown up connected to agriculture rely on minimal foundational consumer-use knowledge.

This study explored whether there was a difference in agricultural literacy between students who have and have not studied agriculture in high school among first year university students enrolled in agriculture and related degrees in Australia. To achieve the proposed objective, this study tests the following hypotheses: (1) studying agriculture in high school impacts agricultural literacy at the university level; (2) the median and distribution of agricultural knowledge scores differ between categories of agricultural study in high school (No, Yes, Only as part of a mandatory subject).

Methodology

An online assessment was used to explore the agricultural literacy of first-year students enrolled in university degrees related to agriculture in Australia. The assessment was made using the United States Judd-Murray Agricultural Literacy Instruments (JMALI) adjusted to an Australian content. Modifications to the assessment included a change in terminology (e.g., 'river' versus 'stream'), Australian/British spelling and framing within the Australian context (e.g., Australian legislation). This is the first known application of an instrument of this kind in Australia. The online assessment was hosted in survey platform Qualtrics and distributed through social media and direct email to course co-ordinators of relevant agriculture, agribusiness, agricultural economics, animal science, environmental science or general science degrees at Australian universities. The assessment was targeted anonymously to only first-year students enrolled in their first degree associated with agriculture. The assessment was approved by the CQUniversity Australia Human Research Ethics Committee (approval number 23858).

Assessment Instrument

The assessment comprised two sections. The first section presented 12 demographic questions to characterise the sample population (e.g., age, gender, university, degree name, current and childhood location, and whether students were working in the agricultural sector). Two additional questions were aimed at addressing the research objective. The first question explored whether participants studied agriculture during their high school education in three possible categories (i.e., Yes, No and Only as part of a compulsory subject). The second question explored participant self-efficacy of their knowledge of the agricultural industry (i.e., Not at all knowledgeable to Extremely knowledgeable).

The second section presented 25 knowledge questions (Table 1) in areas such as sustainability, quality control, production systems, animal welfare, environment, climate change, crops, technology, precision agriculture, consumer choices, food labels, distribution and price of food, and food supply. As JMALI is a validated instrument (Judd-Murray et al., 2024), the questions were not modified except for adaptations to the Australian context. The assessment used different types of questions: simple and multiple-choice, true/false, drag and drop, and match sentences.

Data Analysis

The results of the assessments were explored through descriptive statistics to determine the frequency of responses and to demographically characterise the respondents. The answers to the questions were analysed with two different approaches. First, independent responses were considered, and the performance per question was assessed across all students. Second, a final score per student was estimated by integrating their responses to all the questions present in the knowledge section of the questionnaire.

Performance by question.

To explore the association between having studied agriculture in high school and the accuracy of the response obtained for each question, the statistical significance between the association of categorical variables, Chi-Square Tests (Fisher's exact test) was used. The hypothesis being tested (H_0) was that studying agriculture in high school was independent of how each question (Q_i , $i = 1-25$) was answered. In each case to be analysed, the frequency of correct answers was quantified for each question. The number of correct answers varied depending on the nature of the question (i.e., multiple choice, drag and drop, or a true/false option). There was no penalty for selecting incorrect answers or for not answering the question. The responses obtained were

classified into a) Correct: all correct answers selected; b) Partially: at least one correct answer selected; and c) Incorrect: no correct answer selected. After counting, the proportions (%) of correct, partially correct, and incorrect answers were estimated without considering missing data.

Performance by student.

The final knowledge score was obtained by the summation of all the correct questions answered assigned a value of 1 (one). For example, the correct answer in a true or false question receives a score of one. However, for multiple choice questions, each correct answer received a score of one (questions with three possible correct answers result in a score of three if the student answers all correctly). No scores were deducted for wrong answers. The maximum final knowledge score eligible was 64, with a higher number representing a higher agricultural literacy score. Prior to answering the survey, students were not informed how a score would be estimated from their answers. To analyse the medians and the distribution of the final knowledge scores obtained (continuous variable with non-normal distribution; $p < .001$, Shapiro Test) comparing whether or not agriculture was studied in high school, a non-parametric Kruskal-Wallis test was used (Corder & Foreman, 2014). The hypotheses being tested (H_0) were: The median and distribution of the final knowledge score are the same across categories of studied agriculture at high school. Additionally, Spearman's non-parametric correlation was performed to analyse the correlation between the final knowledge score and student self-efficacy of their knowledge of the agricultural industry (as a continuous variable). All data were summarised using Microsoft® Excel® (Version 2311) and statistical analyses were performed using IBM SPSS Statistics (Version 28.0.0.0 (190)) with a significance level of $\alpha = .05$.

Results and Discussion

The survey was answered by 88 students between March and June 2023. 96.6% of the students eligible to complete the survey were studying in their first year of university in degrees related to agriculture. Responses were received from students across Australia including Queensland, New South Wales, Victoria, Western Australia, and Tasmania.

Of the 88 students, 76 answered the first section (demographic questions), comprising 60.53% female, 35.5% male, 2.63% non-binary/third gender and 1.32% preferring not to say. The majority of students were between 18 and 20 years old (62.3%), followed by 21 and 25 years old (26.23%). The most frequent university degrees students were enrolled in were Agriculture or Agricultural Science (64.47%) followed by Agribusiness or Agricultural Economics (17.11%) (Figure 1). Responses to the survey were from students studying at 13 different universities.

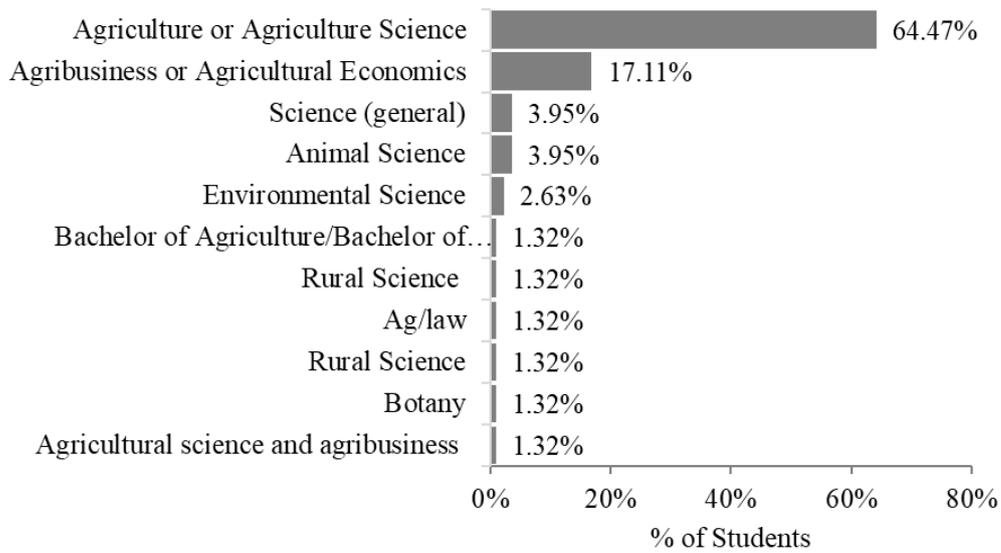


Figure 1. The distribution of students based upon the degree enrolled into.

Students were asked about their childhood and current location, with the largest growing up in remote areas (small rural towns; 42.11%). This reduced to 23.68% when students commenced the first year of their degree (current location). Conversely, 30.26% of students spent their childhood in a regional area (large town), with this proportion increasing to 46.05% when considering their current location. Less variation (2.63%) was found in the proportion of students who lived in metropolitan areas during their childhood relative to where they lived currently (Figure 2). In the first year of their degree, 38.16% of respondents work in the agricultural industry. Figure 4 shows the frequency of student visits to farms, with the majority visiting a farm multiple times a year (38.16%) or living on a farm (35.53%).

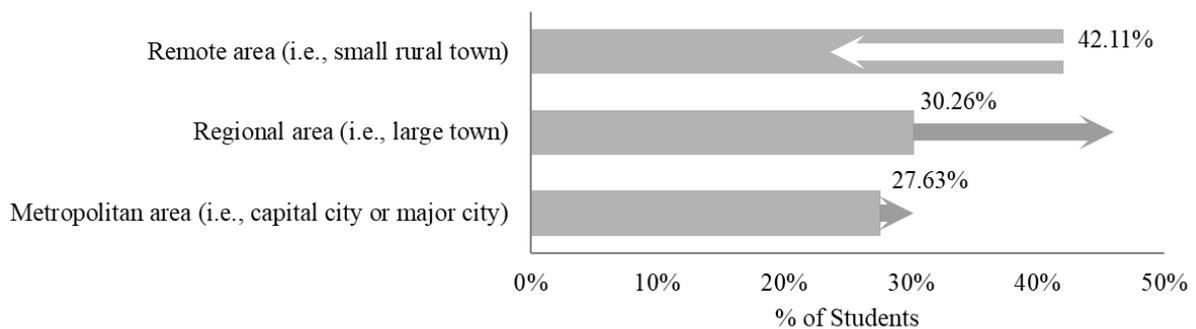


Figure 2. Childhood and current location based on regionality.

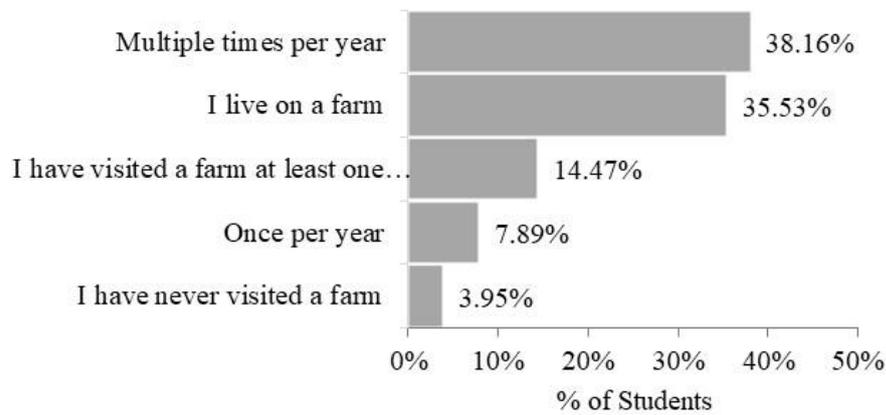


Figure 3. Frequency of how often students visit/ed a farm

Half of the students (50%) did not study agriculture during their high school education. A smaller proportion (36.8%) studied agriculture, and 13.16% had only been exposed to agriculture as part of a compulsory subject. Students reported an average slightly or moderately self-efficacy in their agricultural industry knowledge, with an average level of 4.99 and standard deviation of 2.36 (0 = not at all knowledgeable, 10 = extremely knowledgeable, Figure 4). Approximately 34.5% of the students considered that they have a moderate knowledge of agriculture. This value is lower than Gehrs (2019), who reported that 50% of the students surveyed had an average knowledge of agriculture using an assessment developed by Pense and Leising (2004). However, these were from the United States and from a variety of colleges that were not all associated with agriculture.

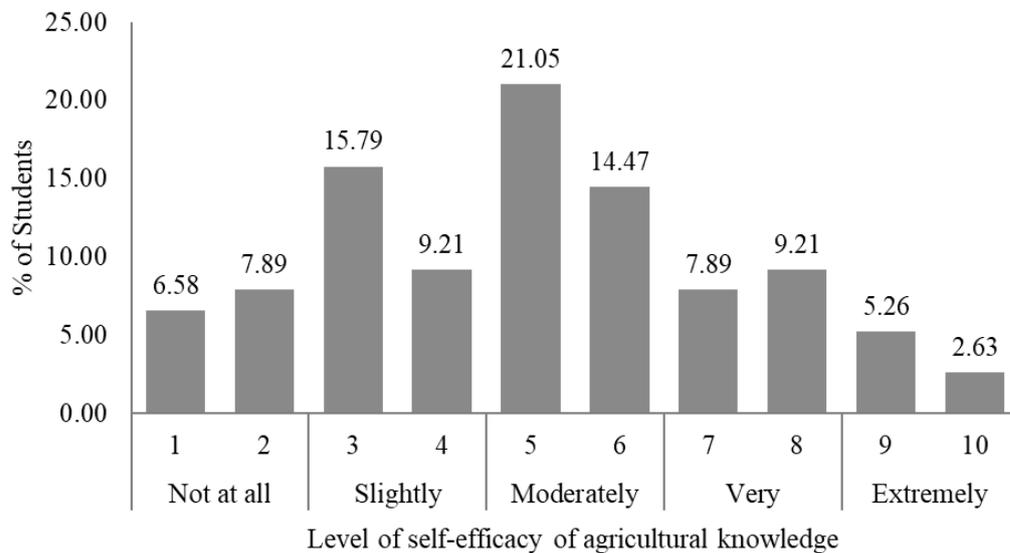


Figure 4. Student self-efficacy of their knowledge of the agricultural industry.

Results by Questions

Only 58% of students responded to survey questions related to knowledge in agriculture. The average results across the assessment were 63.79%, 32.82% and 4.7% for answers categorised as completely correct, partially correct and completely wrong, respectively. This could represent that despite there being no effect on whether having studied agriculture in high school, in general, the performance per question is positive (Figure 5). However, caution is

needed when interpreting these data given the smaller sample size for a relatively large cohort (first-year students studying agriculture-related courses across Australia) and the potential bias in the results.

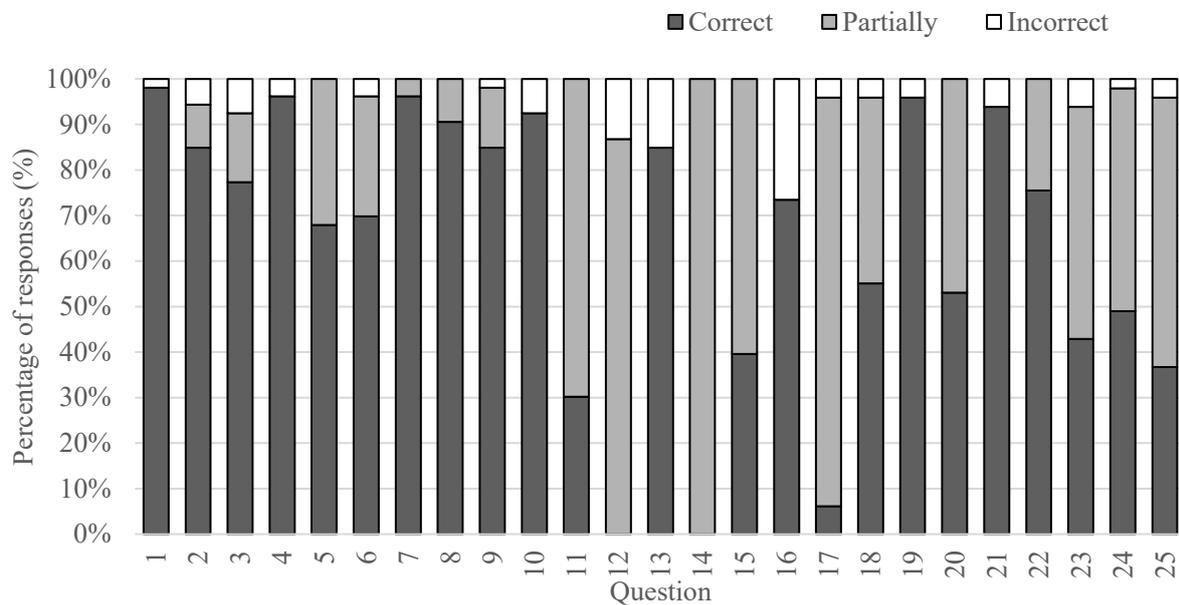


Figure 5. Summary of the proportion of correct, partially correct and incorrect answers integrating all students per question.

The highest rate of incorrect answers was observed when 26.53% of the students selected as true the statement 'there are few incentives for farmers to protect the environment and natural resources' (Q's 16, Table 1, Figure 5). This could be explained by the increase in social expectations and demands regarding care for the environment and food production conditions (Hampton et al., 2020; Martin & Williams, 2011). The proportion of incorrect answers was followed by 15.09% and 13.21% when students selected as false the statement 'The geographic location of your food source plays a part in determining the price of the food' (Q's 13, Table 1, Figure 5 and 'wildlife levels' or 'animal stocking rates' answering which of the following practices is benefitted by using precision agriculture (Q's 12, Table 1, Figure 5), respectively. This aligns with what was published by Cosby, Manning, Fogarty, Snowden, et al. (2022), who mentioned that many students still did not recognise the technologies that are used on farms. Then, 7.55% of the students incorrectly chose 'false' when asked to determine whether the statement was true: 'An adequate global food supply is dependent upon the continued development and appropriate use of science, technology, and engineering'. Also, 7.55% of the students selected incorrect examples of sustainable agricultural practices (Q's 10 and 3, Table 1, Figure 5). This reinforces the importance of developing learning opportunities related to technological skills to ensure future agricultural workforce capabilities using data and technology to improve sustainability, productivity (Cosby, Fogarty, et al., 2022) and social benefits (Rose et al., 2021). Finally, 6.12% of the students selected incorrect answers related to laws of supply and demand and climate change (Q's 21 and 23, Table 1, Figure 5), identifying the need to reinforce and deepen the knowledge of technological, sustainability, market, and economic aspects of agriculture.

Table 1 presents the association between studying agriculture in high school and each of the 25 knowledge questions (JMALI instrument). Only six knowledge questions had a significant association with studying agriculture in high school. This could be due to the small sample and

the heterogeneity of the students surveyed. Students come from different educational backgrounds and are currently studying in different career programs related to agriculture.

Table 1. Association between having studied agriculture in high school and each of the 25 knowledge questions Q's (JMALI instrument).

Q's	Modified JMALI instrument	n	Fisher Value	Exact Sig (2-sided)
1	Determine if the statement is true or false: Sustainable agriculture is the practice of producing food, fibre and fuel in a way that is profitable to the producer, supports quality of life and protects natural resources	53	2.043	.509
2	Drag and drop the natural resource into the box with the corresponding sustainability practice.	53	10.498	.007*
3	Select all examples of sustainable agricultural practices.	53	9.036	.027*
4	Determine if the statement is true or false: The inspection of meat and poultry for quality control purposes is mandatory in Australia.	53	3.053	.131
5	Match the name of the production system with its appropriate description.	53	4.122	.139
6	Farmers must abide by state and territory animal welfare laws. Select all the laws that must be observed in Australia.	53	8.121	.045*
7	Interpret the information given on this food label. Match the correct answer with the correct description.	53	3.053	.131
8	Select all the processed foods.	53	1.352	.552
9	Select all the marketing terms that are used to influence consumer choices.	53	7.841	.043*
10	Determine if the statement is true or false: An adequate global food supply is dependent upon the continued development and appropriate use of science, technology, and engineering.	53	.897	.810
11	Select all the following technologies that are frequently used in agricultural production systems.	53	4.396	.108
12	Which of the following practices is benefitted using precision agriculture?	53	.413	.867
13	Determine if the statement is true or false: The geographic location of your food source plays a part in determining the price of the food.	53	2.878	.216
14	Select all factors that affect a country's production and distribution of food.	53	-NA	-NA
15	Select all the following jobs related to agriculture?	53	3.531	.176
16	Determine if a statement is true or false: There are few incentives for agriculturists to protect the environment and natural resources	49	4.324	.109
17	Select all the following management practices used by agriculturalists to promote environmental conservation	49	3.994	.387
18	Select all the examples of organic nutrients	49	15.509	<.001*
19	Determine if the statement is true or false: Agriculture allowed humans a way to have a reliable and consistent food source	49	.651	1.000
20	Select all the food labels that indicate the style of production used on the farm that produced the item	49	3.203	.242
21	Select the option that best completes both blank spaces in the statement. Following laws of supply and demand, as consumers buy ____ of a select product, farmers produce ____ of the product in demand	49	.991	.739
22	Determine if the statement is true or false: All types of scientific discoveries and applications of technology are accepted by consumers if they increase food production	49	7.467	.021*
23	Select all the following ways farmers will be affected by climate change	49	4.211	.361
24	A farmer has 50 acres of land to grow a crop, which factors would need to be considered before making a choice about what to plant? Select all the correct choices	49	2.405	.817
25	Select all the positive impacts of trade agreements on the Australian food supply	49	2.919	.646

*P value < .05. NA: No statistics are computed because the answer was a constant (100% of the answer was Partial).

Results by Students

The final agricultural literacy score, indicated by the median value highlighted that half of the students obtained a score greater than 79.7% of the maximum score (Figure 6). The final score was not impacted by students who did and did not complete agriculture during high school ($p = .136$). However, there was a significant difference in the distribution of the final score ($p =$

.032; Table 2, Figure 6). This could indicate the heterogeneity and effectiveness of the agricultural education received prior to university study. Students were not penalised for incorrect answers, so the agricultural literacy level could be overestimated. Even so, the literacy values obtained in this study are higher than those obtained in studies from the U.S. For example, Dale et al. (2017) stated that the mean score was 56% in a study on agricultural literacy at a U.S. land-grant university and Gehrs (2019) reported similar results (79%) at the College of Agricultural Sciences at Southern Illinois University through a criterion-referenced test (Pense & Leising, 2004).

Table 2. Effect of studying agriculture in high school on the total score result

Null Hypothesis Tested	Test	Sig. ^a
The medians of Total Score are the same across categories of Did you study agriculture at high school?	Independent-Samples Median Test	.136
The distribution of Total Score is the same across categories of Did you study agriculture at high school?	Independent-Samples Kruskal-Wallis Test	.032*

*P value < .05

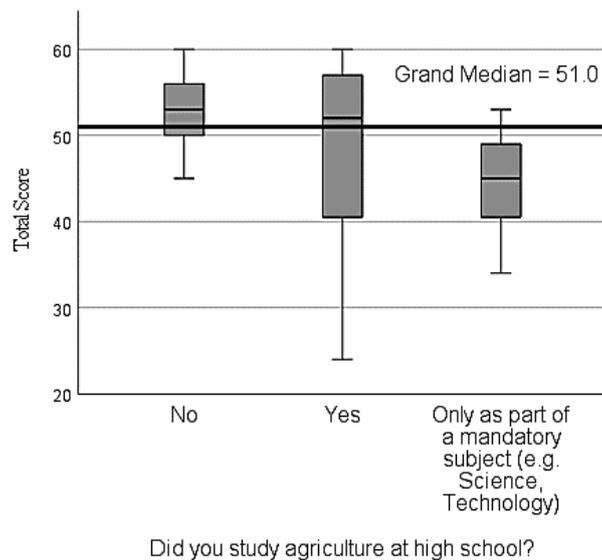


Figure 6. Distribution of the Total Score based on whether students studied agriculture at high school.

There was no association ($p = .787$) between the final score and the level of agricultural knowledge self-perceived by students (Figure 7). This implies that students who consider that they have a high level of knowledge do not necessarily perform well as measured by total score with the instrument used in this study. This aligns with the results reported by Porter (2013), which suggest that students' responses to questions about how much they have learned are largely unrelated to actual learning progress. This could indicate a discrepancy between the agricultural literacy received formally in high school or informally regarding the questions asked through the survey. However, the perception of knowledge varies depending on the person, the vision of the world around them and the context in which they grew up (Cosby, Manning, Fogarty, McDonald, et al., 2022).

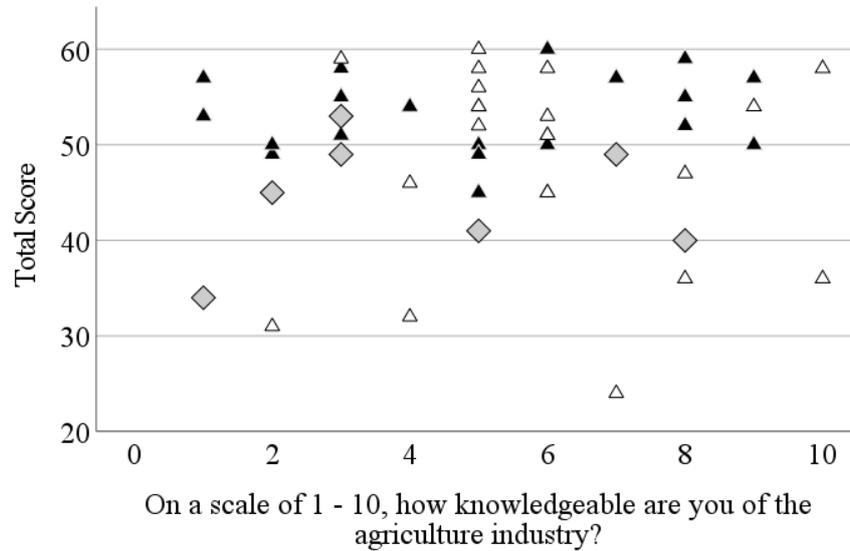


Figure 7. Scatter plot of the Total Score and student self-efficacy of their knowledge of the agricultural industry. Legend: Did you study agriculture at high school? No (▲); Yes (△); Only as a part of a mandatory subject (◇).

Although there were no statistically significant interactions between the frequency of farm visits (Figure 3) and the final score ($p = .524$), a trend can be seen where students who have never visited a farm obtained a lower final score. However, there was a significant impact on agricultural knowledge scores based on farm exposure previously (Cosby, Manning, Fogarty, McDonald, et al., 2022). For instance, in a study that involved students from primary and high school in Australia, students who never visited a farm reported lower final agricultural knowledge scores (Cosby, Manning, Lovrick, et al., 2022). Therefore, this highlights the need to conduct agricultural literacy research inside and outside of the agricultural education field (Hancock et al., 2024; Kovar & Ball, 2013).

Limitations

The results of this study were limited to students who had access to the internet and were able to complete the survey online. Furthermore, the scope of the demographic was limited by course coordinators and universities sharing with their students. Therefore, it should not be generalised to all students of agriculture-related degrees in Australia. The sample size that allows for robust conclusions was not previously evaluated, since it was a pilot test. This is the first study where the JMALI instrument has been implemented in Australia and provides data on the agriculture knowledge literacy level for the observed sample. Future research is necessary to reach a reliable estimate with a high completion rate by university students. Teachers could also complete the instrument to analyse if teachers have the required baseline level.

Conclusion

Agricultural literacy is important for future education, workforce, and economic development. The lack of compulsory agricultural subjects in schools, the limited availability of qualified teachers, and the lack of a framework to assess agricultural literacy are concerns for the future growth and development of the Australian agricultural sector and supply of agricultural

workforce. The modified JMALI instrument demonstrated that 50% of first-year university students studying an agriculture-related degree demonstrated a high level of agricultural literacy. The results suggest studying agriculture in high school did not guarantee greater literacy with only relevance for some knowledge questions. Interestingly, students who considered themselves to have a high perception of knowledge did not necessarily have a high total score. In addition, there was a trend where students who had never visited a farm received a lower final score. From the results, it emerges that reinforcement would be needed in terms of knowledge of technological aspects, sustainability and economics. The development of a formal assessment framework for all year levels across the Australian education continuum is recommended, allowing for benchmarking and evaluation.

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