Utilizing GPS technology and science to improve digital literacy among students in Australia and the United States of America

C. W. Knight[1], A. M. Cosby[2] and M. G. Trotter[2]

[1] University of Maine - Orono, Maine USA
[2] Central Queensland University – Rockhampton, Queensland Australia

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Abstract

A key issue facing regional, rural and remote communities, in both Australia and the United States of America (USA), is the low level of digital literacy among some cohorts of students. This is particularly the case for students involved in agricultural studies where it is commonly perceived that digital literacy is not relevant to their future occupation. However, this perception is far from the truth, as the reality of farming today means students who intend on entering the agricultural workforce must have excellent comprehension of technology. The agricultural industry is changing with the ever-increasing use of technology across the supply chain demanding a workforce with higher degree skills in STEM and digital literacy to facilitate the transformation of this sector. The 'GPS Cows' project is a collaboration between researchers, industry professionals and educators in both Australia and the USA to engage students using emerging agri-tech to excite them and showcase the higher education and career opportunities available in the agricultural sector. The pilot program will see the development of learning materials to assist students increase their digital literacy skills using agriculture as a case study. The culmination of the pilot program will see students work with their teachers and/or 4-H regional leaders to develop a poster outlining a science investigation they designed and undertook using GPS livestock tracking technology.

Keywords
STEM, agricultural education, GPS livestock tracking, digital literacy

Introduction

The emphasis placed on developing digital literacy skills in students to prepare them for the jobs of the future is increasing (Foundation for Young Australians, 2015; Institute for Information Technologies in Education, 2011). Digital literacy has a myriad of definitions with many organizations providing descriptions of the term (Walton, 2016). Examples include:

- '…the ability to find, evaluate, utilize, share, and create content using information technologies and the Internet.' (Cornell University, 2015).
- '…a person's ability to use cognitive and technical skills to appropriately use technology in its various forms to locate, assess and interpret information. A person who has achieved digital literacy is able to use technology to convey information to others and collaborate and contribute to their own learning.' (Blake, 2015).
- '…being able to search and navigate, think critically and analyse, create and communicate information using a variety of digital media. It encompasses a broad range of critical skills to engage in the information driven world in which we live.' (Deakin, 2017).

It is clear from these definitions that digital literacy is more than just being able to operate software or a digital device. High level analytical, communication and numerous technical skills that allow a person to successfully function in a digital environment are required to be digitally literate (Eshet-Alkalai, 2004).
Many countries, including the United States of America (USA) and Australia, have responded to the challenge by developing curriculum and resources focused on providing mandatory school aged students digital literacy skills (Foundation for Young Australians, 2015). One of the learning areas in the Australian Curriculum is digital technologies. It is compulsory for students from Foundation to Year 10 to develop knowledge and understanding, and skills in production and processes of digital technologies (ACARA, 2018). Not all States and Territories in Australia have adopted the Australian Curriculum, however all have included digital technology as a component of their respective curriculums.

In the USA, each State is responsible for developing curriculum and determining education standards (U.S. Department of Education, 2017). The *Every Student Succeeds Act* provides each State grant funding for 'Student Support and Academic Enrichment' under Title IV Part A (International Society for Technology in Education, 2018). As part of this grant program, one of the ways the Maine Department of Education aims to improve the academic achievement of students is by improving "the effective use of technology to improve the academic achievement and digital literacy of all students through blended learning, providing access to digital learning experiences, and increasing professional learning and infrastructure related to classroom technology (Maine Department of Education, 2018)."

There is a unique opportunity to develop resources which align with digital technology curriculums in Australia and the USA using agriculture as a real life example of why digital literacy skills are important for future employability. The use of technology in agriculture is ever increasing, and although traditionally not perceived as a high-tech industry, this is changing. To remain competitive on a global, agricultural businesses must be innovative and continue to adopt new technologies (Australian Government Parliamentary Committee 2016). To enable this, the agricultural workforce must have sufficient digital literacy skills and have the confidence to implement agricultural technologies across the value chain.
Tracking livestock using global positioning systems (GPS) has been a focus of animal behavior research for over 20 years (Bailey et al., 2018). Animal location data can be used to interpret and manage grazing behavior (Turner et al., 2000), pasture utilization (Putfarken et al.,2008), grazing distribution (Ganskopp, 2001) and reproductive activity (Fogarty et al., 2015). It is anticipated that in the near future this technology will become economically viable and commercially available (Bailey et al., 2018). Graziers and ranchers will need the skills and knowledge required to collect and interpret real-time animal location and behavior data to increase their property's productivity, profitability and environmental sustainability by manipulating animal behavior or selecting animals predisposed to more efficiently utilize the landscape.

The GPS Cows program (GPS Cows) is a collaborative project bringing together researchers, industry professionals and educators in both Australia and the USA who understand the importance of, and are passionate about engaging students in agri-tech. The aim of GPS Cows is 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, and to encourage them to consider tertiary study and a career in the agricultural sector. It is also hoped that the international collaboration will demonstrate to students the importance of agriculture globally and increase their knowledge and appreciation of the industry in other countries.

Methodology

The GPSCows pilot is currently running in Australia and the USA and is lead by Central Queensland University (CQU) and University of Maine (UoM) respectively. There are key differences between agricultural education in Australia and the USA and therefore GPSCows has different modes of operation in each country. In Australia, the main method high school students participate in agricultural education initiatives is through their high school agricultural program. In the USA students not only have the opportunity to study agriculture at school but participate in extra-curricular activities, predominately 4-H and Future Farmers of America (FFA). GPSCows will initially involve 4-H youth in Maine and Arizona, however, it is hoped that the program can be expanded into schools across the country. Students from Australia will engage with researchers in the USA, and vice versa, giving them the opportunity to learn first-hand about agriculture in a different country and engage with experts in livestock tracking behavior.
Eight high schools and one vocational training college are participating in the Australian pilot program. Each of which have been given five GPS tracking collars which they can deploy on their school livestock (Fig. 1). Teachers from each institution will undergo

professional development to build their skills and confidence to allow them to incorporate how to collect and analyze GPS livestock tracking data into their digital technology and food and fiber production teaching programs.

In the USA, 8 students from the local 4-H Club are participating in the GPS Cows pilot program. Each student will complete several workshops at the University of Maine on a range of topics including precision agriculture and how GPS tracking technology has been incorporated into livestock research. Following the initial training, students will be given the opportunity to construct their own GPS tracking collar.

Evaluation

A major part of research surrounding the GPS Cows program is developing learning materials to increase the digital literacy of students using agriculture as a case study. As part of an action research process (Reason and Bradbury, 2001) after the initial development of the learning materials these will first be evaluated by educators (teachers and 4-H leaders) to determine whether they perceive they will be effective in assisting students to achieve digital literacy learning outcomes and importantly engage students. This feedback will be used to improve the draft materials and they will then be shared with educators who will deliver them to their students. Students will also be given the opportunity to evaluate the GPS Cows materials and provide researchers with suggestions for improvement. At the end of the pilot program (July 2018) the final materials will be made available on a dedicated open access website allowing educators and students across the world to participate in the GPS Cows program. Qualitative data will also be collected from participants (e.g. researchers, teachers, 4-H club leaders and industry professionals) throughout the development and delivery of GPS Cows and this will be used to determine best practice for the collaborative development of resources designed to increase digital literacy using agriculture as a case study.

Results and Discussion

The preliminary results from GPS Cows consist of the learnings obtained from designing and developing the materials and initial feedback received from participants. The GPS cows materials, when finalized will consist of a range of innovative resources, and will develop and evaluate innovative learning materials for use in digital technology, agriculture and STEM curriculums. The learning materials will be designed so that they consist of a series of lessons which can be used individually or as a sequence. It became evident in trialing the initial materials with teachers that extensive scaffolding was required to guide and support student learning (Hmelo-Silver et al., 2007). Acknowledging the different learning styles of students, materials will be presented using different methods including written instructions, videos and hands-on activities (Pashler et al., 2008).

To provide clear scaffolding to assist student learning the materials will consist of preparatory information introducing students to the basic concepts of GPS, why livestock location and behavior data is important to the agricultural industry and how farmers/ranchers can use this information to increase the productivity, profitability and environmental sustainability of their enterprise. A video case study will be developed showcasing how a farmer is conducting research on their farm using GPS tracking collars

and they intend on using the data to make decisions on the farm. This will demonstrate to students how digital literacy skills are applied in the real world. To fulfil the students who are good at and enjoy hands on activities there will be an opportunity to learn how to build a GPS collar using GPS data loggers (Figure 2). Students will have the opportunity to construct GPS tracking collars for cattle developed for research (Knight et al 2018). These collars utilize an inexpensive, easy to use, and readily available GPS data logger, the Mobile Action i-gotU GT-120 (New Taipei City, Taiwan) making them accessible for schools.

Next, students will access data from the case study farm and complete a structured workshop which steps them through basic analysis in Microsoft Excel and a Geographic Information System (GIS). One of the issues faced in the preliminary development of the GPS Cows materials was the availability of a reliable and economically sustainable platform to analyse the data collected. Researchers often use costly GIS software to interpret livestock location and behaviour data (Bailey, 2009), however the price of this software is often prohibitive to high schools. ESRI has made ArcGIS Online (a condensed version of software ArcGIS Pro) free to high schools participating in the GPS Cows program both in Australia and overseas. ESRI Australia Education Manager Skye Rodgers says "ESRI are committed to the development of digital literacy, spatial awareness, critical thinking, and analytical skills in students across the world. We want every student across every school to be able to access our software and engage with real world issues by analysing big data and making informed decisions. Industry leading software helps prepare students for careers in the modern world by developing their digital literacy skills."

Using this platform, students will not only be able to analyse the data they collect, but they will be able to share and compare data across Australia and the USA, allowing project participants to learn about agricultural production systems across the world. Students will be provided with written directions and also short instructional videos to teach them how to use these software programs.

Fig. 1 Students and teachers from Atherton State High School and Malanda State High School with GPS tracking collars deployed on their livestock.

Fig. 2 4-H Club Members at the University of Maine constructing their own GPS tracking collar.

Students from schools participating in the pilot program in Australia and 4-H club members in the USA will then be given the opportunity to develop a hypothesis and then collect and analyze livestock tracking data to answer their research question. The culmination of the pilot program will see students work with their teachers and/or 4-H regional leaders to develop a poster outlining a science investigation they designed and undertook using GPS livestock tracking technology. Students will compete against other students in their region, and winners will go on to participate in an international competition. Posters will be judged, by academics from CQU and UoM, industry representatives and farmers/ranchers on the quality of their experimental design, visual appeal and ability to communicate their findings. The knowledge developed in this part of the program will allow students to demonstrate the culmination of the digital literacy skills they have acquired through participating in the GPS Cows program.

Conclusion

The 'GPSCows' project is expected to provide numerous benefits to the students engaged in the program including: improved digital literacy, increased skills and knowledge of emerging agricultural technology and its application in the livestock sector, a deeper understanding of future opportunities available to them in the agricultural industry, and a connection with agriculture in different countries, as well as, an awareness of the impact the sector has on the global stage. The exposure to commercial GIS systems such as ArcGIS Online will provide students who have participated in the GPS Cows program with technical skills that will increase their employability in agriculture, and other disciplines which employ similar software. It is hoped that this pilot program will be expanded into more schools and 4-H clubs across Australia and the USA, and potentially to other countries across the world. It is anticipated that the GPS Cows poster competition will be an annual event and sponsorship will be sought to attain prizes for the winners.

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