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Learning and Capacity Building for Irrigators in Western Australia's East Wanneroo Area: A Theoretical Framework for Educational Provision and a Sketch of the Socioecological Context

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In Western Australia the East Wanneroo horticultural area is reliant on a superficial aquifer, the Gnangara Groundwater Mound, for irrigation. The area is affected by social and political change as the sprawling city of Perth expands, as well as by ecological changes resulting from a decline in groundwater levels. Horticulturalists face increasing competition for water allocation particularly with the drier conditions which are the consequence of two decades of reduced rainfall. This study provides a rationale for an educational intervention; explores the social, political, and ecological context of the East Wanneroo agricultural area; identifies gaps in current knowledge and understanding of the irrigation community and linkages between this community and their context which require further investigation and clarification; and outlines a theoretical framework which can be applied to develop a customized educational strategy aimed at improving irrigation practices and promoting sustainable communities and water usage.

The inefficiency of irrigation practices in Australia is a well-known issue which has implications for the environment, for agricultural production, and for the sustainability of communities reliant on horticulture for income. In 1983, researchers at the CSIRO Centre for Irrigation Research noted that "world survey data [for irrigation] suggests an overall project efficiency of about 38%" (Smith, Mason, Meyer, Barrs, 1983, p. 115). They go on (p. 116) to state that, "published data on Australian irrigation efficiencies, though deficient . . . indicate considerable scope for increasing the efficiency with which the high-quality water from existing sources is utilized."

These and other statements made by Smith et al. (1983) imply scope for

substantial improvement in irrigation efficiency by changing irrigation practice. In the 20 plus years since, research in Australia has addressed the lack of information and the development of a broad range of strategies to improve irrigation efficiencies. The scope of the research includes technological innovation, improving understanding of irrigation practices and their impact on associated ecological systems, developing a more sophisticated understanding of the ecological systems where irrigation is practiced, and development of “best practice” frameworks.

That irrigation efficiency can be improved significantly using existing technologies indicates the potential for substantial improvements with intervention at the level of behavioral change and irrigation practice. This is highlighted in a report to the Australian National Program for Irrigation Research and Development (NPIRD) which notes that “our knowledge about . . . socio-economic issues lags well behind our technical knowledge. Yet net benefits from changes in economic and social structures and relationships are possibly as great as those from technical breakthroughs” (Kingma & Beynon, 2002, p. 3).

The report *Socio-Economic Research and Development for Irrigation Communities* (Kingma & Beynon, 2002) emphasizes the importance of an holistic and integrated approach to improving irrigation practices: “the issues are complex and will not be able to be handled in isolation . . . the linkages within and between natural systems and the interplay of economic, social and biophysical factors that influence natural resource decision making, will require a more coordinated and integrated approach” (Kingma & Beynon, p. 3). Within this integrated framework “Learning” is identified as one of the four key research categories required to “equip us with the insights and tools to shift towards more sustainable production systems and water use and management regimes”(Kingma & Beynon, p. 9). At the level of behavioral change, the emphasis is on “capacity building and learning” (Kingma & Beynon, p. 9) which must necessarily be tailored to the needs of specific irrigation communities since “irrigation communities are not easily defined . . . blanket recommendations and broad strategies for change across these various groups may fail to attract the appropriate responses” (Kingma & Beynon, p. 3).

These findings are consistent with research conducted internationally in the areas of sustainability and conservation. Berkes, Colding, and Folke (2003) focus on the interventions required to develop sustainability, and to restore “resilience” to disrupted ecosystems. While they do not specifically identify educational interventions as a strategy for building capacity, they do identify “the ability to build and increase the capacity for learning and adaptation” (Berkes et al., 2003, p. 13) as one of the three defining characteristics of ecosystem resilience. They note, further, that the “challenge is to analyze

critical linkages in social-ecological systems, and to generate insights into how to interpret, respond to, and manage feedbacks from complex systems” (Berkes et al., p. 13).

Similarly, environmental education has been identified by the World Wildlife Fund as one of the six key strategies used to achieve their mission, thus, “Promoting environmental education and building capacity to enable people to sustainably manage the natural resources on which life depends” (Scott and Gough, 2003, p. 213). A study on the effectiveness of World Wildlife Fund’s international educational provision notes that “Education is widely acknowledged to be one of the key social strategies for the conservation of biodiversity, at least by those who understand that what people do in their ordinary lives both matters and can make a difference” (Scott and Gough, p. 213).

East Wanneroo Irrigation

The East Wanneroo rural zone is located within the City of Wanneroo local government area northeast of Perth Central Business District, Western Australia. Horticulture has long been a part of the Wanneroo economy with market gardens producing vegetables for local consumption. Currently, due to urban growth, land use in the area is predominantly residential, with some areas of industrial land use, and of course, the horticultural areas that make up the East Wanneroo rural zone. Rural land use in the area is predominantly horticulture (market-gardening) including strawberries, though with some diversification: flowers are produced for local and overseas markets, and turf farms supply roll-on lawn for a range of domestic and commercial clients. Due to Western Australia’s dry climate, horticulture is dependent on groundwater irrigation for production. The source of the groundwater is the superficial aquifer of the Gngara Groundwater Mound, a source which is under considerable strain due to heavy demands and reductions in both rainfall and recharge. Consequently, there has been criticism of all abstraction and use of water from the mound, including water abstracted privately for use in horticulture.

The use of more efficient and sustainable agricultural practices has been proposed as a solution to water and land management issues in the Wanneroo area (City of Wanneroo, 2000; Western Australian Planning Commission, 2004). While it may be possible to effect these changes through the monitoring of irrigation practice by external agencies and the introduction of penalties for noncompliance with guidelines, a preferred approach is the provision of education to irrigators to enable them to make informed decisions about the ways they practice horticulture, and thus promote sustainability. For, as Ehrenfeld (1993, p. 183) has noted, “If we have to conserve the earth in spite of ourselves, we will not be able to do it.”

The development of an educational strategy to promote learning and thus build

capacity in the irrigation community in East Wanneroo requires an understanding of the social, economic, political, and ecological features of the system in which irrigation is practiced, and the interrelationships among these features. It requires, as well, investigation to “uncover the factors and complexities that facilitate motivation and learning” (Kingma & Beynon, 2002, p. 3) in this community. And it must, of course, integrate knowledge from research and development projects in irrigation and horticultural practices. What follows is a proposed theoretical framework and process for designing learning initiatives consistent with, and sympathetic to, a local community and their learning environment. That is, designing an educational intervention developed along the interface of the social ecological system in which it is to be implemented, and aimed at improving the ability of the learners to interpret, respond to, and manage feedbacks from the system in which they are working and of which they are a part.

Towards an Educational Model

The necessity of tailoring education to specific communities and environmental concerns is well-documented. However, the literature shows little evidence of a systematic approach to developing educational strategies to promote learning and capacity building. What should be done is relatively clear; how this should or even could be done is less apparent. The following is an attempt to formulate and articulate a theoretical framework for the development of tailored environmental educational strategies. It is proposed to apply this framework to the context of the irrigation community of East Wanneroo.

In order to design an educational strategy to promote learning and thus build capacity, it is proposed to apply existing principles; guidelines and models drawn from education to the social-ecological context of the learning community in which it will be applied. Specifically, elements of the ADDIE model used in Instructional Design (Fardouly, 1998) will be used to develop an understanding of the learning needs, preferences and tasks of (in this instance) the irrigation community and to inform the design of learning strategies and resources.

Inherent in the application of this model to the East Wanneroo context will be the recognition that environmental education should be based on the principles and guidelines of adult education (andragogy) rather than those of pedagogy. In this case, the educational strategy will be designed to take into consideration the characteristics and motivations of adult learners in general and the characteristics and motivations of the East Wanneroo irrigation community specifically.

Addie Model and Adult Learning

The notion that education must be tailored to a specific audience is consistent

with the principles and models of Instructional Design which is the art and science of designing teaching and learning resources and strategies in “ways that facilitate knowledge construction” (Jonassen, 1998, p. 217). That is, of making informed decisions about the best ways to promote learning, based on the needs and preferences of the learners and the specific skills and knowledge being taught. There are a number of models used in instructional design; one of the most popular and frequently used is the ADDIE model (Fardouly, 1998). ADDIE is an acronym for the processes involved in developing learning materials. These are Analysis, Design, Development, Implementation, and Evaluation. The analysis phase is of particular significance in the development of environmental education and in the context of an irrigation community. Information gathered during this phase will be used to inform the design, development, and implementation of learning strategies, and it is at this stage that the specific characteristics and motivations of the irrigation community will be identified.

In the context of East Wanneroo, the use of this model will be coupled with the recognition that key stakeholders in the irrigation community are adults, and that the learning principles relevant for adults and adult learning should be incorporated into the educational design. Within educational theory and practice, “andragogy” is the term used variously to refer to the principles, guidelines, and models used in adult learning. Carlson (1989) notes that, although this term was first coined by Alexander Kapp in 1833, it is generally associated with Malcolm Knowles who worked extensively in the field of informal adult education. Knowles attempted to build a comprehensive theory of adult learning based on the characteristics of adult learners. This model or theory is considered problematic since it uses ideas from two quite different and opposing fields of psychology—humanist and behavioral (Smith, 2002). Further, it is unclear whether Knowles’ work actually comprises a theory or model, or, is rather, a set of guidelines for practice (Smith, 2002). In the current context, the more limited definition of andragogy, whereby it refers to the characteristics of adult learners, will be used. Similar characteristics of “how adults learn” have been articulated in the work of the International Institute for Environment and Development. The IIED works extensively to promote sustainable agriculture in the developing world using participatory approaches. Table 1 gives a comparative summary of the characteristics of adult learners drawn from Lieb (nd) and Pretty, Guijt, Scoones, & Thompson (1995).

These characteristics are an important starting point in the design of an educational strategy to promote learning and capacity building in an irrigation community. To ensure that the educational initiative “fits” the learning community, it is essential to gain a further understanding of the audience, to clarify the goals of the learning, and to develop an understanding of the environment in which the learning will be applied. The analysis phase of the

design process will include gathering and interpretation of two types of data.

Table 1 Characteristics of adult learners

Knowles (From Lieb)	From IIED
Adults are autonomous and self-directed.	Adults are voluntary learners.
Adults have accumulated a foundation of life experiences and knowledge that may include work-related activities, family responsibilities and previous education.	Adults have usually come with an intention to learn.
Adults need to be shown respect.	Adults learn best in an atmosphere of active involvement and participation
Adults are goal oriented.	Adults have experience and can help each other to learn
Adults are relevancy oriented.	Adults learn best when it is clear that the context of the training is close to their own tasks or jobs.
Adults are practical.	

Existing information and data on the social-ecological system of East Wanneroo will be analyzed to gain an understanding of the broad scale social, political, economic, and ecological factors and their relevance to the irrigation community and to horticultural production in the area. Primary data will also be required to explore and clarify key issues relevant to the design, development, and implementation of the educational intervention which are not covered, or are insufficiently covered by existing data. There is, for example, no specific data regarding the demographic composition of the irrigation community or the language/s they speak. In addition, the impact and influences of social, political, and environmental changes on the irrigation community in East Wanneroo have not, to date, been systematically explored.

Audience and Learning Needs Analysis

Answers to the questions typically asked in the analysis phase of instructional design (Fardouly, 1998.) follow, with further clarification of the types of information required. The sketch of the social and ecological landscape of East Wanneroo is a synopsis of the information currently available. Further research will be designed according to the analytical framework of audience analysis,

and targeted specifically by drawing upon existing knowledge of the social-ecological system.

Who are the Learners?

Analysis of the learning audience is necessary to develop an understanding of the extent to which, and ways in which, the learning characteristics of the irrigation community are aligned with the characteristics attributed to adult learners. Analysis will also identify the specific goals and motivations of the community, and identify levels of previous knowledge and experience, as well as any cultural and language considerations that need to be considered in the development of an educational initiative. These questions can only be answered through communication with the learning audience, in this instance, members of the irrigation community.

What are the Goals of the Learning?

The goals of learning for capacity building are, to a certain extent, self-evident. The intentions in this instance are: to promote more efficient use of water; to ensure ongoing production, to reduce, halt, and hopefully restore damage to the environment caused by unsustainable agricultural practices; and to ensure the on-going livelihoods of the irrigators. The extent to which this is possible and the ways in which this level of success can be achieved will be dependent not only on the irrigation community and the success of the educational initiative but also on the sociopolitical context of this community. That is, the degree of success (and sustainability) achieved will be affected by the level of cooperation or hindrance offered by various community sectors and government agencies, and by the economic and environmental constraints experienced by the irrigators themselves. This final point brings us to the third aspect of the analysis phase.

What is the Environment in Which the Learning will be Applied?

Successful implementation of learning to promote capacity building in East Wanneroo demands that the educational initiative be consistent with the ecological, social, and political context of the area. It is important, in designing an educational initiative for sustainability, that this is based on an understanding of the context in which the learners are applying their knowledge. It is essential to understand the ecology of the area in which the irrigation community is situated, to be able to comprehend the indicators that signal degradation of this system and, thus, choose the most strategic interventions. It is also essential to understand the social and political systems of the area; this understanding will delineate between reasonable and unreasonable expectations in terms of the behavior and technologies that irrigators can adopt.

Sketching the Social and Ecological Context

Some aspects of the social and ecological context of the East Wanneroo irrigation community are well-known and documented; others less so. Tools for further data gathering will be designed through a combination of analysis of gaps in the existing knowledge and the questions asked in the analysis phase of the ADDIE process.

Social Context

Anecdotal evidence suggests that most irrigators in the Wanneroo area are first or second generation migrants. However, extensive interrogation of the Australian Bureau of Statistics census data for the area did not provide any clear indications regarding the demographic composition of the irrigation community. Data for East Wanneroo is contained within the data set for the Local Government area of the City of Wanneroo. While these data showed some demographic trends including a significant migrant population, it was impossible, due to the size of the data set, to determine whether these trends were relevant to the irrigation community. In addition, despite the apparent strong urban growth in areas previously zoned for rural use, no data were available to show migration trends either within the Wanneroo area, or into and out of the area.

To inform the design of the educational initiative, more specific information regarding the demographic composition of the irrigation community is necessary. If, as is supposed, the irrigation community is comprised partly of people from a non-English speaking background then it is also necessary to identify the language or languages commonly used. It is also important to determine whether the use of English in the delivery of educational resources will create a barrier to participation in the learning process, and, if so, what strategies should be used to address language considerations.

Information regarding migration both into and out of the Wanneroo area, and within the area is important in determining whether and how land zoning changes are impacting on the irrigation community. Also, the length of tenure and the stability of the irrigation population will provide an indication of the types of interventions that irrigators may be willing to adopt. A transitory population is less likely to be willing (or able) to adopt technologies and practices with high initial uptake costs (International Environment Technology Centre, November 2003, p. v).

Water Allocation and Monitoring

The Gnangara Mound is a large source of groundwater comprised of at least three identifiable aquifers—the Leederville and the Yarragadee aquifers which

are older, deeper and largely confined, and the unconfined Superficial Aquifer. Water is abstracted from all three aquifers to supplement Perth's scheme water supply. However, private abstraction—including industry, land developers, and market gardens—is permitted from the Superficial Aquifer only. This groundwater source is closely monitored and subject to two management proposals, specifically, *Gnangara Groundwater Resources* and *Groundwater Resource Allocation East Gnangara*. These proposals focus on “abstraction from the Superficial Aquifer because pumping from this aquifer has the greatest potential to impact on the environment” (Water and Rivers Commission, 2004, p. 8).

There has been a substantial decline in the groundwater levels of the mound with significant environmental consequences. These include the loss of some unique groundwater dependent species in the Yanchep cave system, increased acidity of some wetlands (Sommer & Horwitz, 2001), fires in wetlands resulting in loss of organic rich sediment, and a decrease in the health of wetland vegetation in some areas (Water and Rivers Commission, 2004). A number of possible reasons have been cited for this decline. These include a decrease in Perth's rainfall, increased evapotranspiration caused by higher than average summer temperatures, reduced recharge caused by pine plantations and significant urban growth, and the overallocation of water for private abstraction (Salama, Bekele, Hatton, Pollock, & Lee-Steere, 2002). In response to this decline, the Water Corporation has been required to shut down approximately 40 bores used for abstraction for public water supply (Water and Rivers Commission, 2004), additional funding has been provided to the Water and Rivers Commission to employ eight staff to “increase inspections and compliance surveys” of private water abstraction (Water and Rivers Commission, 2004, p. 8), and some wetlands are being maintained artificially by pumping in water (Water and Rivers Commission, 2004).

Current literature does not provide a clear indication of the impact that reduced groundwater levels and the associated environmental consequences have on irrigation practices and horticultural production. Further data gathering is required to elicit irrigators' understanding and perceptions regarding the groundwater system on which they are dependent. It is also necessary to clarify irrigators' understanding of sociopolitical issues pertinent to their water supply—that is, monitoring and regulation of water allocation and the impact of these measures on their horticultural practice.

Land Use and Zoning

In addition to water allocation issues, horticulturalists in East Wanneroo are affected by land use conflict as Perth's population grows, and urbanization spreads. Land in the Council of Wanneroo is increasingly attractive for urban development—a relatively affordable and attractive option for many home

buyers— particularly when compared to subdivision and redevelopment of suburbs closer to the Perth Central Business District. Rezoning of land from rural to urban is also driven by the widespread belief that changing from rural to urban land use will reduce demands on the groundwater system. The Department of Planning and Infrastructure's report notes that "When all of the existing Urban and Industrial zoned land is fully developed over the next 5 years, there may be the potential to recoup significant groundwater allocations and to reallocate groundwater to other rural areas" (2004, p. 13). The move from rural to urban zoning is further reinforced by the fact that a substantial portion of land zoned for rural use has no water allocation, (69%) and cannot be used for agricultural production (Western Australian Planning Commission, 2004). Due to water management proposals for the Gnamptara Groundwater area, there are allocation limits on water available for private abstraction. The limits have been reached in some areas and issuing of licenses has ceased (Water and Rivers Commission, 2004). It is "the Department of Environment's view that it is most unlikely that the large amounts of groundwater required to utilize all of the land zoned . . . for productive irrigated horticulture would ever be available" (Western Australian Planning Commission, 2004, p. 17).

As a consequence of rezoning of land previously used for horticulture, agriculture is being displaced from the southern areas into the northern area (Western Australian Planning Commission, 2004). However, following the development of the Interim Report, some areas in Wanneroo have been set aside for rural use, with no prospect of urban development, at least in the short term. Further clarification of the impact of land zoning issues and the movement of agriculture from the southern rural area into the northern areas is necessary to determine the possible and actual impacts on horticultural practice and the environment.

Summary

Scott and Gough (2003) among others have noted that environmental education is one of the key strategies to promote sustainability. It is also apparent that there is a potential to produce improvements in the sustainability of agriculture dependent on irrigation through learning and establishing learning cultures and communities. Robottom (2004, p. 22) has noted that, "the socially constructed (and therefore socially, historically, and geographically situated) nature of environmental issues implies a necessary context-dependency for environmental education." The contexts in which irrigation is practiced are certainly complex and in general little understood.

In order to design and develop a contextualized educational strategy it is essential to first understand the social ecological context where the educational intervention will be implemented, including the specific characteristics of the learning community. In the context of the East Wanneroo irrigation community,

it is important to develop an understanding of the community and their motivations, their agricultural practices, and the interactions between the community and the socioecological system in which they are situated and of which they are a part. A substantial body of research has been undertaken in the East Wanneroo area, principally focused on monitoring of wetlands and groundwater levels. However, to date, this includes little information specific to the East Wanneroo irrigation community, their irrigation practices, or the interactions and linkages between this community and the context of their production. This information is vital to the development of a customized educational initiative “that will facilitate innovation and a learning community” (Kingma & Beynon, 2002, p. 14).

This report has provided a synopsis of current information on the social ecological context of East Wanneroo. It has also detailed key characteristics of the irrigation community and their linkages with the social ecological system that require further clarification. Further data collection and analysis is required to understand more fully the nature of the learning audience, including their motivations and learning preferences, the goals of the learning, and the ways in which the irrigators interact with, and are affected by the social ecological context of their production. It is anticipated that this data will be collected using interview-based social research. The interview will be designed to gather specific knowledge and information regarding the irrigation community and their learning needs and motivations. Interview questions will be structured around the questions typically asked during the analysis phase of the instructional design process, and refined both by questions regarding the specific motivations and characteristics of the learning audience, and by current understandings of the social ecological context in which the education will be implemented.

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