Australian and International Journal of

Rural Education

Do Teacher Workshops as a Professional Development Activity Provide the Adequate Skills, Knowledge and Confidence to Deliver the GPS Cows NSW Stage 4 Technology Mandatory Module?

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Abstract

The GPS Cows Module is a co-developed, Australian resource that aims to increase the knowledge and skills of high school students in emerging agricultural technologies. It aligns with many outcomes in the New South Wales (NSW) Stage 4 Technology Mandatory Syllabus, a compulsory subject for Stage 4 students (Years 7–8), that engages students in production and design activities for agriculture, food and other technologies. GPS Cows is a complete resource that teachers can apply into their teaching program. To facilitate the knowledge, skills and confidence required to implement the module, a one-day workshop was offered to NSW teachers in 2018 and 2019. To evaluate the workshop, participants completed a survey containing open- and closed-ended questions. Additionally, classroom clickers were used throughout the workshop to gauge the development of skills, knowledge and confidence over time. Overall, the workshop was well received, with over 98% of respondents enjoying the workshop and 97% indicating that the workshop was a good use of time. Positive aspects included the activities and engagement with data analytics, the resources provided, and the clear link between agricultural technologies and the real world. Identified improvements included the time allotted for workshop activities and minor changes to the resource. In conclusion, the professional development workshops enabled teachers to successfully implement GPS Cows in their teaching program.

Keywords: *agricultural technologies, agri-tech education, digital technologies, high school teachers, professional development, teacher workshops*

Introduction

The GPS Cows Module (also referred to as GPS Cows) is a collaborative resource, developed in New South Wales (NSW), Australia, that aims to increase the "*knowledge and skills of high school students in emerging agri-tech, specifically tools and systems which provide animal location and behaviour data*" (GPS Cows, 2020). The module was co-designed by the NSW Department of Education staff and CQUniversity Australia researchers and aligns with many of the outcomes in the New South Wales (NSW) Stage 4 Technology Mandatory (Tech Mandatory) Syllabus (NSW Education Standards Authority [NESA], 2017). NESA has legislative responsibility under the NSW Education Act 1990 for developing syllabuses to be taught in NSW schools. The national Australian Curriculum is incorporated into NSW K–10 syllabuses and is represented through codes and icons within the syllabus documents. The NSW Department of Education is responsible for NSW Government schools and provides support for implementation of the NSW curriculum.

Tech Mandatory was first implemented in NSW Department of Education classrooms in 2019. The subject is compulsory for Stage 4 students (Years 7–8; 12–14 years of age) and engages students in production and design activities covering four major technology contexts: (i) agriculture and food technologies; (ii) digital technologies; (iii) engineered systems; and (iv) material technologies. Delivery of all four contexts is compulsory across Years 7–8, and at least one design project that addresses each of the aforementioned areas must be taught. GPS Cows consists of 10 weeks (25 hours) of content and was developed to provide teachers with a complete module to apply in their Tech Mandatory teaching program, specifically addressing the relevant outcomes of the agriculture and food technologies and digital technologies contexts.

Although the teaching of agriculture and food technologies is a compulsory component of the Technology Mandatory Syllabus (NESA, 2017), a lack of understanding and awareness of agricultural issues, particularly in urban areas, may impact on the quality of education students receive (Dodd, 2011). When coupled with the commonplace activity of out-of-field teaching—a solution used to address the shortage of qualified teachers in a particular subject area (Australian Mathematical Science Institute, 2017)—the quality of education may decline further. In research by Kola and Sunday (2015), teachers' qualifications and subject matter knowledge were positively correlated to student achievement. Similarly, Awal et al. (2012) found that when teachers have a limited knowledge of agriculture, students are not aware of the available job prospects in the sector. To improve teachers' understandings of agriculture, and in turn the quality of agricultural education, the supply and delivery of adequate professional development can be used as a method of increasing teacher exposure to the field (Dodd, 2011) and to build their knowledge and confidence of the subject matter. Professional development for teachers refers to continuing education activities that aim to develop an individual's skills, knowledge, expertise or confidence as a teacher (Organisation for Economic Co-operation and Development, 2009).

The aim of teacher professional development is twofold. Firstly, the program should extend the teachers' knowledge and confidence of a particular subject area. Secondly, the program should refine teaching practice to ensure that efficient student learning can occur (Ko et al., 2006). According to Loucks-Horsley et al. (1998), professional development may be achieved in five broad ways: immersion, curriculum development, curriculum implementation, examining practice, and collaborative work. Professional development by immersion occurs when teachers perform the requisite work under the guidance of a trained professional. GPS Cows is an example of this, with the use of workshops to educate teachers on how to implement the module in the classroom. Curriculum development and curriculum implementation refer to teachers developing new resources for use in the classroom (development) or applying and refining existing resources (implementation). Examining practice refers to the analysis of real classroom instruction. Finally, collaborative work refers to peer coaching and mentoring. In a study of professional development in mathematics and science teachers, Huffman et al. (2003) found that

examining practice and curriculum development were significant predictors of teachers' use of standards-based instruction. Curriculum development was also more likely to result in improved student achievement for mathematics teachers.

In research by Archibald et al. (2011), characteristics of high-quality professional development included an alignment with state assessments, standards and school goals; opportunities for active learning; a focus on core content, including strategies for implementation; opportunities for teacher collaboration; and embedded follow-up and continuous feedback. Alignment between professional development, state assessments and standards and overall school goals is important to ensure teachers receive consistent messaging. This alignment helps to build a shared vocabulary and common goals, while minimising confusion and uncertainty in what and how to teach (Archibald et al., 2011; Desimone, 2009).

Professional development with opportunities for active learning has also been shown to result in greater changes in teacher instructional practice (Desimone, 2009). Active learning generally requires more time for implementation in comparison to traditional passive learning (e.g., lectures, seminars). In addition to a focus on increasing teacher knowledge, effective professional development should model strategies for implementation into the classroom. For example, in a study of mathematics teachers in California, Cohen and Hill (2000) noted that professional development that included strategies for application resulted in positive changes to teacher practice. Comparatively, teachers who attended workshops that solely focused on knowledge exhibited little change in their teaching practices. Change can be achieved by instructional coaching of how content can be applied in the classroom and examples of how the new knowledge can be incorporated into practice (Archibald et al., 2011). Collaborative learning can also improve the quality of professional development, providing opportunities for discussion of instructional practices and delivery of feedback. Finally, the inclusion of embedded follow-up may be achieved by providing access to collaborative discussion following the implementation of new practices. Coaching is another way to provide this continuous feedback (Archibald et al., 2011).

As previously mentioned, out-of-field teaching is a common solution for addressing teacher shortage in a particular subject area (Australian Mathematical Science Institute, 2017). This may result in teachers with limited subject matter knowledge and can impact on student learning. Out-of-field teaching can also lead to teachers feeling vulnerable and "*out-of-place*" (du Plessis et al., 2014, p. 92). Professional development can ameliorate this, by empowering teachers and bolstering confidence. Focusing on Australian agriculture teachers, it is important that professional development is widely available, particularly for rurally based teachers. In particular, teachers should be given the opportunity to engage in sustained learning through extended courses and programs (Wallace & Boyland, 2007). According to the NESA (2021) website at December 2021, there were no agriculture-specific NESA-accredited courses, delivered by either NESA or by third-parties (including the NSW Department of Education), except for GPS Cows.

Of course, other organisations may deliver professional development courses that are not accredited by NESA. These courses are still considered valuable and may meet NESA's elective professional development criteria (NESA, 2021), such as those delivered by the NSW Department of Primary Industry (e.g., *AgPatch – Garden Connections* and *Climate challenge for NSW teachers*, as described by the NSW Department of Primary Industries, 2021). However, the lack of NESA-accredited courses highlights the need for high quality professional development for those teaching the agriculture and food technologies context in the Stage 4 Technology Mandatory curriculum.

The aim of this paper is to evaluate the one-day face-to-face GPS Cows professional development workshop delivered to NSW teachers in 2018–2019. The research question—Do teachers who participated in the GPS Cows professional development workshop obtain the skills, knowledge,

and confidence required to implement the module into their teaching program?—is addressed. The paper focuses on workshop evaluation only, including the best aspects of the workshop and areas needing improvement. The paper also discusses how the workshop impacts on teacher knowledge, skills and confidence in delivering curriculum outcomes. Evaluation of the GPS Cows Module, including whether it comprises the content required for students to achieve some of the learning outcomes of the NSW Stage 4 Technology Mandatory curriculum, is considered outside the scope of this paper.

Materials and Methods

One-day teacher professional development workshops were held across 16 metropolitan and rural NSW locations during 2018 and 2019. The workshops were open to all NSW secondary teachers from government, independent and Catholic schools. The aim of the workshops was to upskill teachers to support the implementation of the GPS Cows Module into their teaching program. The module was delivered by industry experts in the fields of agricultural education and new and emerging technology, specifically livestock tracking technology. A qualified teacher also co-presented during the workshop and facilitated discussions around implementation, including curriculum links and the barriers to uptake.

At workshop commencement, participants were provided with an overview of GPS Cows and background information on general technology advances in livestock production. This information enabled a baseline understanding of the challenges faced by the agricultural sector and the use of technology to address these issues. Following the general introduction, a video resource introduced participants to a case study farm and current challenges that could be addressed using livestock tracking technology. This was supplemented by a real-life, authentic livestock tracking (GPS) dataset to undertake a few of the activities that form GPS Cows, including using Microsoft Excel and Esri ArcGIS Online (a Geographic Information System software) (Esri, 2021). A summary of the workshop structure and activities is shown in Table 1.

Data Collection and Analysis

Classroom clickers were used throughout the workshop to gauge the skills, knowledge and confidence of participants whilst undertaking the workshop activities. This included questions to gauge the participants' understanding of concepts taught and the ability to complete workshop activities. Following workshop completion, participants were also emailed a survey with open- (n = 4) and close-ended (n = 21) questions, enabling them to evaluate both the workshop and the GPS Cows Module. The open-ended questions also allowed participants to provide feedback on the best aspects of the workshop and what improvements were required, with results presented as thematic analysis. Data from the clickers and survey were anonymous. Responses to each question from the clicker questions and the post-workshop survey were not compulsory and had a mean response rate of 49.6% and 94.5% respectively. All questions were approved by the CQUniversity Australia Human Research Ethics Committee (approval number 21324).

Table 1: ***Overview of the Content and Activities in the GPS Cows Professional Development Workshop***

Topic	Content and activities
GPS Cows Module	Introduction to the module and available resources Relevance to the NSW Stage 4 Technology Mandatory Syllabus Career opportunities in Agriculture
Participant background information	Clicker questions
GPS background information	History of GPS Process of GPS data transmission and communication Application of GPS
Technology advances in livestock production	Agriculture in terms of food and fibre production Comprehension of livestock tracking technology Technological advances in the livestock sector Tracking technologies such as GPS
How to collect your own animal location data	Collecting your own GPS data Case study farm and sample GPS dataset
Analysing and interpreting data in Esri ArcGIS Online	Accessing ArcGIS Online Creating your own groups and student accounts Importing and visualising data Bad data Clicker questions
Using GPS data to make key animal welfare, productivity and profitability decisions	Paddock utilisation Interpreting livestock tracking data and water visitation rates
Analysing and interpreting data Microsoft Excel	Clicker questions Importing and graphing data Correctly using formulas Utilisation of water Temperature data analysis Water visitation and temperature interactions Rainfall data analyses Water visitation and rainfall interactions
Discussion	Importance of livestock tracking technology is important for livestock production, monitoring and welfare Curriculum/Syllabus links discussion

Note: Shaded boxes indicate hands-on opportunities for participants. Non-shaded boxes indicate theoretical presentation of knowledge.

Results

Participant Information

A total of 185 participants attended the 16 workshops held across metropolitan and rural NSW locations in 2018 and 2019. The response rate from the clicker questions was 49.6%. Comparatively, the post-workshop survey had a mean response rate of 94.5%. Most participants identified as female (61.4%; n = 113) and had over 16 years of teaching experience (40.4%; n = 74). Only 2.2% of participants (n = 4) had less than one year of teaching experience. Almost half of the participants worked in schools located in towns of between 5,000 and 49,000 people (49.5%; n = 91). Of the remaining participants, there was an almost even split between those who worked in rural towns of less than 5,000 people (28.3%; n = 52) and those who worked in major or capital cities (22.3%; n = 41). Just over half of the participants currently taught agriculture (56.2%; n = 104).

Workshop Evaluation

The majority of participants indicated that they enjoyed the GPS Cows Stage 4 Technology Mandatory workshop, with 42.7% (n = 76) and 55.6% (n = 99) respectively agreeing or strongly agreeing with this sentiment (see Figure 1). A similarly high proportion of participants either agreed (42.9%; n = 75) or strongly agreed (53.7%; n = 94) that the workshop was relevant to their teaching. A combined total of 97.8% of participants (n = 174) agreed or strongly agreed that attending the workshop was a good use of time (see Figure 2). A similar proportion also stated that they would recommend the workshop to their colleagues (see Figure 3). Overall, the length of the workshop was considered appropriate (87.5%; n = 155), with only 10.2% and 2.3% stating that the workshop was too short or long, respectively.

Figure 1: ***Participants' Responses to the Survey Question that Asked About the Relevance of the GPS Cows Workshop to Their Teaching Programs***

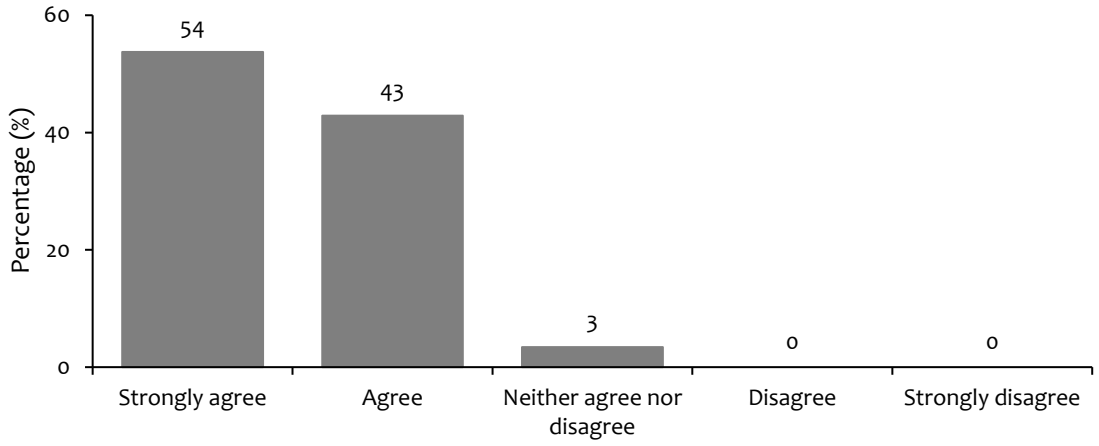


Figure 2: ***Participants' Responses About the Survey Question That Asked Whether Attending the GPS Cows Workshop was a Good use of Their Time***

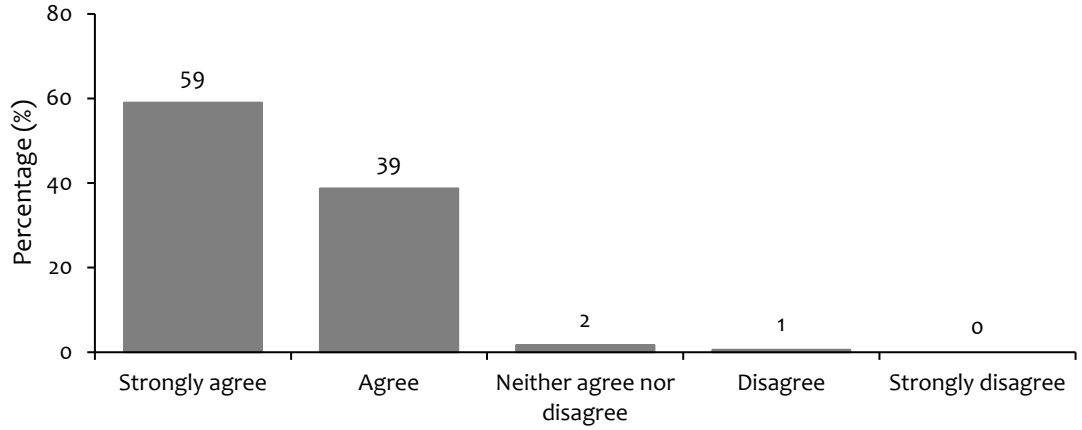
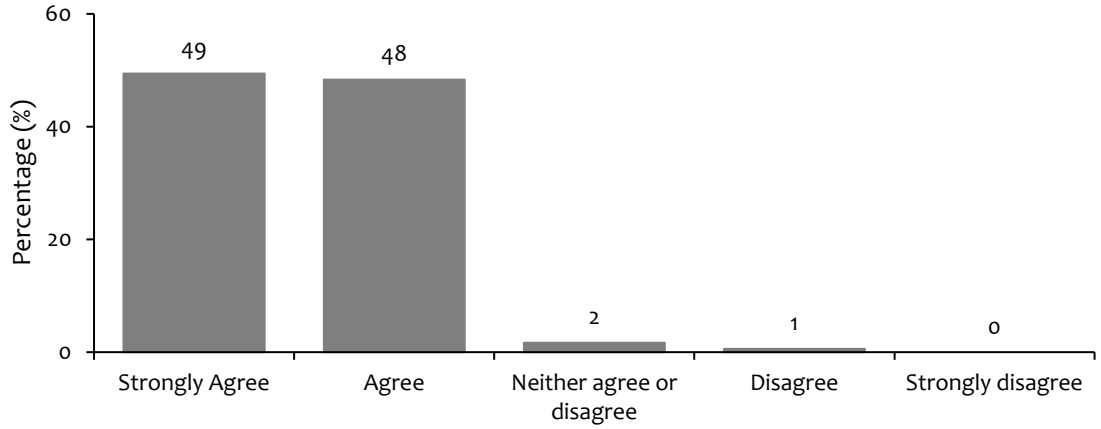


Figure 3: Participants' Responses to the Survey Question That Asked if They Would Recommend the GPS Cows Workshop to Their Colleagues



Positive Aspects of the GPS Cows Stage 4 Technology Mandatory Workshops

Most of the positive feedback from the GPS Cows workshop was in relation to the workshop activities and engagement with data analysis sections (n = 53; see Table 2), with comments such as preference for the "*active engagement with data analytics*" and "*learning and using new skills.*" One participant stated that "*being able to actually track and analyse data firsthand deepened my understanding of how to apply this technology within the classroom.*" The resources provided to participants were also highly regarded (n = 40). One participant stated that the "*amount of resources provided*" was important, with another noting that the resources were "*interactive [and] easy to use*". Similarly, *it was stated that the "in-depth booklet which gives step by step instructions was very useful and something I can more easily put into practice.*" Participants also valued the linkage to the real world and the value of technology in agriculture (n = 37). This included comments that indicated that they liked "*the practical applications and real-world data,*" "*collaborating and understanding technology advances in the agriculture industry,*" and "*[the] use of GPS in real life situations and future careers.*"

Another highly valued aspect of the workshop was the presenters themselves, with participants highlighting that the "*presenters were knowledgeable and helpful/approachable*" and the content was "*well explained and the presenters were very helpful.*" Additionally, the delivery of "*consolidating learning as we progressed through the day to ensure we understood before moving on*" was an important attribute of the presenters and contributed to the high success and

enjoyment of the workshop. The use of a small workshop size was also highly valued, including the benefits of "*connecting with other ag[riculture] teachers … [there is] not enough PD around*" and "*sharing ideas and helping each other work through the exercises.*" A summary of the positive workshop aspects identified by participants is shown in Table 2.

Table 2: ***Positive Aspects of the GPS Cows Workshop Identified by Participants***

Positive aspect*	**Count**
Workshop activities and engagement with analytics	53
Resources provided	40
Link to the real world and value of technology in agriculture	37
Presenters	35
Interesting information	14
Link to the NSW Syllabus	9
Small group/social aspect	7
All aspects	3
Other (catering etc.)	4
TOTAL	202

***** Each participant was able to identify three aspects.

Improvements Required for the GPS Cows Stage 4 Technology Mandatory Workshops

Overall, 49.7% of participants stated that they did not believe any improvements were required for the GPS Cows workshops (n = 73). Some participants stated that there was insufficient time or that they felt rushed, including that "*more time would be useful to fully investigate and understand the program*" and that "*there was a lot of content to cover in one day.*" Minor resource improvements were also suggested (n = 13), including clarity of instructions and discrepancies between the instructions provided and different software versions. Further explanation including worked examples was suggested by 13 participants, stating that "*the reasoning behind … certain calculations could have been explained better.*" Additional time to allow participants to discuss how they include GPS Cows into their teaching program would have also been well received (n = 4), as evident by comments such as "*direct links to the new syllabus outcomes so teachers can see how it all fits together with both the digital technologies and food and agriculture focus areas*" or a "*brainstorming session on how this could be practically used [in the classroom].*" A summary of the suggested improvements is presented in Table 3.

Table 3: ***Suggested Improvements for the GPS Cows Workshop***

Workshop aspects to be improved	Count
More time/felt rushed	24
Resource	13
Further explanation required including more worked examples	13
Technology issues, e.g., internet access, software requirements	9
Less background theory	5
Provide clearer connections to the NSW curriculum	4
Provide extension activities	4
Other (workshop location etc.)	2
No changes	73
TOTAL	147

Assessment of Teacher Skills and Knowledge Development Throughout the Workshop

Clickers were also used during the workshop to understand how participants skills and knowledge were improving as the workshop progressed. This was conducted through "pop-quiz" style questions where participants were asked to indicate the correct answer to various workshop activities (see Table 4). Overall, participants correctly answered the questions 84% of the time, with the number of responses per question (response rate) varying from 15.7% to 69.2%. Comprehension of livestock tracking technology was the lowest (61.5% correct; Table 4), highlighting the lack of understanding of how the tracking data from GPS can be used to calculate distance travelled. Comparatively, participants were highly competent in interpreting livestock tracking data and water visitation rates (88.3%) and understanding the interactions between water visitation and temperature interactions (90.4%), as shown in Table 4.

Table 4: ***Skills and Knowledge of Participants Based on Clicker Responses to Questions and Activities During the Workshop***

Workshop skills and knowledge	Correct response (%)	Incorrect response (%)	Response rate (%)
Comprehension of livestock tracking technology	61.5	38.5	42.2
Livestock tracking data analyses	74.8	25.2	66.4
Interpreting livestock tracking data and water visitation rates	88.3	11.7	69.2
Correctly using formulas	98.4	1.6	68.1
Utilisation of water	90.9	9.1	65.4
Temperature data analysis	90.2	9.8	27.6
Water visitation and temperature interactions	90.4	9.6	62.2
Rainfall data analyses	73.7	26.3	20.5
Water visitation and rainfall interactions	89.7	10.3	15.7

Assessment of Teacher Confidence

Clickers were also used to understand the development of teacher confidence throughout the workshop. Specifically, teachers were asked to indicate their confidence in relation to performing two workshop activities: creating groups for their students in Esri ArcGIS Online, and delivering a module activity surrounding data cleaning and the importance prior to analysing livestock tracking data. These activities required an understanding of the ArcGIS program and general concepts regarding data integrity. Overall, 79% and 96% of participants stated that they were confident to deliver the respective activities. More importantly, during the post-workshop survey, participants were asked if they were confident to use GPS Cows as part of their Tech Mandatory teaching program. A combined total of 86.4% stated that they were confident (55.7% [n = 98] agree; 30.7% [n = 54] strongly agree). Twelve percent of respondents were neutral in their confidence to apply the module (n = 21), and only 2% were not confident (n = 3).

Discussion

The results of this research show the benefits of using teacher training workshops for professional development. The presented results can be considered in two main ways: (i) an evaluation of the workshop itself as a method of improving teacher knowledge, skills and confidence to implement GPS Cows into their teaching program; and (ii) the benefits of teacher workshops as a professional development activity.

Workshop Evaluation

The GPS Cows workshop was well received by most participants, with over 98% expressing that they enjoyed the workshop. In addition, over 96% (2018) and 97% (2019) of participants felt that the workshop was relevant for their teaching and a good use of their time.

Having a strong knowledge of a particular subject area is a known factor affecting teacher skills and confidence (Bednarz et al., 2013). For example, in studies of geography educators, a lack of content knowledge (Bednarz et al., 2013) and geographical mapping skills (Anderson & Leinhardt, 2002) was reported to negatively impact teacher confidence. The GPS Cows workshop delivered a comprehensive introductory session at the commencement of the workshop, focusing on improving knowledge of agricultural technology. This information enabled a foundational understanding of the challenges faced by the agricultural sector and the use of technology to address these issues.

Activities throughout the workshop were designed to build on this foundation, allowing both theoretical and working knowledge to be a focus. Evaluation of knowledge development using pop-quiz style questions showed a strong development of knowledge throughout the workshop (see Table 4). Overall, participants had a high number of correct responses, ranging from 61.5% to 98.4% (mean 84%). In addition, there was a trend for increased numbers of correct responses over time, suggesting that participants developed their knowledge over the course of the workshop. Conversely to this however, the response rate of participants appeared to initially increase then decrease over the course of the workshop. This may suggest that only those who were confident in their answer submitted a (correct) response, while those who were possibly confused by the question chose not to respond, or that enthusiasm to respond decreased over time. Comprehension of livestock tracking technology had the lowest number of correct responses. This is not surprising given the subject matter is most likely novel to most participants. This was also the first question of the session and reflected the new subject material covered.

The use of the pop-quiz style questions throughout the workshop was also useful for indicating teacher skill development over time. For example, over 88% of participants were able to correctly interpret livestock tracking data and relate this to water use. Furthermore, over 98% of participants were able to correctly use Microsoft Excel formulas to analyse various aspects of

livestock behaviour and use this to develop behaviour alerts. Knowledge and confidence was previously identified as a significant barrier to increasing education of food and fibre concepts in teaching programs (Cosby, Manning, et al., 2019). Thus, the ability to quantitatively assess the development of this throughout the GPS Cows workshop is crucial. Of course, not all participants felt that they had developed the required skills throughout the workshop. Of note, two participants noted that "*Excel [was] a bit difficult*" and that the workshop was a "*bit heavy for non-computer tech people.*" Nevertheless, based on the results presented in Table 4, it is clear that the majority of participants were able to develop knowledge and skills throughout the workshop and that, overall, the workshop was successful in developing participant knowledge and skills for implementing the GPS Cows Module.

One vital aspect of teaching is having the confidence to effectively teach new concepts to students. Currently, lack of educator confidence is a major issue faced when incorporating agricultural content into their teaching programs (Cosby, Manning, et al., 2019). This may be in part due to increasing numbers of out-of-field teachers and a subsequent lack of subject matter knowledge. As previously mentioned, teaching out-of-field can impact educators' confidence, leaving them feeling "out-of-place" (du Plessis et al., 2014, p. 92). Out-of-field teaching can also impact teachers' identity and self-efficacy, which can in turn impact the quality of education (Hobbs, 2012). In the current research, only 56% of participants taught agriculture outside of the Tech Mandatory unit, thus highlighting the prevalence of out-of-field teaching amongst the research participants. For this reason, the development of teachers' confidence is crucial for successfully implementing the content of this workshop in the classroom. Overall, it appears that the GPS Cows workshop was successful in developing teacher confidence. This was evident by the large number of participants stating that they were confident or strongly confident to use the module as part of their Tech Mandatory teaching program.

Although the GPS Cows workshops appeared to be successful overall, the workshop participants noted some improvements that could be made (see Table 3). The most common limitation was that more time was required or that participants felt rushed. The GPS Cows workshop presents a significant amount of content to teachers in a relatively short time frame (6.5 hours, including meal breaks). In addition, the concepts and skills presented are likely to be novel for many participants. For this reason, it may be beneficial to run the workshops over two or more days, to ensure that teachers become more familiar with the content. This may be particularly beneficial for out-of-field teachers, who may not have significant experience in the subject material.

However, with limited time being previously identified as a barrier for professional development implementation by Cosby, Trotter, et al. (2019), extending the workshop duration is likely not feasible. Other limitations identified in this study were regarding the resources provided and the need for further explanation of the general concepts. For the former, comments included that "*some parts of the booklet were a little confusing first time through*" or that "*booklets were great – but some instructions need updating and checking [due to software version differences].*" This is similar to comments about the latter limitation, which noted that "*more examples*" or a "*worked example in real time, rather than a video*" would have been helpful. One participant stated that it "*[felt] like the reasoning behind why we had to select certain fields or use certain calculations could have been explained a bit better.*" This may have been impacted by the relatively short duration of the workshop and it highlights the need for comprehensive step-by-step resources, adequate workshop duration and teachers with sufficient digital literacy skills to ensure the development of background knowledge.

The Use of Workshops as a Professional Development Activity

As previously mentioned, professional development may be implemented using five broad methods: immersion, curriculum development, curriculum implementation, examining practice, and collaborative work (Loucks-Horsley et al., 1998). In the case of the GPS Cows workshops, the

professional development can be considered predominantly an immersion activity, with teachers learning new skills under the guidance of trained professionals. In addition, the module can also be considered more broadly as professional development through curriculum implementation and collaborative work.

Immersion professional development is most commonly achieved through workshops and experiences and is particularly useful for improving content-specific understandings, such as mathematics, science and language. In conjunction with learning new content, immersion professional development can also be used to highlight how the content can be taught in the classroom, including higher level thinking and the flow of instruction (Loucks-Horsley et al., 1998). In the current study, most positive feedback was in relation to the GPS Cows workshop itself and engagement with data analytics, with participants stating that they enjoyed "*learning and using new skills.*" Several participants also stated that the "*hands on learning*" was the best part of the workshop, while another two participants stated that they enjoyed engaging in the "*learning the students will be undertaking*" and that the "*workshop provided a concise overview of the program and how it could be used, as well as a practical step by step [guide for implementation]*".

This highlights the benefits of immersion workshops where teachers are introduced to the concepts they are expected to teach through hands-on-learning. In addition to workshop content, another key element of successful immersion professional development is the use of qualified and experienced facilitators (Loucks-Horsley et al., 1998). In this study, presenter quality was another commonly identified positive aspect of the workshop, with comments such as "*the presenters were knowledgeable and helpful/approachable*" and they "*consolidated learning … through[out] the day to ensure we understood before moving on.*" In research by Huffman et al. (2003), although immersion did not appear to impact teaching practice of mathematics and science teachers, the authors stated that immersion is more likely to have a "*long-term and amorphous effect,*" due to the focus on improved concept understanding. Workshops have also been identified by Easterly and Myers (2019) as having the highest value for agricultural educators and the highest level of implementation into practice.

Curriculum implementation professional development involves teachers applying and refining instructional materials for use in the classroom. This differs from curriculum development, where teachers are directly involved in the creation of instructional materials (Huffman et al., 2003). The benefits of curriculum implementation vary in the literature. In research by Cohen and Hill (2000), curriculum implementation was found to improve teachers' knowledge of mathematics. In contrast, Huffman et al. (2003) did not find a significant impact of curriculum implementation on the teachings of mathematics or science educators. Huffman et al. (2003) attributed this to a lack of ownership over the resources, resulting in teachers being less likely to implement them due to the resources not completely fitting within their current program, or because they did not have the requisite skills to implement them. In contrast, curriculum development was found to significantly impact student achievement for mathematics teachers (Huffman et al., 2003). This was particularly true for teachers with lower-achieving students due to teachers having to develop creative teaching strategies outside the traditional curriculum. Curriculum development was also found to improve teacher engagement and creativity by Mooney Simmie (2007), especially when resource development occurred in a team environment.

Although GPS Cows does not provide the opportunity for teachers to develop the resources themselves, the module can be considered a form of curriculum implementation, as teachers are supplied a complete 10-week resource that can be easily applied or adapted in the classroom to suit their teaching program. The resources provided were highly regarded by participants, particularly the volume of resources and the ease of use. This was stated by one participant: "*being provided with [the] vehicle whereby students can engage with data collection and analysis in a meaningful way.*" Other participants also commented that it was beneficial "*having the*

resources to take home and the availability of Moodle for resources" and having "*the resources [freely available] afterwards.*"

Finally, GPS Cows can be considered a form of professional development through collaborative work. Collaborative professional development refers to work conducted in study groups, peer coaching and mentoring situations (Loucks-Horsley et al., 1998). Collaborative work is considered important as it encourages teachers to try new ideas and reflect on the outcomes (Butler et al., 2004). It is also beneficial for the development of co-operative behaviours and internal accountability (Loucks-Horsley et al., 1998). For the GPS Cows workshops, seven participants identified that the small group and the social aspect were valuable. One participant stated that the "*support from fellow teachers*" was beneficial, while another enjoyed "*sharing ideas and helping each other work through exercises.*"

Again, while collaborative work was not found by Huffman et al. (2003) to significantly impact the use of standards-based instruction with mathematics and science teachers, the authors concede that collaborative work is still highly valuable, particularly when it has a specific focus or structure. Given that the GPS Cows workshop is highly structured, its collaborative aspect is likely to provide additional benefits to the professional development experiences of participants. Furthermore, following workshop completion, participants are able to collaborate further through access to a dedicated "*chat* room" on the virtual "*Statewide Staffroom*" (NSW Department of Education, 2021). In this collaborative space, teachers are able to continue to discuss how to implement GPS Cows in the classroom, and to troubleshoot any issues they are facing. This site is monitored by a NSW Department of Education staff member and, alongside GPS Cows workshop presenters, can answer any questions that arise.

Conclusion

GPS Cows is a complete resource for Tech Mandatory teachers that aligns with many of the outcomes in the NSW Stage 4 Technology Mandatory Syllabus (NESA, 2017). To facilitate the knowledge, skills and confidence required to implement the module and to encourage module uptake, a one-day workshop was provided to NSW teachers in 2018 and 2019. Data were collected during the workshop, using classroom clickers, and following workshop completion, using an online survey. Overall, the workshop was well received by participants, with over 98% of respondents enjoying the workshop, and 97% indicating that the workshop was a good use of time and they would recommend it to a friend. Positive aspects of the workshop included the workshop activities and engagement with data analytics, the resources provided, and the clear link between agricultural technologies and the real world. Identified improvements included that more time was required and that more worked examples would be helpful.

The development of skills, knowledge and confidence over time was assessed through the use of pop-quiz questions throughout the workshop, and showed an average correct response rate of 84%. The results of this work show that professional development that incorporates immersion activities, as well as curriculum implementation and collaboration, can provide teachers with the knowledge and confidence to implement resources that support student achievement of learning outcomes, even if the content is outside the discipline they are trained in. This suggests that professional development workshops are essential to increase the quality of agricultural education, an area where many teachers are teaching out of scope.

Declarations

Availability of Data and Materials

The datasets generated and/or analysed during the current study are not publicly available, due to the potential to indirectly identify individual study participants based on a combination of demographic characteristics and location data. However, select subsets of data are available from the first author on reasonable request.

Competing Interests

The authors declare that they have no competing interests.

Funding

This project was funded by the NSW Department of Education.

Acknowledgements

The authors would like to gratefully acknowledge Andrew Murray, co-presenter, for his patience and support during all workshops, and Sally Bannerman and Dan Rytmeister for their ongoing collaboration and reviewing of all GPS Cows materials. Finally, thanks to all the NSW Stage 4 Technology Mandatory teachers who participated. We value your ongoing commitment to increasing student knowledge, capacity and confidence around Australian agriculture.

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