TeacherFX - Building the Capacity of STEM, Agriculture and Digital Technologies Teachers in Western Australia

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Abstract

Whilst agriculture is Australia's fastest growing industry, the negative perception of career opportunities by high school students and the lack of educator confidence in teaching about food and fibre concepts is a major issue currently faced by the sector. The Teacher Farm Experience (TeacherFX), a joint program of Rabobank's Western Australia Client Council and CQUniversity Australia, aims to increase awareness, knowledge and appreciation of the agricultural industry. This free two-day program designed for teachers entailed visiting four farms in the Great Southern region of WA on the first day and professional learning on the second day. Pre- and post- event surveys were conducted to gain baseline information on the participants, their perceptions of agriculture, quality of learning materials and reaction to the experience. Additional support in the form of professional development and networking opportunities was identified as required to assist teachers to implement learnings from TeacherFX. Event survey results were overwhelmingly positive, with 100% of teachers recommending their colleagues attend a future event. However, whether this positive result will translate to change in the classroom is unknown. Additional research needs to be conducted to measure the long-term impact of the program.

Background

Australia is facing many challenges as a society including living in a changing environment and managing natural resources including water for food production. Citizens that possess skills and knowledge in science, technology, engineering and mathematics (STEM) are well placed to help address these challenges (Lim, 2015). In response to this, government agendas are demonstrating an increasing focus on STEM, identifying it as a critical requirement for our future generations to possess skills in these areas to contribute to Australia's economic productivity (Gough, 2015). As part of the National Innovation and Science Agenda, the Federal Government committed $64 million to early childhood and school-based STEM initiatives (Department of Education and Training, 2018).

It is not widely appreciated or understood that agriculture and food and fibre provide an excellent context for teaching and applying STEM principles (Bray & Cay, 2018). However, there is a growing demand for graduates with STEM skills to choose a career in the agricultural industry to support food and fibre production (Hegerfeld-Baker, Anand, Droke, & Chang 2015). Teachers are known to have the ability to impact the future career path of a student both informally in their role as an advisor or formally through curriculum (Patton, 2005). It is

therefore important that teachers, who are reported to be an important source of knowledge about careers for students, have awareness of the many aspects and varying job opportunities that the agricultural industry provides (Matthews & Falvey, 1999). This has become increasingly important as the number and quality of employees entering the agricultural industry has declined and concern has arisen that there will not be enough human capacity to support future food and fibre production (Bell & Biddulph, 2009).

Australia is a highly developed country with 90% of the population living in urban areas as of 2016 (Trading Economics, 2018). Therefore, it is unsurprising that there is an increasing disconnect between the wider population and the agricultural industry (Hillman and Buckley, 2011). The National Farmers Federation's (NFF) 'ag poll' highlighted that 83% of Australian's have a distant or non-existent connection with farming (National Farmers Federation, 2017). Furthermore, in research conducted by the Australian Council for Educational Research, only 58% of Year 10 students (n = 606) correctly identified cotton as a plant product and 27% of Year 6 students (n = 210) did not know that yoghurt is a product from animals (Hillman & Buckley, 2011). Rabobank commissioned research has also highlighted the urban-rural divide in young people, with 77% of teenagers between 15-18 years old residing in the city (n=600) knowing little or nothing about food production (Heydon, 2014). This is a concern for numerous reasons, but foremost because people are not aware of where their food or fibre, basic necessities of life, comes from or how it is produced. This apparent disconnect has numerous potential implications for community expectations and industry social license. Social licence can be described as 'the latitude that society allows to its citizens to exploit resources for their private purposes' (Williams & Martin, 2011, p. 3). Examples of social license issues include whether irrigation for agricultural crops is accepted (Shepheard & Martin, 2008) and the expectations of consumers regarding animal welfare (Coleman, 2017).

A number of reports have been published over the past few years reviewing agricultural education at both a national and state level. All reports have recommended that more agricultural education in schools is required to address workforce shortages in the industry (Parliament of Victoria Education and Training Committee 2012; Senate Standing Committee on Education, Employment and Workplace Relations, 2012; Pratley, 2013). However, few of the recommendations have been implemented. One of the exceptions is the 'Lighthouse Schools' network in New South Wales (NSW) which was formed by the state government to share and build agricultural knowledge (ABC, 2016). However, not all governments are following the lead of NSW. Despite recommendations, the Western Australian government decided in late 2017 to cut funding to its specialist network of high school agricultural colleges and ten smaller schools with agricultural programs by 20% (Wolfe & Dupe, 2018). Intense backlash from the families who utilise these services led to the decision being overturned by the state government (Plesse & Strutt, 2018).

Although agriculture is Australia's fastest growing industry, only 4% of respondents to the NFF survey correctly identified this fact (National Farmers Federation, 2017). With many jobs in agriculture and related industries remaining unfilled, there is an urgent need for suitably qualified people to enter the sector. The number of people graduating from agricultural degrees has fallen from a high of 600 graduates in 2003, to a low of under 200 in 2013, with a turnaround observed to see 300 finish in 2015 (Bolton, 2018). Despite an increase in students undertaking tertiary study in the agricultural field, there are still an estimated four jobs available for every tertiary agricultural graduate in Australia (Pratley & Botwright-Acuna, 2015). For continued growth of the agricultural industry, it is essential that the number of people electing to study agriculture at a tertiary level increases, especially if industry is to reach

its target of $100 billion of farm output by 2030 (Poole, van Delden, & Liddell, 2018). However, the negative perception of careers in agriculture, including that the only option is to be a farmer, the industry has negative impacts on the environment (Matthews & Falvey, 1999) and the lack of knowledge about the wide variety of jobs is deterring young people from electing to study or find a job in the industry (Cecchettini, Sommer, & Leising, 1992; Turner & Spence, 2014).

To change this perception, there must be additional food and fibre concepts incorporated into teaching programs, to highlight the issues faced by agriculture producers and the opportunities available to students. Not surprisingly, students who study agriculture at school are more likely to consider a career in agriculture (Cecchettini et al., 1992; Thompson & Russell, 1993). Therefore, by increasing the knowledge and confidence of educators in teaching food and fibre concepts, it is believed that they can be the drivers of change and the career options available in agriculture will be showcased to students. In an effort to address the lack of knowledge and increase the profile of agricultural education in Western Australia, the Teacher Farm Experience Program (TeacherFX) was developed. TeacherFX is an example initiative aiming to increase the awareness, knowledge and appreciation of the agricultural industry to teachers in the hope that they will in turn increase student realisation of possible career options in the sector.

Introduction to TeacherFX

Rabobank has seven Client Councils across Australia comprised of the clients who work together with the bank to address a range of issues; including long-term industry capacity, sustainability, rural-urban divide and rural health (Rabobank, 2017). The Western Australia (WA) Client Council previously initiated the Student Farm Experience Program (StudentFX), which involved urban youth spending time with farming families to develop an understanding of food and fibre production (Rabobank, 2015). Although successful, the WA Client Council was keen to engage with more students than StudentFX could cater for. It was decided to pursue the development of a program targeted at teachers with the belief that each educator would have the opportunity to disseminate their knowledge to many students.

The TeacherFX program, a joint initiative of Rabobank's WA Client Council and CQUniversity Australia (CQUni) was developed to enhance the knowledge, practical skills and networks of educators teaching agriculture, STEM and digital technology subjects in Western Australia. It was hypothesised that by immersing teachers in farm life and giving them an insight into the latest advancements in food and fibre production, that their interest and understanding of agriculture would increase, and potentially enable this knowledge to be passed onto their students.

The TeacherFX program was a free two-day event held in July 2018 with teachers visiting four farms on the first day and undertaking professional learning on the second. The farms, all located in the Great Southern region of WA, opened their gates to the teachers so they could learn first-hand about innovative practices and new technologies utilised to improve production, profit and environmental sustainability. One unique aspect of the program is that teachers were billeted out to local farmers for the night so that they could connect with and experience life on the farm. Personal relationships were therefore expected to develop between the teacher and host family. This would give educators a contact in the agricultural industry that they could draw on for accurate information. On the second day, teachers undertook training utilising a livestock tracking learning resource. This learning resource was chosen as

it could be aligned closely to the WA digital technologies, and design and technologies curriculum (School Curriculum and Standards Authority 2017a; School Curriculum and Standards Authority, 2017b) and used data and information, derived from the farm visits on the first day of the event. In addition, the GPS livestock tracking data allowed emerging agri-tech to be showcased in the hope that this could be used as an example by the teachers to excite students who perhaps had not considered a career in agriculture previously.

Methodology

To evaluate the effectiveness of TeacherFX in achieving its aim, the Kirkpatrick Four Levels of Training Evaluation model was used (Kirkpatrick & Kirkpatrick, 2006). This model comprises of four categories of evaluation: reaction, learning, behaviour and results. It has been the principal method used to evaluate training delivered by organisations for the past 30 years (Kirkpatrick & Kirkpatrick, 2006; Passmore & Velez, 2012), across a wide range of industries (Honeycutt, Karande, Attia, & Maurer, 2001; Passmore & Velez, 2012).

The first step, reaction, is evaluated through a survey conducted directly after the training and is used to assess the relevance and the quality of the training (Kirkpatrick & Kirkpatrick, 2006). The second step, learning, is designed to gauge the knowledge gained as part of the training and is more difficult to assess than reaction. The third and fourth steps, behaviour and results, are challenging to measure. Behaviour involves the participant in the training adopting the principles and practices learnt in the workplace. Results refers to whether the desired outcomes of the training have been realised. It is often difficult to directly attribute the training as the direct cause of change in the organisation as there may be many external factors that have contributed (Honeycutt et al., 2001). The emphasis of this paper is the pre-and post-program surveys with future publications to evaluate the impact TeacherFX has had on teachers and students.

In addition to the four levels of evaluation, Kirkpatrick and Kirkpatrick (2006) state that it is important to determine the training needs of the target audience (Kirkpatrick & Kirkpatrick, 2006). To satisfy this step, teachers who were selected to attend TeacherFX (n=27) all completed an online survey three weeks prior to their attendance at the event, providing researchers with a baseline dataset on the current knowledge and perception of food and fibre production, if they currently or wish to incorporate agriculture into their teaching programs, the barriers to doing so and one thing they hoped to walk away from the training with. The survey also collected basic demographic information about participants.

The ‘reaction’ and ‘learning’ of participants (Kirkpatrick & Kirkpatrick, 2006) of the TeacherFX program was gathered through a second online survey that was completed by participants to obtain their perspectives on various aspects of the event including the quality and effectiveness of the learning material developed and how they perceived they would use the knowledge gained in their classroom. It also asked questions to determine whether they had improved their knowledge of current practices in agriculture, in particular the use of technology on farms.

The ‘behaviour’ and ‘results’ of the TeacherFX program will be reported in a future publication. A follow-up survey seven months (February, 2019) after the event will be conducted to determine whether teachers have changed their behaviour and have drawn on their TeacherFX experience in the classroom. It will establish whether they have utilised the skills, knowledge and contacts gained by participating in TeacherFX to increase the level of

food and fibre content in their teaching programs. The survey will also ask teachers to detail the perceived effect their experience has had on their students (Human Research Ethics Approval no. 21171).

Results and discussion

This paper considered the pre- and post-event surveys participants in TeacherFX completed. Twenty-seven teachers from a range of regions and schools across Western Australia attended the inaugural TeacherFX event in July 2018. Forty-one percent of participants came from schools in major or capital cities, while the remaining fifty-nine percent were from regional areas (Table 1). Participants had a range of teaching experience, however the majority (74%) had more than ten years in the industry (Table 1).

Table 1. Pre-program TeacherFX Survey - Demographic information about TeacherFX participants (n=27)

Location of school	**Count**	**Percentage**
Rural Town – less than 5,000 people	10	37%
Town – 5,000-18,000 people	3	11%
Large Town – 19,000 – 49,000 people	3	11%
Major City – 50,000-250,000 people	4	15%
Capital City – 250,000+ people	7	26%
Number of years teaching		
<1	1	4%
1-5	5	18%
6-9	1	4%
10-15	10	37%
15-20	3	11%
21+	7	26%

Because one of the key objectives of TeacherFX was to increase the exposure of students to food and fibre concepts, thus it was important to include participants teaching across a range of subjects. Participants at TeacherFX taught from K-12 and subjects taught include science, maths, agriculture, digital technologies and home economics. More than half of the schools the teachers came from did not teach agriculture as a subject. Yet, 60% of participants noted that they currently incorporate food and fibre content into their programs (Table 2). Importantly, over 80% of participants indicated that they would like to increase the level of agricultural content in their teaching programs.

Table 2. Pre-program TeacherFX Survey - Teaching program information about TeacherFX participants (n=27)

Does your school offer agriculture as a subject?	**Count**	**Percentage**
Yes	10	37%
No	16	59%
Don't know	1	4%
Do you incorporate food and fibre concepts into your current teaching program?		

Yes	17	61%
No	11	39%
Would you like to increase the level of food and fibre concepts in your teaching program?		
Yes	22	82%
No	2	7%
Maybe	3	11%

Teachers were asked in the pre-program survey what barriers they faced in increasing the level of food and fibre content into their classroom, to help inform the design and delivery of the program and resources. Teachers indicated knowledge was the biggest barrier, followed by time and financial resources (Table 3). Other barriers identified by respondents include understanding how food and fibre content can be incorporated into other subjects and lack of supportive colleagues to engage and collaborate with. Considering that only 37% of participants' schools offered agriculture as a subject, this is not surprising (Table 2). Encouragingly, no one indicated that their school was not supportive of them incorporating more food and fibre content into their teaching programs. However, 30% of participants did indicate that they did not have the appropriate resources to increase agricultural content (Table 3). One major barrier for teachers was insufficient internet connectivity and computer resources in their schools to implement the learning materials. Teachers disagreed (19%) that their students would have access to sufficient internet connectivity to complete the computer practical and resources. Furthermore, 22% of participants from rural schools disagreed that their students would have access to the required computer equipment needed to complete the practical. With a strong emphasis in state and national curriculums for digital technology and ICT skills, it is imperative for schools to have access to computers and adequate internet connectivity (Australian Curriculum, Assessment and Reporting Authority, n.d.). There is also an increasing reliance on internet and IT due to the growing agriculture innovations that rely on it and therefore is an important consideration for technology adoption (Aubert et al., 2012). Additionally, surveyed agriculture producers in Zhang, Baker, Jakku, and Llewellyn (2017) indicated the importance of adequate internet connectivity in order to successfully run their enterprise. Yet, internet use is not equitably distributed (Willis & Tranter, 2006), with previous data highlighting that remote and regional areas of Australia are at least 40% less likely to have internet access when compared to cities (ABS, 2007). Whilst these barriers cannot be addressed in the TeacherFX program, it is considered a limiting factor to the implementation of learning materials provided and has the potential to influence the post event survey results in relation to the success of the program and usefulness of the learning materials provided.

To understand how to encourage teachers to increase the level and improve the quality of agricultural content taught to students, participants were asked what support and/or resources they needed. More professional development opportunities, online resources and increased networks and support from other teachers were all identified as important additional support and resources needed (Table 3). The need for money to establish a program was also identified by one participant as a resource that they required. Each state of Australia has an Agricultural Teachers Association which offers professional learning opportunities for teachers (with the National Association organising a bi-annual conference; PIEFA, 2015). There are also other organisations offering conferences such as the School to Industry Partnership Program managed by AgForce Queensland and workshops by AgCommunicators South Australia. However, these professional development opportunities may be viewed by non-agriculture teachers as irrelevant or they may believe they do not have the background knowledge required to attend. Until it ceased operation in 2015, the Primary Industry Centre for Science Education

(PICSE) provided professional learning opportunities showcasing the science that underpins agriculture to teachers from eight locations across Australia (Lembo, 2014). The gap left by the closure of PICSE has not been filled and this initial research appears to indicate there is a demand for increased opportunities for food and fibre professional development, aimed at an audience broader than agriculture teachers. Therefore, programs like TeacherFX need industry and government support to allow Australian teachers another opportunity to increase their awareness, knowledge and appreciation of the agricultural industry.

Table 3. Pre- TeacherFX survey - The barriers inhibiting and support required by TeacherFX participants (n=27)

What barriers do you face in increasing the level of food and fibre concepts in your teaching program? (Select all that apply)	**Count**	**Percentage**
Knowledge	21	78%
Time	15	56%
Confidence	9	33%
Financial resources	10	37%
School is not supportive	0	0%
School doesn't have the appropriate resources	8	30%
Curriculum doesn't allow it	6	22%
Other	6	22%
What support/resources do you need? (Select all that apply)		
Personal relationships with farmers	13	48%
More professional development opportunities	23	85%
Networks and support from other teachers	20	74%
Online resources	22	81%
Other	1	4%

General awareness and connection to the agricultural industry across the general community is low (NFF, 2017) and teachers attending TeacherFX were asked to indicate their level of agreement with the facts outlined in Table 4. Agriculture is an important industry to the Australian economy with the gross value of farm production in 2018–2019 expected to be worth $A60 billion (ABARES 2018). Agriculture has also been named as having the greatest prospects of all sectors in Australia to overtake mining as the key driver of economic growth (Deloitte, 2015). It was therefore encouraging that the majority of participants were able to identify agriculture as a significant contributor to Australia's economy. However, 33% of participants answered 'neutral' (Table 4) to the fact that Australian farmers feed 600 people per year (National Farmers Federation, 2018), indicating that agriculture was recognised as a key economic contributor, but the productivity level of farmers was not widely known.

It could be assumed that the years of study required to become a vet (5-7 years) compared to an agricultural degree (3-4 years) results in a higher salary. However, the graduate salary of veterinarians at $46,000 (Graduate Careers Australia, 2015), is lower than the average starting salary of $51,000 for graduates of agricultural degrees in Australia (Graduate Careers Australia, 2015). A careers panel was therefore incorporated on the second day of TeacherFX

to showcase to teachers the broad and lucrative career opportunities available in both urban and rural areas in agriculture.

Table 4. Participants level of agreement with agricultural facts.

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Each Australian farmer feeds 600 people per year including 450 people overseas (NFF, 2018)	26%	33%	33%	0%	8%
Agricultural graduates have an average starting salary higher than a veterinarian (Graduate Careers Australia, 2015)	0%	7%	70%	23%	0%
The agricultural industry is a significant contributor to the Australian economy (ABARES, 2018)	59%	30%	4%	0%	7%

The 'learning' aspect of the training was evaluated by the change in participants' knowledge from the pre- to the post-event survey. This centred around teachers' knowledge of the effect technology is having on the agricultural industry, specifically animal welfare, farm business profitability and environmental sustainability. Technology has the potential to transform food and fibre production across the globe. In order to realise this, the next generation workforce must have the skills and knowledge to use the data derived from new sensors and systems to improve profitability, productivity and environmental sustainability (Frangoul, 2018; CSIRO, n.d.). Agriculture's social license to operate is also increasingly under threat and through the use of technology the industry can begin to address numerous issues, including animal welfare (Heath, 2018; Williams & Martin, 2011). Consequently, the wider community needs to be made aware of the potential for technology to contribute to addressing issues of social license and events like TeacherFX can help to showcase this.

Prior to attending TeacherFX only 33% of teachers 'strongly agreed' that technology had the ability to improve farm animal welfare (Table 5). After attending, this rose to 78%, demonstrating that visiting farms, talking with researchers and completing the livestock tracking practical over the two-day event resulted in participants learning how technology can improve animal welfare. The shift from 52% to 81% of teachers 'strongly agreeing' that new and emerging technology can improve productivity and profitability (Table 5) is encouraging. The shift from pre- to post-survey results regarding the ability of technology to improve sustainability was not as great as for the previous two statements (37% to 56% strongly disagree) (Table 5). Thus, this is one area of the learning in the presentation and materials developed for TeacherFX that could be improved. Overall, the results of the learning portion of the study is important for the research team to consider. In further development of the program a greater focus will be placed on technology contributions to environmental sustainability. A key aspect of this improvement will include practical examples and requests for host farmers to place more emphasis on new and innovative practices they employ for environmental sustainability to provide an authentic learning experience for participants. There are many reported benefits of visiting farms as part of an authentic educational experience in agriculture (Morgan & Cox, 2006; Smeds, Jeronen, & Kurppa, 2015). These include supporting a wide range of learning preferences, improved retention and increased understanding of the concepts presented (Smeds et al., 2015). It is possible the survey format could have misled

respondents through inconsistent positive and negative language. There were two positively worded statements followed by a negative one, which related to environmental sustainability, potentially resulting in participants misinterpreting the statements. This is also important for the researchers to consider in future survey design.

Table 5. Pre- and post-survey responses to potential for technology to improve aspects of the agricultural industry.

	Strongly Disagree		Disagree		Neutral		Agree		Strongly Agree	
	Pre	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**
Technology has the ability to improve farm animal welfare	7%	0%	0%	0%	7%	4%	52%	19%	33%	78%
Agricultural businesses can improve profitability and productivity by adopting new and emerging technologies	0%	0%	0%	0%	19%	4%	30%	15%	52%	81%
Agricultural technologies do not have the ability to improve environmental sustainability	37%	56%	48%	19%	11%	4%	0%	0%	4%	22%

Professional learning on day two of the program, including a classroom ready computer resource, was positively received by participants. A large proportion of participant's agreed (33%) to strongly agreed (59%) that analysing authentic data improves a student's learning experience. Providing real-life data and examples in learning resources, not only provides a unique opportunity to develop digital literacy skills and meet the digital and design technologies curriculum in WA, but highlights issues that are currently faced in agriculture. Overwhelmingly, 100% of participants said in the event survey that their overall perception of the agricultural industry was positive. Furthermore, 96% of participants agreed that they would now encourage their students to consider a career in agriculture. Teachers are the drivers of change in the classroom, so the results are reassuring that these educators view agriculture and careers in agriculture as a positive option for their students to consider.

It is clear that the TeacherFX program was a very positive experience for all who attended with 100% indicating they would recommend their colleagues attend a future event. When asked to describe their experience in one sentence, comments such as '*outstanding PLD [professional learning development], with opportunities to improve my knowledge STEM in a key economic industry in WA*' and '*fantastic, by far the best professional development I have ever attended*' were received from participants. This information, along with 4.89/5 for overall experience suggests that the TeacherFX program was enjoyed by all. However, whilst the post-event results are positive, the true return on investment will be known once the follow-up survey to be conducted in February 2019 has been completed ('behaviour' and 'results' analysis). It is vitally important the participants of TeacherFX use their new knowledge and skills and impart

these on their students for the event to be a true success. It is hoped that teachers will continue to draw on the networks created over the two days and utilise the livestock tracking learning material in the classroom.

Conclusion

The inaugural TeacherFX was successful in achieving its aim of increasing engagement between teachers, farmers and agricultural professionals to improve their knowledge, perception and appreciation of the agricultural industry. The follow-up survey to be conducted in February 2019 will evaluate if teachers have changed their behaviour after attending TeacherFX and the results this has had on their students. Based on discussions with Rabobank the TeacherFX program will be expanded to each of the Rabobank Client Council regions across Australia in 2019-20. Furthermore, that both targeted primary and secondary teacher events will be held in alternate years. By providing opportunities across Australia, it is hoped that the confidence and knowledge of non-agriculture educators to incorporate food and fibre concepts into their teaching programs will increase. Further, the possibilities and career opportunities offered by the agricultural industry will become better known.

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