

Agricultural Context in Science Curriculum in Australia

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Abstract

The *Gateway Schools to Agribusiness project* aims to help young people make a successful transition from school into further education or employment, through a number of initiatives primarily by embedding an agricultural context in a broad range of curriculum in schools in Queensland, Australia. It encourages meaningful collaboration between schools, vocational education and training, universities and industry to provide career opportunities in rural industries for students. There are 16 schools in Queensland, Australia that are designated as Gateway Schools to Agribusiness which provide a broad education for 13 to 18 year old students. Stage 1 of the project (2008-2011) created links to agricultural industries in the school regional areas and developed a strong program of vocational education for students. In 2012, the objective is to embed agricultural context into curricula in the schools. This paper *Agricultural Context in Science Curriculum in Australia* outlines this process and the outcomes. The aim is engage schools in developing curriculum resources contextualised to their specific local agricultural industries. The process is driven through a reference group comprised of school teachers, agricultural industry experts and curriculum writers. The outcomes have been industry-based learning in subjects other than traditional agricultural subjects to engage with students who may not have considered an agricultural career until that time. Rural industries have been very receptive of this approach to raising the profile of careers opportunities and the opportunity for direct engagement with schools.

Learnings from the process of engaging with industries and linking regional businesses to their local schools can be applied to other contexts to enable students to have a broader understanding of their regional career opportunities.

Keywords: Agricultural education; school partnerships; rural careers; Gateway Schools

1.1 Introduction

1.1.1 Gateway to Industry Schools Program (GISP)

In 2006, the Queensland Government created a model for school/ industry partnerships through the Gateway to Industry Schools Program (GISP). The program has created a new connectedness between local communities and schools and a stronger partnership with key regional industries. GISP aims to ensure students make a successful transition from school to work or further education, and are engaged in education and training for the long term. It provides opportunities for young people to experience a range of careers in the industries with the need to address skill shortages at all levels. Through the establishment of meaningful partnerships between school and industry, students are provided with access to industry focused curriculum, work experience opportunities, school based apprenticeships and traineeships, up to date industry career information, structured workplace

learning opportunities and much more. By participating in the Program, and championing support for young people to make informed career choices, industries can ensure their future workforce needs are met.

Gateway to Industry Schools Program is a partnership between Skills Queensland (<http://www.skills.qld.gov.au>), Agrifood Skills Australia (<http://www.agrifoodskills.net.au>) and Department Employment, Economic Development & Innovation (<http://www.deedi.qld.gov.au>). There are six Gateway Schools Projects within GISP, each associated with a key industry in the Queensland economy. These are Agribusiness; Aerospace; Building and Construction; Manufacturing and Engineering; Mining and Energy & Wine Tourism.

This hands-on, industry focused learning prepares students by giving them the opportunity to be fully immersed in an industry, by way of structured contextualised curriculum, work experience, school-based apprenticeships, traineeships and industry visits.

Emphasis is placed on curriculum development which is contextualised to the industry, professional development for teachers, providing access to contemporary industry facilities, development of industry-school partnerships and career awareness opportunities.

Students gain valuable experience in an industry while still at school, providing them with the tools and knowledge to make informed decisions about training and employment upon leaving school, and at the same time raising the profile of careers in the industry sector.

GISP has been the springboard for students to access further education and training in their chosen industry by developing and maintaining school, university, vocational education and training and industry networks.

This expansion of schools into their communities is in response to the combined drivers of schools wanting to give their students more practical outcomes and industry requiring a broader workforce. At the same time, a gradual change has occurred in Australia as schools have developed partnerships with industries of all types. Christian Maroy (2009) characterised this movement of schools outside of a traditional role as “variants of a post-bureaucratic regulation regime” to develop a “quasi-market model”.

1.1.2 Gateway Schools to Agribusiness project

Agricultural industries in Australia face a looming crisis in its workforce due to ageing of their staff, skilled workers exiting to the mining sector, and poor attraction and retention rates over an extended period which have left an insufficient pool of young workers.

By 2018 over 102,000 of the current labour force – equating to 33.4 per cent – will be aged 65 years and over. A staggering 56.2 per cent of the current workforce will be aged over 55 years. Half of our agricultural scientists are nearing retirement (AgriFood Skills Australia (2011)). It is predicted that the tipping point when more of the workforce will leave than enter will occur between 2013 - 2018.

The Gateway Schools to Agribusiness Project has the dual aims of addressing the issue of a decreasing workforce and to creating agricultural literacy in the general populace. It has been said

that the population that possesses an understanding of agriculture is more likely to make informed decisions concerning agricultural policies that benefit society (Ryan & Lockaby, 1996). Creating agricultural literacy will not solve the problem of a declining agricultural sector but it will raise the importance of food and fibre production.

There are 16 Gateway Schools to Agribusiness registered as part of the project, all based in Queensland, Australia. The schools are grouped according to geographic region – South, Central and North regions. Each regional group is led by a Coordinator. The Coordinators have experience as teachers, two of whom are based in the Department of Education. The third Coordinator is experienced in both education and rural industries with the aim of bringing expertise in creating industry partnerships.

The Gateway Schools to Agribusiness project has focused on:

1. Industry School Partnerships - Strong education, training, industry and community partnerships developed to address employment needs.
2. Innovative Curricula - The implementation of contemporary, industry relevant curricula, supported by professional development for teachers.
3. Access to contemporary industry focused facilities - Increased access gained by young people to a contemporary industry focussed working environment that supports the development of knowledge, skills and attributes required by industry.

This research concerns the introduction of curricula contextualised to rural industries across a range of subject areas in South Region Gateway Schools to Agribusiness.

2.1 Development of the Project

2.1.1 Theoretical framework

Research has indicated that providing relevant curriculum at an appropriate age, along with professional development for teachers can influence students thinking about agriculture and their propensity to take up careers in primary industries.

A study conducted in the US in 1999 found that there can be an improvement in the agricultural knowledge of middle school students (11-14 years) through instruction about agriculture. This age group of students represents an important educational stage for developing an increased understanding and appreciation about agriculture (Brown & Stewart, 1992). Despite this increase in knowledge, there was not a significant relationship between agricultural knowledge and the agricultural attitude of these students.

However, Birkenholz et al (1990) found that a better approach involved a structured curriculum at the seventh or eighth grade (12-14 years) level. The curriculum was designed to accommodate a module within an existing course or to encompass an entire quarter, semester, or year-long course. This approach was to infuse instruction about agriculture into the public school curriculum and is further supported by research conducted in Arizona with 3rd and 5th grade classes (8-10 years) (Schmidbauer, Pastor & Elliot 2005).

The curricula used were in the subject areas of reading, language arts (writing), and mathematics. The research found that the program was an excellent opportunity to create agriculturally literate people; however, if elaborate instruction is not given for passing along what teachers have learned to their students, the information does not progress.

In *Agricultural In-service: Needs of Technology, Life and Careers Teachers*, Christensen et al (2008) found that agriculture in the United States will continue to require qualified applicants to fill open positions. In order to provide this training for students, teachers must be current in their knowledge of the agriculture industry and agricultural careers. The best way to do this is by providing current, meaningful professional development according to what teachers perceive as important and the topics they perceive themselves less able or prepared to teach.

2.1.2 Gateway Schools to Agribusiness pilot schools

Gateway Schools to Agribusiness (<http://www.gatewayschools.qld.gov.au/agribusiness/>) work together in the sharing of information, ideas, teacher professional development and resources as well as strengthening partnerships with Agribusiness industries. From these partnerships, opportunities for work experience, structured work placements and school based traineeships or cadetships with Agribusiness industries at all levels become increasingly possible.

Schools in the Gateway School to Agribusiness project endeavour to embed key learning areas and associated curriculum with a range of agribusiness related contexts and activities in and out of the classroom. A review of the Gateway Schools program in 2011 found that working together to develop new curriculum materials enhanced professional engagement and learning opportunities (Kapitzke & Hay 2011). An example of this cooperation is the development of mathematics units as part of the Wine Science unit of study in the Gateway Schools to Wine Tourism program.

Two schools in a cotton growing area were selected as pilot schools for this project with the objective of embedding the cotton curriculum into other cotton growing regional based schools after review of the project outcomes. The pilot schools were Goondiwindi State School (5-12 years) and Goondiwindi State High School (13-17 years) in Queensland.

2.1.3 The Australian Curriculum

The Australian Curriculum (<http://www.australiancurriculum.edu.au/>) sets out the core knowledge, understanding, skills and general capabilities important for all Australian students and is delivered to all students from Foundation to Year 10 (5-15 years). It is being implemented in Queensland in 2012 for English, Science, Mathematics and History with other Key Learning Areas to be progressively introduced.

The Australian Curriculum includes a focus on seven general capabilities (literacy, numeracy, information and communication technology competence, critical and creative thinking, ethical behaviour, personal and social competence and intercultural understanding) and three cross-curriculum priorities (Aboriginal and Torres Strait Islander histories and cultures, Asia and Australia's engagement with Asia, and Sustainability).

The Australian Curriculum determines what all young people should be taught through the specification of curriculum content and the learning expected at points in their schooling through the specification of achievement standards. The introduction of a uniform Australian Curriculum enables curriculum resources to be utilised across state boundaries, which was impossible in the past due to different state-based curriculum. As part of the introduction of the curriculum, schools are required to contextualize their curriculum to their regional area. This is an opportunity, at a base level, for rural industries to influence the context of the examples and case studies used in classrooms.

2.1.4 Contextualised curriculum

This approach to contextualisation of content and pedagogy using agricultural experiences offers options to improve the relevance of education and influence career direction for students. Curriculum processes are often very demanding and leave little opportunities for interpretation of the content. Decentralized curricular interpretation and adaptation and contextualisation of contents and methods need to be possible within prescribed national curricula (Vandenbosch, 2007). This researcher continued that “Participatory curriculum development where relevant stakeholders and experts are involved contributes to better curricula”.

There were three phases to successfully embed contextualised curriculum into schools.

1. Establishment of a reference group comprising curriculum writers, educators and industry representatives. The role of the group is to provide advice on curriculum choice, review the resources and create partnerships between the school and industry.
2. Resources created by an external curriculum writer with experience in education and rural industries in order to understand the perspective of both groups and provide outcomes that will meet the needs of both schools and industry.
3. Professional development sessions for classroom teachers to give them knowledge of both the resources and industry context so that they have confidence in their classroom delivery.

Significant support is needed in schools to assist teachers to implement contextualised curriculum. Ash (2008) stated that education authorities will need to follow the lead of successful projects such as Primary Connections initiatives in generating full contextualised courses of study with unit and lesson plans. Through using such materials, teachers have the opportunity to develop their conceptual knowledge as well as experiencing contextualisation, without being expected to invent the wheel themselves.

2.2 Reference Group

To ensure acceptance of contextualised curricula by industry and schools, we have found it is imperative that a reference group lead the process. The reference group for this project was made up of representatives of the schools, the Gateway Coordinator, local training providers, Cotton Australia (industry representative organisation), cotton growers and government.

The group has met regularly to plan and lead the project, however, the schools and their teaching staff have taken a more prominent role as the resources have been developed and reviewed. It has been particularly important that classroom teachers have had input to the resource development as they are the ‘coalface’ of delivery and without their support, the resources will not be delivered to students.

Interaction with the pilot schools was an important part of the integration of the cotton curriculum into the schools' programs. Teachers are very busy in their classrooms and are time-poor in creating their own resources. Thus it has been important to gain the trust and involvement of the school administration and staff to ensure that the resources are used in the classroom.

2.3 Curricula Development

This project is developing classroom resources to be used as part of the Australian curriculum in Queensland schools. Currently, curricula have been contextualised to the cotton industry, with on-going work to contextualise resources to the macadamia industry.

3.3.1 Cotton industry

In Australia cotton is grown in southern, central and north-western New South Wales (NSW) and central and southern Queensland. The majority of these cotton farms are family owned. Approximately two-thirds of Australian cotton is grown in NSW and the remainder produced in Queensland.

The typical Australian cotton farm is:

- Australian owned
- Family owned and operated
- Medium sized (an average 400 hectares of cotton)
- A mixed enterprise growing other commodities such as grain and livestock

Australia's growers produce very high quality cotton with low contamination that is in demand on the world market and commands a premium price. For Australia's growers to compete in a heavily subsidised world market they must be extremely efficient, grow high yields and keep their costs as low as possible. Australia is the fourth largest exporter of cotton in the world.

The cotton industry committed to funding this project with the aims of informing the community about their industry and creating an awareness of the industry with the expectation that more students will choose agricultural studies or farming careers as they complete their schooling.

2.3.2 Cotton curriculum

The science curriculum was selected for lesson development based on:

1. Alignment of science with the nature of agriculture
2. Discussion of the needs within the schools
3. Dialogue with an industry reference group in the local area

Following the choice of curriculum area, each school chose the most appropriate year levels for lesson delivery. The following year levels and curriculum topics were determined to provide the best possible approach to including as much information on the cotton context as possible at a level that is age appropriate.

Table 1: Selected curriculum for contextualisation of science curriculum

Year level	Student age (years)	Topic	Content
2	7	Good to grow	Students explore the way living things grow, change and have offspring similar to the parents. Understand the life stages of living things through investigating the growth of a Heliothis (moth pest of cotton) under different temperature conditions.
5	10	Survival in the Australian environment	Students explore how cotton survives in the Australian environment. How the structures of a cotton plant help it to survive in its environment and how other plants & animals have adapted for survival.
7	12	Water — waste not, want not	Students explore what they think they know about water, where it comes from with regard the relationship between water and cotton. To provide hands- on, shared experience of the lay- out and function of an Irrigated Cotton Farm with regards to its water use. To explore the movement of water across the landscape. To teach students to describe sources of water on cotton farm, how it is collected, transported, accessed, used, saved and recycled. To support students to research sustainable water use and management on cotton farms.
8	13	Building blocks of life - cells, and their specialised structures and functions	Students explore how organisms reproduce, starting at a cellular level. They focus on cell structure, function and reproduction. (Plant section only)

An independent curriculum writer was used to write the lesson plans as they were able to take an independent view of what was required. Teachers in schools are time-poor and do not have time to develop such resources themselves.

Resources were developed to meet the requirements of the newly introduced Australian curriculum to enable Lesson Plans that are developed in one region to be transferable to other similar regions, based on the transferability of a national standard of curriculum. Thus, these lesson plans may be used in other cotton growing areas or could be used by other schools who may wish to introduce a rural flavour to their lessons.

The development of the resources has been a collaborative effort with drafts of lesson plans reviewed by experienced teachers in each school. Feedback from the reviews was incorporated into the final lesson plans to receive a final sign-off in the schools.

2.3.3 Lesson plans

Science is a dynamic, collaborative and creative human endeavour arising from our desire to make sense of our world through exploring the unknown, investigating universal mysteries, making predictions and solving problems (Australian Curriculum Assessment and Reporting Authority, 2012). The Australian Curriculum: Science provides opportunities for students to develop an understanding of important science concepts and processes, the practices used to develop scientific knowledge, of science's contribution to our culture and society, and its applications in our lives.

In this project, lesson plans were developed that provides this opportunity through contextualisation to an agricultural industry ie. Cotton. The lesson plans are based on five sequential steps that build on a topic in a logical manner. These are Engage; Explore; Explain; Elaborate; and Evaluate: the 5Es (The Australian Academy of Science Primary Connections, 2012).

This is an inquiry-orientated teaching and learning model where students use their prior knowledge and literacies to develop explanations for their hands-on experiences of scientific phenomena. Students have opportunities to represent and re-represent their developing understanding. They are engaged actively in the learning process.

Table 2 The 5 Es An elaboration of the PrimaryConnections 5Es teaching and learning model Adapted from Bybee (1989)

Engage	A lesson that mentally engages students with an activity or question. It captures their interest, provides an opportunity for them to express what they know about the concept or skill being developed, and helps them to make connections between what they know and the new ideas.
Explore	Students carry out hands-on activities in which they can explore the concept or skill. They grapple with the problem or phenomenon and describe it in their own words. This phase allows students to acquire a common set of experiences that they can use to help each other make sense of the new concept or skill.
Explain	Only after students have explored the concept or skill does the teacher provide the concepts and terms used by the students to develop explanations for the phenomenon they have experienced. The significant aspect of this phase is that explanation follows experience.
Elaborate	This phase provides opportunities for students to apply what they have learned to new situations and so develop a deeper understanding of the concept or greater use of the skill. It is important for students to discuss and compare their ideas with each other during this phase.
Evaluate	The final phase provides an opportunity for students to review and reflect on their own learning and new understanding and skills. It is also when students provide evidence for changes to their understanding, beliefs and skills.

An example of the lesson plan sequence is available at Appendix 1.

2.4 Professional Development

An integral part of the process of embedding contextualised curricula into classrooms is to gain the support and understanding of classroom teachers. They have the capacity to review and evaluate the resources and include the new learning activities.

A two hour workshop was held in each school for each set of resources to provide background and context on the cotton industry for classroom teachers. This is particularly important for teachers who may not be from a rural background. The teachers need to be comfortable in their knowledge of the rural industry; although it may be considered that the cotton industry information in these resources may be at a basic level.

An industry representative presented background to the resources at a level that was relevant to the student age level. For example: teachers heard information about *Heliothus sp* (a devastating cotton insect pest) that was important for teachers to utilise the Year 2 (7 years) resources appropriately.

The curriculum writer, an experienced teacher, presented information on the activities in the set of lesson plans and methods for teachers to use these in their classrooms.

An important aspect of the professional development sessions were the networks created that encouraged teachers to take their students out of the classroom onto the farms that were supporting the program. The industry representatives were also available as an on-going resource and mentor for the teachers as they had made a personal connection via the professional development session.

3.1 Key Outcomes

A major component of the success of the project is the effective support and links schools have with industry. Industry must be supportive and see a need to invest now in their future workforce by attracting young people at the school level.

Support is required from local industries located within close proximity to a Gateway School as well as larger corporate industries that can support a school even though they are not necessarily in close proximity.

On a more practical level, classroom resources, contextualised to the cotton industry, based on the Australian curriculum can be transferred to other schools in cotton growing areas. Sets of lesson plans for Years 2; 5, 7, & 8 (7, 10, 12, 13 years respectively) have been developed.

It is envisaged that the lesson plan resources be made available to other Gateway to Agribusiness Schools in cotton growing regions in Queensland. Following this next stage, the resources should be reviewed to incorporate feedback from a wider audience.

It is expected that the resources could be available for distribution to other cotton growing regions (outside Queensland) in early 2013.

The aim is for students in classes other than agriculture to gain knowledge of rural industries and to see the benefits of progressing into this industry at many levels throughout its supply chain. At the very least, students are in a situation to make a more informed decision on whether this was a pathway they wished to pursue.

Teachers in schools have become more informed about the cotton industry and its links to their local area. Industry is more informed on how they can assist schools; and schools become more aware of the industry and its operations.

3.1.1 Further development

The lesson plans will be reviewed by the reference group at the completion of the pilot at the end of 2012. Following any adaptations, the lesson plans will be available for other schools in cotton growing regions. Due to the introduction of the Australian Curriculum, there is uniformity across all Australian schools in the timing and format of curriculum in Science, English, Mathematics and History (to date).

It is planned that schools will not be able to implement the resources into their program until they have completed a professional development session for their classroom staff that will provide background on the cotton industry provided by industry members e.g. extension staff or growers.

The outcome is that class resources developed for one agricultural theme may be utilised in a number of growing regions for the one commodity. It is also expected that other Gateway Schools will utilise the resources. Loganlea State High School, an inner city school has expressed interest in the completed program as they view the resources as a way of informing their students about opportunities in an industry outside their usual scope.

The resources are also important in providing background to students who may never choose to work in the cotton industry or indeed agriculture. These students will gain a broader understanding of the context of a rural industry as part of their knowledge base of science.

As a result of the pilot project, another industry has committed to funding and supporting curricula development for their industry. The macadamia industry will invest in classroom resources that will be contextualised to another subject curriculum for Years 9/10 (14/15 years). It is expected that 2 x 5 week units will be completed that will use case studies of macadamia farming businesses. This work will provide proofing of the model developed in this project.

4.1 Conclusion

The Gateway Schools to Agribusiness model for creating school/ industry partnerships to contextualise curriculum in schools has proved successful in engaging with teachers and agricultural industry. It is important that all phases of the model are utilised as they are co-dependent and successful embedding of curriculum will not occur without each step being implemented.

Future curriculum development should involve establishment of a reference group comprising curriculum writers, educators and industry representatives; resources created by an external curriculum writer with experience in education and rural industries and a professional development session for classroom teachers to give them knowledge of both the resources and industry context. The reference group is important to ensure the outcomes meet the needs of both the agricultural industry, the teaching community and most importantly, the students.

As classroom teachers are time-poor and will not engage easily when further calls are made on their time, it was important in this project to provide a solution to making their ownership of the outcomes as smooth as possible. Without teacher ownership, resources that are imposed onto them will not be well utilised.

The industry must be involved in the early stages to ensure that resources are compliant with industry expectations. Teachers have to be involved in a review process but only after resources have been drafted.

This convergence of interests has been successful in this project in creating a lasting legacy that can be extended beyond the pilot program and will boost interest in the cotton industry as a career path and a part of the rural framework.

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6.1 APPENDIX 1

Water- Waste Not, Want Not- Year 7 Unit

Table 2 Unit at a Glance

PHASE	LESSON	AT A GLANCE
ENGAGE	LESSON 1 Water- Where Does It Come From	To capture students' interest and find out what they think they know about the water, where it comes from and how it is used.
EXPLORE	LESSON 2 Understanding the cotton/ water cycle.	To have a greater understanding of local weather averages. To explore the relationship between water and cotton.
	Lesson 3 Session 1 Farm Walk Session 2 Ground Water	To provide hands- on, shared experience of the lay- out and function of an Irrigated Cotton Farm in regards to its water use.
	Lesson 4 Overland Flow	To explore the movement of water across the landscape that further expands the students' knowledge of water harvesting on cotton farms.
	Lesson 5 Water Story Of A Cotton Farm	To support students to describe a cotton farm's sources of water, and how it is collected, transported, accessed, used, saved and recycled.
ELABORATE	Lesson 6 Sustainable Water Use Session 1 Interview Planning Session 2 Guest Speaker	To support students to research sustainable water use and management on cotton farms.
EVALUATE	Lesson 7	Students reflect on their learning to develop an opinion concerning the use of water in the cotton industry.