The *Web* in the West :
Reflections on *Web of Life* Biology inquiry teaching and learning for senior secondary students in Western Australia

BETJEMAN, Kenneth Jon
M.Sc., M.Sc.Ed., Dip.Ed, HC, FACE.

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The *Web* in the West : Reflections on *Web of Life* Biology inquiry teaching and learning for senior secondary students in Western Australia

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Abstract:
This paper is a history of the adoption and implementation of *The Web of Life*, an inquiry based biology course for senior secondary students in Western Australia. It focuses on the period from 1965 to 1990, outlines the issues at the time, events, and timeline of implementation and reflects on inquiry teaching and learning. It is a historical record written from the first hand experience of key people who provided comment to be quoted and were proud of their association with the *Web*. There is no other such record for *The Web* in the West. Inquiry remains today an important goal, across all years of school education, both as a way of teaching science and as a student outcome skill and value. Since the halcyon days of inquiry around the introduction of *The Web of Life* there has been regression to a path of lesser teacher support for the teaching and learning of biology and many of the perceived and potential benefits arising from the introduction of *The Web of Life* have been lost. Experienced biology teachers, now retired or currently teaching, claim students and teachers have been let down by the lack of adequate on-gong support specific for inquiry teaching and learning of biological sciences. They also claim that shared professional dialogue and motivation has suffered. Much the same can be said also for other school sciences. From 1985 System support shifted away from subjects to school development and more recently to the clarification of student achievement. Support for science teacher knowledge and understanding of biology and of science teaching methodology has been severely neglected. Thus there exists an even bigger gap now than ever before between the inquiry intent of *The Web of Life* and current biology teaching and learning. A consequence is that there is opportunity for both biology teachers and students to do inquiry better, much better. There is also a need to record more recent history of biology teaching and learning. Forty five years after the introduction of the *Web* in the West inquiry remains both a relevant and powerful biology (science) teaching strategy and a significant intellectual outcome for students to master.

Introduction

There is no other record

It has been stated about the history to adapt and adopt inquiry teaching and learning resources for senior secondary biology students in Australia that: *'The sources are scattered, the principal actors have not written their accounts, and it is not clear what were the principal issues in the decision.' (*Lucas 1980 (1) p.17). Adopting *Web of Life* biology was a decision to be made by each individual State. As an employee of the Education Department of Western Australia from 1961 until 1997 working in a variety of positions including science teacher, science advisory teacher and as Superintendent of Science from 1974 to 1986, and as one of the editors and authors for the *Web,* the author was in the right place at the right time to participate in and to influence the adoption and evolution of *Web of Life* biology in all secondary schools. In view of the impending demise after 1986 of the Subject Superintendency for Years K to 12 as the Western Australian Education System radically changed its entire structure to focus on whole-of-school development, the history of the *Web* in the West was collated in detail by the author and archived for future reference by education scholars (as were all science curriculum projects - state, national and international - with which the author had been involved over the period 1967 to 1986). It was later discovered that despite various security measures the entire archive had been destroyed by late 1987 by unknown persons within the Education Department to convert the storage area to a cleaners' store. Such is life – significant historical curriculum records and material evidence, replaced by diminishing and uncollated records scattered throughout schools and the changing recollections of aging science teachers. This paper goes some way to rectify the situation for the *Web* in the West - there is no other such comprehensive record of its history. Its compilation has been helped by contributions mainly from teachers who played key roles at the time and their recollections have been used only if substantiated by the few surviving documents or the opinions of others. In view of the loss of the archive this paper should serve a useful purpose.

Web of Life Legacy

Web of Life origins, philosophy, course structure, resources and evolution are adequately dealt with elsewhere (including Lucas 1980 (1)). The 'bottom line' about its history in Australia is that it delivered a necessary and desirable change in the teaching and learning of senior secondary biology at an appropriate time. It was a successful stimulus for secondary school biology that focussed the attention of science teachers to new science learning outcomes achieved by new science teaching strategies in a new classroom environment. It demonstrated to biology teachers for the first time how to manage expanding unpredictable knowledge. It generated and rejuvenated professional excitement and commitment among biology teachers, enhanced the status of biology in secondary schools and offered students a very different classroom experience to all of their other studies. Not only did it teach the biology of its time, but also intended to help students to make sense of future unknown biology discoveries and to become scientifically literate. As is reasonable to expect with any innovation it had both strengths and shortcomings as summarised by Lucas (1980 (2)) and later for Western Australia such as by Sydney-Smith and Treagust (1992); but for its time it lead the way in the teaching and learning of science and generated national debate about effective science teaching and learning. The shortcomings related mainly to the gap between the intended and real inquiry curriculum, the critical role of ongoing teacher support and examinations. There is no doubt in the

minds of biology teachers at the time that it made biology lessons uniquely interesting and different. It impacted on hundreds of thousands of secondary school science students and, it can still be argued today, more than any other national curriculum project in the history of Australian science education. It had a lasting effect, still evident today, on many senior or retired biology teachers.

Many biology teachers that experienced first hand its origins, implementation and evolution claim to look back on those decades as a significant time in their professional careers. They have provided reflective comment to be quoted throughout this paper and were proud of their association with the *Web*.

'They were great times and the reflection will rekindle many emotions.' (Personal communication, Teale, May 2005)

'*I have strong feelings for the Web of Life (and feel it) is what we still need.*' (Personal communication, Horne, May 2005)

'… *the validity and the veracity of the Web of Life teaching style … stayed with me throughout my teaching career … they were heady, optimistic days where science was all powerful. I consider …Web of Life to be a tremendously important curriculum change that for me, changed my classroom practice forever and enabled me to adjust my teaching to the changing cohort over time. It made you reflective, flexible and student-centred in everything you did and it so happens that now, in an environment where most kids stay on at school, that is exactly how you have to be to succeed (and survive).*' (Personal communication, Deleuil, May 2005)

'Since that time (1969) I have used an inquiry approach with my Biology classes and was still doing so when I last taught Year 11 and 12 Biology a couple of years ago.' (Personal communication, Newton , May 2005)

To be presented in my first year of teaching with a comprehensive and thoroughly researched set of teaching resources including the Web of Life text, teachers guide and laboratory manuals was an enormous support for me. The knowledge and skills that I developed teaching Web of Life set me up for the rest of my teaching career. (Personal communication, Wilson, May 2005)

'I can now look back over nearly thirty years of teaching biology, mostly using Web of Life resources and realise the profound impact the program has had on me as well as the students under my tuition.' (Personal communication, Patterson, May 2005)

'I would have to say that the Inquiry philosophy in Web of Life completely changed my teaching strategies from the font of all knowledge to a confidant who is enjoying the process of discovery with the kids. … In terms of my life in general I would be happy to say that I have followed this inquiry line in most things that I have done.' (Personal communication, Criddle, June 2005)

'Right from the very beginning of my teaching, I realised that I didn't want to teach in the traditional way, where teachers did most of the talking and students copied copious quantities of notes from the board. I knew that wasn't teaching and it certainly wasn't

conducive to learning. I wanted to engage the students and encourage them to become actively involved in the learning process. Web of Life provided me with the structure, philosophy and resources to allow me to do this. Because all the wonderful resources were prepared for me, it allowed me as a teacher to focus on my core business of teaching. I could spend most of my time working with students to determine what they had actually learnt rather that spend most of my time preparing what I would teach. This is a very important shift in teaching and not all teachers are able to make that transition. Web of Life allowed me to do that.' (Personal communication, Wilson, June 2005)

The author supports those comments – he had first hand experience of the trials, state-wide implementation and the next two decades of the *Web* in the West; he observed in hundreds of biology classrooms its impact on teacher motivation and student interest and its effects on school science departments and other organisations and institutions. It also created many spin-off effects with respect to the teaching and learning of other science subjects in the West, some of which are cited later in this paper. The decision to embrace *Web of Life* philosophy and resources was, from different points of view including schools and tertiary institutions, good for science teaching in Western Australia.

Before the Web

The Australian scene at the time was described by Lucas (1980 (1) p.15): '*The typical secondary school science student follows a non-specialist science course from the beginning of secondary school … until year 10. … But at year 11 (age 16) this diversity disappears.*'

In the early 1960s science subjects were offered in Western Australia as disciplines at 'Junior' (Years 8 to 10) and 'Leaving' (Years 11 and 12) levels. Primary science (Years 1 to 7) was trapped in a 'nature study bog' without sound broad science outcomes, no science trained teachers, no quality science support materials or teacher training in science. For secondary students it was usual but not necessary to select and continue a science subject from Junior to Leaving level. Most students in Government secondary schools studied Science A (General Science) in Years 8 to 10 with approximately 25% of the more able and interested also studying Science B (Physics and Chemistry) in Years 9 and 10. Other schools, mainly non-Government, usually offered Years 8 to 10 a selection from Biology, Physiology & Hygiene, Physics, Chemistry, Geology and Agricultural Science. All science courses at all levels in all schools were 'traditional' in that they were based on content knowledge through teacher centred 'chalk and talk' delivery and laboratory demonstrations. They had changed little in the past decade and were exam oriented.

Public examinations and science courses

Prior to 1913 there were two public external examination times in Western Australia for secondary school students – the 'Junior Exam' at the end of Year 10, and the 'Leaving Exam' at the end of Year 12. They were run from the University of Adelaide. From 1914 external examinations were the responsibility of the University of Western Australia. The syllabus statements and public examinations for all subjects were the responsibility of a Public Examinations Board. Board membership came from the University of Western Australia, Education Department of Western Australia and Independent schools (Public Examinations Board 1965, p.3). Syllabus Committees of the Board annually reviewed

syllabus statements and Public Examination Panels annually set and publicly reviewed external examinations. Syllabus statements were published annually in the Board's Manual of Public Examinations. Science courses approved by the Board for 1966 included Biology, Physiology & Hygiene, Physics, Chemistry, Geology and Agricultural Science at both Junior and Leaving levels, and Science A (General Science) and Science B (Physics and Chemistry) at Junior level. Schools offered a selection of these science courses depending on school tradition, student numbers and school location. Members of syllabus committees and exam panels indirectly exerted great influence on schools.

A typical senior secondary science syllabus statement c1965 was introduced by the comment: *'This is not a teaching syllabus but shows the ground that examiners consider it desirable to cover.'* It described a two year course and any change would commence from the Year 11 intake that year. It then listed the content classified is some appropriate way followed by a list of reference resources. By default it defined what was to be taught, the most likely books to be used and what was to be examined at the end of Year 12.

Issues at the time

There were a number of issues at the time, c1965-1975, that needed to be resolved about the process and product of secondary science courses; such as curriculum relevance and structure, expanding knowledge, student engagement and motivation, learning outcomes, current understandings of pedagogy, retention rates, teacher science qualifications, teacher support and laboratory infrastructure. These issues are perennial. They occupied the minds of curriculum developers well into the 1970s as a plethora of science curriculum courses emerged from western education, initially in the physical sciences and particularly from America, stimulated by 'Sputnik' and the shortage of scientists after the second world war (Stanhope 1965). They remain of concern today and to maintain quality in school science so they should. The time for change was due and not only for the teaching and learning of Biology.

The Commonwealth Government's funding of school science laboratory infrastructure in the 1960s in all states was underwriting the importance of secondary school science. It begged the question about the role of laboratory work and changes to laboratory design that would help learning. At the time there was much attention to ideas about learning; such as the growth of logical reasoning of adolescents, especially about appropriate experience as a basis for 'thinking scientifically' (Inhelder and Piaget 1958, pp.272-350); also, such as cognitive sophistication, obliterative subsumption and concept formation, learning based from appropriate experience and the role of discordance (Ausubel 1958, pp.548-568); and student oral language and teacher wait-time creating engagement and reflection (National Association for the Teaching of English 1976). An inquiry philosophy about teaching and learning was emerging (Biological Sciences Curriculum Study 1963, BSCS (1), (2) and (3)). Such ideas supported the *Web of Life* course philosophy and provided reassurance for educators at the time in Western Australia that the decision to adopt the course had a sound base in education research and debate. Reassurance for change also came from an increasing number of well regarded teacher education publications supporting inquiry such as Voss and Brown (1968, pp.6-11) who argued: '*Due to the rapid accumulation of knowledge about our environment and the living things inhabiting it, it is inadvisable to learn a vast array of isolated facts. It would be more effective if teaching were based on broad conceptual schemes introducing big ideas that can be applied to a greater variety of situations.' … 'Inquiry is based on student*

participation. This involves searching, reading, identifying, posing, experimentation, judging, hypothesising, observing, data, interpretation.'

When the *Web* was first being used in South Australia and Victoria in 1967 it was also being investigated by a few teachers in the West and their confidence in its philosophy and in its importance as a biology course was gaining increased support.

The underlining tenet to the *Web's* inquiry philosophy was adequately described at the time by Rogers (1967): '*The only person who is educated is the person who has learned how to learn; the person who has learned how to adapt to change; the person who has realized that no knowledge is secure, that only the process of seeking knowledge gives a basis for security.'*

Going green 1965 - 1967

Biology teachers who kept abreast of their subject were increasingly aware of American school biology resources and an emerging inquiry philosophy in teaching biology. In Western Australian Government Senior High Schools in 1966 there were only nine teachers throughout the state appointed to senior positions specifically to manage biology courses for senior students. The Education Department Superintendent of Science had a physical science background. Only a handful of biology teachers from Government and non-Government schools attended 'show and tell' biology meetings conducted a few times each year by the fledgling Science Teachers Association of Western Australia. It was basically the responsibility of biology teachers as individuals rather than as a professional collective to maintain currency in their subject and how they taught it.

The origin of the *Web* in the West has two key groups of players; the Public Examinations Panel for Biology and a small group of secondary school biology teachers. Finch from the Zoology Department at the University of Western Australia and Smith from the Botany Department alternated each year as Chief Examiner and Check Examiner for the Biology Panel during at least the significant *Web* change period 1966 to 1971. They were also members of the Public Examinations Board Biology Syllabus Committee. Over past years Biology had changed little in terms of what was taught and how it was taught. Both believed that school biology could be improved and were aware of available resources for students. They questioned the usefulness of stuffing facts and terminology and were to become advocates for the inquiry philosophy of *Web of Life*. A small group of four and eventually six teachers played the key role during 1966 to 1969 in adopting the *Web* in the West. They were at four schools; Puzey and Clarke at Governor Stirling Senior High School, McMillan at Guildford Grammar School, Criddle at John Forrest Senior High School, Teale later at Governor Stirling Senior High School and Betjeman at Northam then Churchlands Senior High School. Following the activities of the two groups reveals the story of the *Web* in the West. No doubt other biology teachers were becoming aware of the Biological Sciences Curriculum Study and *Web of Life* resources and were testing their usefulness; they might have been interested in change but they did not identify at the time as either advocates or leaders for change.

Professional literature and personal contacts with local colleagues and those in other states were the main source of information for these two groups. It was the Biological Sciences

Curriculum Study Green Version (1963 (3)) resources that attracted the interest of the groups because of its ecological approach; one apparently more related to the everyday world of students. Puzey had been Senior Master (SM) Biology at Governor Stirling Senior High School since 1965 with Clarke as an experienced biology teacher.

'I do remember (the) Chief Examiner… at the end of an examiners' meeting … tabling I think the three versions of BSCS and referring to them as interesting or some such. Probably (Clarke) and (McMillan) were also there. Certainly Clarke was very keen and I think it was his enthusiasm that persuaded me and got us moving at Govo (on BSCS).' (Personal communication, Puzey, June 2005).

Puzey and Clarke invited approximately fourteen students to join a special biology class to try a different course being offered in parallel to the normal Year 12 course in 1966 (Personal communication, Patterson, 2005. He was offered the course as a Year 12 student but decided to stay with the traditional course.). The proposed course was based on BSCS Green Version (Personal communication, Clarke, 2005. He taught the special class). The syllabus approved by the Public Examinations Board was sufficiently flexible to accommodate the use of BSCS supplemented by other material, which was mainly a *'… crash course in traditional facts.'* (Personal communication, Puzey, June 2005). The school again established a special Year 12 biology class in 1967. In 1966 McMillan was Teacher-In-Charge Biology and a Housemaster at Guilford Grammar School teaching Years 11 and 12. He was an advocate to make biology more interesting through laboratory and fieldwork and regularly demonstrated such ideas at meetings held by the Science Teachers Association. He was trying out selected BSCS activities but largely using his own; a situation that continued in 1967. As a consequence of reviewing biology books for local distributors Betjeman, then an experienced biology and chemistry teacher at Applecross SHS, obtained in 1965 copies of the three versions of BSCS. Betjeman promoted to SM Science at Northam SHS in 1966 and continued to use selected BSCS Green Version materials mixed with his traditional biology courses. He had just completed a postgraduate degree in Geology and the marine fieldwork spread over two years further reinforced the importance of first hand experience, inquiry skills and the relationship between broad ecosystem and microscopic views necessary for a scientific understanding of the living world. Also, the Education Department was revising its Science Teachers' Handbook for publication during 1967 and he was invited to write a sample Year 11 and 12 Biology teaching program. Ultimately two sample programs were submitted late 1966 as a guide for biology teachers; one 'traditional' and another 'ecological' reflecting the BSCS Green Version (Personal correspondence, Betjeman, 1967 (1)).

Betjeman promoted to SM Biology at Churchlands SHS in 1967 and continued to take an interest in BSCS resources and improving the nature and role of laboratory and activity work in senior biology and lower secondary science and used some of the laboratory activities from BSCS Green Version and Web of Life resources. He discussed and demonstrated the nature and importance of laboratory work and *Web of Life* resources with Fitzpatrick, Relieving Superintendent of Science in the Education Department of Western Australia, during a number of visits by him to the school. Throughout 1966 and into 1967 there was no co-ordinated awareness or use of BSCS resources in the West, only a few teachers were aware of the *Web of Life* materials now being widely used in Victoria and South Australia, but an interest in change was growing. Turning point events occurred in May 1967.

Turning points in 1967

A Biology In-service Course was held at Tuart Hill SHS during the May vacation for all SM Biology and Regulation 188 Biology teachers. The program included Finch, lecturer in Zoology at the University of Western Australia and then Chief Examiner for school Biology for the Public Examinations Board. She showed a copy of the recently published *'Biological Science : The Web of Life'* (Morgan et al, 1967) and strongly recommended it to all biology teachers. For most of those present this was the first time it had been drawn to their attention. She was very supportive of the ecological theme and of how the nature of the questions at the end of each chapter demanded much more than factual recall, but she did not have the laboratory manuals or explain the course philosophy. It was not understood by most present that the text was not the prime resource – rather it was the problems and guide questions and the end of each chapter together with the laboratory manuals and 'Invitations' that used and built inquiry skills and demonstrated course philosophy. Until that time most biology was taught using traditional textbooks lacking a cohesive integration of content, laboratory work and teaching philosophy. Laboratory work used in Years 11 and 12 was, in the main, of a varied nature designed by individual teachers. The in-service program also included a laboratory demonstration by Betjeman (Personal correspondence, Betjeman, 1967 (2)) based on a BSCS titration activity, most unusual for biology laboratory work, which demonstrated inquiry skills.

As a consequence of the in-service many teachers sought more information about the *Web of Life* and tried to obtain copies of all the course materials. In view of their use of or familiarity with BSCS Green Version resources Puzey, Clarke, Criddle, McMillan and Betjeman were encouraged by Finch's advocacy and sought to adopt *Web of Life* as a two-year course commencing 1968. The Secondary Education Directorate moderated a rush to the *Web* by discouraging schools from adopting the course unless trialling and special in-service training had occurred (Personal communication, Pearson, July 2005). Typically most Government SHSs had only one SM Science and qualified in the physical sciences; only a handful had a second SM Science qualified in the biological sciences. It was usual for Biology to be managed, in some of the larger SHS, by Special Duty Teachers appointed under Regulation 188 to assist the SM. Criddle was one of only a handful of 'Reg.188 Biology' teachers and had been managing biology at John Forrest SHS since 1966. He was aware of BSCS materials from a visit to Puzey the previous year but he did not use them (Personal communication, Criddle, June 2005). The management of science courses in the larger Government SHS was increasingly being split into shared roles by the appointment of a second SM qualified in Biology. Over the period 1966 to 1970 the number of SM Biology positions was increased in Government SHS from nine in 24 SHS (37%) to seventeen in 36 SHS (47%) – an increase that recognised the importance of biology in the science menu and the need for expertise to successfully nurture *Web of Life*. There was also a shortage of teachers qualified in the biological sciences and there was a need for a response to this problem by Tertiary Institutions, commented on by McMillan (1967) as '*… not training to be a teacher but training to understand the subject.*'

It was fortunate that the letter discouraging hasty adoption of *Web of Life* never got to Criddle who had already ordered and paid for a school set of *Web of Life* course materials, which committed John Forrest SHS to use them for all their Year 11 biology students commencing a two-year course in 1968. It is also important to note that Clarke was to be promoted to John Forrest SHS as SM Biology for 1968 and with his experience of BSCS

the stable door had opened to trial the *Web* in the West. Another fortunate event was that Teale was appointed in 1967 to Governor Stirling SHS for his final undergraduate teaching practice and formed a connection with Puzey and Clarke that resulted in his formal appointment to the school as a probationary biology teacher from 1968 when he was *'… essentially an on-looker …'* (Personal communication, Teale, May 2005) but got grounded in new teaching strategies as the *Web* was introduced on trial and BSCS was phased out.

Fitzpatrick, in late August 1967, established a small steering group of teachers, comprising Puzey, Clarke, Criddle and McMillan and co-ordinated by Betjeman, to review the possible use of *Web of Life* materials and the implications for a trial. The group met a number of times over the latter part of the year and enthusiastically endorsed the inquiry philosophy and course resources. They recognised the vastly different nature of the teaching and learning relationship, the enormous potential for improved learning and teacher satisfaction, the ecosystem nature of the content, the value of the intended outcomes and the strong classroom support provided by the resources. They decided to become a change group for biology teaching and learning and to encourage adoption of the *Web of Life* course state-wide. The group held the view that it was important for the trial to be seen to be supported by both Government and non-Government schools. As a consequence of their lobbying the Education Department, with support from the Executive of Guildford Grammar School and the Public Examinations Board, agreed to establish a trial. Board approval was required for all senior school courses offered over Years 11 and 12 that were to be examined externally at the end of Year 12. Four schools were initially selected for the trial; Governor Stirling SHS, John Forrest SHS, Churchlands SHS and Guilford Grammar School, for Year 11 biology students in 1968 and with the intent of continuing the trial into Year 12 in 1969 if the experience was favourable. Betjeman was invited by Fitzpatrick to work with him as Acting Superintendent Biological Sciences commencing February 1968, so the trial was reduced to three schools and Churchlands SHS was removed from the trial. Puzey and McMillan, representing the trial schools, attended a *Web of Life* in-service course in Adelaide with other teachers from Victoria and South Australia (Personal communication, Puzey, June 2005)

The decision to establish a three-school trial meant that special arrangements would have to be negotiated immediately with the Australian Academy of Science for print resources, special laboratory equipment and live material supplies had to be organised, and special external examinations had to be approved for trial students at the end of Year 12. That work leading into the trial was co-ordinated by Betjeman. The decision meant also that although no other schools were formally participating in the trial, many teachers would never-the-less trial aspects of *Web of Life* as part of the traditional course and get first hand experience over the next two years of the new teaching and learning philosophy. Later this proved to be useful because some of those teachers helped in the major *Web of Life* in-service course eventually to be run late in 1969.

The *Web* on trial in the West 1968 – 1969

1968 The first Year 11 trial of inquiry teaching and learning

There was no formal in-service training for the group of trial teachers. They had been absorbing the inquiry philosophy from professional literature and their experience with BSCS. They were self taught, understood the course philosophy and were committed to

ensure inquiry was a very high priority both as a means and an end. One trial teacher describes developing his understanding of inquiry by *'… making myself a student at all times. I did the lab work and questions and had discussions with (other trial teachers) in those first years.'* (Personal communication, Criddle, July 2005). Regular meetings were held leading up to the trial mainly after school hours and often weekly for the first few months of the year. Chapter programs were shared and individual course activities discussed in detail to ensure the inquiry priority was understood and maintained. Most of the meetings were held in the upstairs biology laboratories at John Forrest SHS and on most occasions the entire trial teacher group was able to attend, including Teale on occasions. No special conditions were offered by their schools for additional planning time or reduced teaching loads; it was not usual for such things to be done in those times. The trial was, to use a cliché, a labour of love for an exciting and desirable change in teaching and learning and for small kudos in leading the way. It placed an enormous demand on their professional and personal time which they willingly gave, but which after a year gave rise to such commitment being described as the *'Web of Death'* by one spouse (Clarke).

At the beginning of 1968 the management of science at John Forrest SHS had been split into two positions with one SM managing physical sciences and another the biological sciences. Clarke had promoted there as SM Biology and Criddle continued as the second biology teacher at the same school. All Year 11 classes at the school commenced trialling *Web of Life* Biology. Clarke's two years of BSCS experience was helpful. The *Web* resources needed to be modified to suit regional ecosystems.

'He was quick to develop dichotomous keys that suited Western Australian flora and fauna. The school put a lot of time into field work and ran camps regularly as well as excursions to the local swamp, Bickley stream and the Canning River at Araluen, all helped by the school's own plant community maps which were shared with other schools' (Personal communication, Criddle, June 2005).

McMillan at Guilford Grammar School and Puzey at Governor Stirling SHS also started all Year 11 classes on the trial. Initially, in total, approximately ninety students were involved.

At the Public Examinations Board's annual teachers' and examiners' meeting for biology in March there was no announcement or discussion minuted with the 51 teachers present about the trial or about the future need for a very different type of exam to suit an inquiry based ecosystem course although both Smith and Finch, the Chief and Check Examiners respectively, supported the trial (Public Examinations Board Minutes 1968, pp.61-62). At that time it was early days and the future of *Web of Life* was not yet clear. It was primarily the work of Clarke, Criddle and Puzey that lead the trial at the classroom level throughout the year.

Resource and other support for the trial and an analysis of developing outcomes and consequences had to be presented at State level to the Education Department, Independent Schools and the Public Examinations Board. Betjeman commenced work in February 1968 as Acting Superintendent of Biological Science in the Education Department of Western Australia and for two years was in a position to influence an increasing System acceptance of a need to improve biology teaching for senior secondary students through the state-wide adoption of *Web of Life* (The Education Circular 1974, p.124). It became obvious that resource and infrastructure issues, although frustrating, could be resolved and that the main

challenge was primarily one of teacher mind-set and their classroom behaviour. Inquiry as a means and an end was not easily understood, involved a major shift in teacher values about 'best practice' and would need significant in-service and ongoing support. Betjeman used his time over the next two years within the Department, in his liaison role with external agencies and visits to schools, teachers and classrooms to explain inquiry teaching and learning and to argue a case for state-wide adoption.

1969 The first Year 12 trial of inquiry teaching and learning and first special Public Exam for *Web of Life*

Trials continued at the three schools with the same group of teachers, except that McMillan to a large extend modified the trial to suit his own purposes. Participating students, approximately 150, were now all those in Years 11 and 12. Previous Year 11 programs were refined and major effort now directed to Year 12. Regular meetings of trial teachers continued and now included Teale who, for the first time, was teaching Year 11 *Web of Life* at Governor Stirling SHS with Puzey (Personal communication, Teale, June 2005).

At the Public Examinations Board's annual teachers' and examiners' meeting for biology in April, again there was no announcement or discussion with the 33 teachers present about the trial or about the special exam to suit an inquiry based course to be set in parallel with the traditional exam in November that year (Public Examinations Board Minutes 1969, pp.155-156). Both Finch and Smith, that year the Chief and Check Examiners respectively, still supported the inquiry and ecosystem nature of the *Web of Life* course and in discussion with Betjeman offered to help its state-wide adoption.

Betjeman continued as Acting Superintendent of Biological Science and co-ordinated the trials. He had attended a five-day *Web of Life* in-service course in Brisbane at Saint Lucia University in January. The conference was reported, with a photograph, in the local newspaper (Courier-Mail, 1969, January, p.1). That experience, coupled with the enthusiasm of colleagues participating in the Western Australian trial, further reinforced his valuing of an inquiry based course and the determination to continue to use his position to advocate its adoption state-wide. By July 1969 the Education Department and nearly all non-Government secondary schools agreed to adopt *Web of Life* commencing for Year 11 in 1970. His role was to lead and influence Education Department policy, infrastructure, resources, school timetabling, biology teacher pre-service and in-service training and immediate and ongoing support issues to achieve the state-wide implementation in Government schools and to advise non-Government schools. The old course emphasised anatomical structure and function, with very little ecology and no recommended teaching and learning rationale. The proposed course was radically different in all aspects and a few non-Government schools decided to take more time to consider the change, and by 1971 every senior seconday school state-wide had started the course.

The *Web of Life* would now replace a traditional didactic biology course in which content was delivered over four timetabled periods totalling 160 minutes usually in classrooms with an additional weekly laboratory session for 80 minutes. Biology class access to laboratories had to be increased to a minimum of 160 minutes each week usually timetabled as two 80 minute sessions, and if possible a further two 40 minute laboratory sessions. There were many variations on this theme but the goal was to maximise the time students were immersed in a laboratory and field environment. This required a more demanding timetabling effort in every school and a big shift in the way school

administrators perceived biology relative to the higher priority traditionally given to physics and chemistry. A special equipment issue was organised in crated kits for delivery to every school and included items such as refrigerators, incubators, a new range of chemicals and glassware – equipment previously unheard-of as standard school issue for biology. Biology laboratories were to be presented as places of interest filled with living organisms. A private supplier was organised to provide a range of living, freshly killed and preserved organisms. Most laboratories and classrooms to be used were traditional in design; they favoured the physical sciences, a didactic methodology and had to be modified to suit new seating arrangements that would encourage student discussion in small and large groups and reduce the dominance of the teacher as the font of knowledge and main talker. More laboratory assistants were being appointed to schools; a decision partly driven by a need to provide biology students with wide ranging first hand experience. Those staff had to be trained to support new and very different requirements of biology laboratory and fieldwork. To provide effective support they needed not only to understand all of the laboratory and field activities but also to understand inquiry. Relevant in-service for laboratory staff was an important course support issue.

These changes were accomplished through1969 and two most important events were to take place in November; in-service training for all biology teachers and the first public examination for an inquiry based biology course

Major in-service for state-wide adoption of the *Web* : November 1969

A major in-service course was held at the University of Western Australia in November 1969 over five weekdays and for all biology teachers, about 150, in Government and non-Government secondary schools throughout Western Australia. The course had substantial financial and resource support from the Education Department and the University. Finch and Smith, keen to support the change, mustered strong support from the Zoology and Botany Faculties, which helped with speakers, resources and facilities. D.G. Morgan, sponsored by the Australian Academy of Science, participated as a keynote speaker, mentor and reviewer. The focus of the program was on the course philosophy. It modelled inquiry philosophy by providing first hand experience for all participants in the full range of activities that characterised *Web of Life*. Participants modelled a typical school biology class group of about 25 and assembled as large and small groups depending on the nature of the activity. University staff provided content lectures on areas of biology, such as microbiology, new for most teachers. Trial teachers, supported by other experienced teachers who had been sampling *Web* resources parallel to the trial, ran typical *Web of Life* activities so that small groups could experience first hand role play as secondary students and then discuss desirable teacher behaviours that would radically change their teaching role. This in-service course was the biggest and most expensive held in Western Australia specifically for Biology teachers and has not since been matched. It is a memorable occasion in the recollections of many biology teachers, now promoted or retired.

'I consider Web of Life to be a tremendously important curriculum change that for me, changed my classroom practice forever. … I still remember the 5 days in-service that I attended … that set me on this path. … I remember feeling very valued by this PD, as if it mattered that I honed these skills.' (Personal communication, Deleuil, May 2005)

'I was in my 4th year (of teaching) when the original weeklong in-service course was held. I can remember being filled with great enthusiasm for Web of Life. Since that time I (have)

used an inquiry approach with my Biology classes and was still doing so when I last taught Year 11 and 12 Biology a couple of years ago.' (Personal communication, Newton, May 2005)

'The in-service that we ran at the (University) to introduce the rest of the state to the Web of Life was one of the best. The use of the philosophy to introduce the teachers to it worked brilliantly. After the first couple of sessions the students (teachers) realised that they looked stupid if they did not prepare (do the homework) and if they did not participate in the discussions and laboratory work'. (Personal communication, Criddle, May 2005)

First public exam for an inquiry based course : November 1969

The controlling effect of external examinations on what is taught and how it is taught is well known. The inquiry rationale of *Web of Life*, from the start, received strong support from Finch and Smith who lead the exam panel for Leaving Biology throughout this period. That the external exam would reinforce teacher endeavour in inquiry was never in doubt in the minds of the panel. A special exam titled 'Web of Life Paper' was drafted by trial teachers and approved and produced by the exam panel. Unlike the small single sheet traditional paper it consisted of many pages organised into three sections with multiple choice, short answer and extended answer questions. It contained many figures and data and tried to get students to apply inquiry skills in addition to demonstrating understanding of broad biological ideas. Of the 2141 students that sat for a Leaving Biology exam 64 sat for the special exam and 84.4% passed. Reflecting on the effect of external exams Criddle states:

'It was difficult to accept that an inquiry approach would actually work particularly in an environment where success in the Leaving Examination was so important for individual students, and for schools too.' (Personal communication, Criddle, June 2005).

Also reflecting on this special paper at the Public Examinations Board's annual teachers' and examiners' meeting for biology early in 1970, Smith reported *'The Chief Examiner expressed his satisfaction with the new type of examination, which he thought would eventually be preferred by a majority of candidates to the ordinary paper, and thanked the panel of 'Web of Life' teachers for the advice and hard work they had contributed to establishing the new format of paper.'* (Public Examinations Board Minutes, 1970, p.29). He was referring more to the nature of the questions than the structure of the paper. The examiners had demonstrated to all schools that inquiry skills and major biological understandings were worthwhile outcomes for senior school biology students and could and would be addressed in external exams.

The Public Examinations Board Biology Syllabus Committee also had to construct a new syllabus statement to accommodate changes for wider adoption in 1970

The role of the Public Examinations Board 1966-1975 and the *Web* in the West

The Public Examinations Board authorised what was to be taught and examined for all senior secondary students. It controlled the senior secondary school curriculum. Fortunately for a shift to inquiry there were common people linking the Biology Syllabus Committee, the Biology Exam Panel and the large group of teachers who supported inquiry. People such as Finch, Betjeman, Teale and McMillan provided some of the links. There were shared values about the teaching and learning of biology. For example

Betjeman in 1969-1970 and 1974-1977 was on the Biology Tertiary Admissions Examination Panel and from 1969-1988 was a member of the Joint Syllabus Committee for Biology. McMillan was also a member of the exam panel from 1969 to about 1972. Also, Teale was on the Biology Syllabus Committee 1971-1975 and was Chair from 1975-1977. These people, committed to *Web of Life*, were in key positions to influence its adoption and to achieve student application of inquiry skills in external exams. The Syllabus Committee attempted to remain unbiased and not to be seen to be imposing any particular teaching strategy or teaching resource on schools. But it is interesting to follow its slow change from 1967 to a public endorsement in 1972 in support of *Web of Life*.

Syllabus statements were generally generic and intentionally did not link directly with resources. In 1965,1966 and 1967 the Leaving Biology Syllabus listed a range of fourteen reference books but not textbooks. The book list made its first reference to a BSCS resource in 1965 and repeated it to 1868 – the Blue Version (Biological Sciences Curriculum Studies 1963 (2)). The external exam was described as three hours with a traditional mix of short answer and essay. The 1968 statements were similar despite the fact that the *Web of Life* trials were in progress for Year 11 students. In 1969 the Leaving Biology Syllabus made first reference to all three BSCS resources – the Yellow, Blue and Green versions (Biological Sciences Curriculum Studies 1963 (1), (2), (3)). It also referenced the *Web of Life* and 'Nuffield Biology' (Nuffield Foundation Science Teaching Project 1966-1967) sets of resources. Other than these five, all other references were for 'traditional' biology. It thus retained its neutrality. There was no special comment anywhere about the *Web of Life* trials or the fact that 1969 would be the first special external examination set for Year 12 trial students. Apart from the reference, despite growing support in the field, *Web of Life* might not have existed (Public Examinations Board 1966 to 1969).

The syllabus statement remained neutral also in 1970. Reference resources were as for 1969 and again no special recommendation was made for any one over another despite the fact that nearly all schools had now adopted *Web of Life* for Year 11. Introductory comment, however, gives first public and advanced recognition of a special examination for the many state-wide *Web of Life* students commencing the two year course in 1970: *'A special leaving level paper will be set for candidates of those schools which have received the approval of the Public Examinations Board to adopt the Web of Life method of teaching the present syllabus.'* (Public Examinations Board 1970, p.75). The syllabus statement was worded to subsume the content of both the *Web of Life* and traditional courses and again is preceded by a neutral statement: *'This is not a teaching syllabus but shows the ground that examiners consider it desirable to cover.'* In November a special Leaving Examination paper again titled 'Web of Life Paper', and with a similar structure and weighting to that offered in 1969, was provided for those students who entered the second year of the trial as Year 11s in 1969. For the first time there was an additional paper common for all biology students aspiring to Matriculation and University entry. The Biology Exam Panel described it: *'(the questions) build on information supplied. The candidate must use his ability to interpret the data supplied on the basis of his knowledge and understanding of biological principles…questions have a preamble which states a problem or a situation and, on the basis of this, candidates are asked to answer specific questions.'* (Biology Examination Panel 1970, p.8). The Matriculation examination was designed to take two hours but simply for reasons of consistency across all examinations three hours were made available. Questions were more interpretive, open-ended and not

necessarily with only one correct answer to any question. These changes reflected the Biology Exam Panel's favouring of inquiry course philosophy for all students. Pressure for formal recognition by the Syllabus Committee of inquiry as a preferred teaching method was growing.

The Biology Syllabus Committee nearly commits itself in 1971 to the *Web of Life* course. Its neutrality almost disappears. By now all schools had started the *Web of Life* and all Year 11 and nearly all Year 12 students throughout the state were committed to the course. The references cited in the syllabus statement are for *Web of Life* and Nuffield Biology only. Introductory comment (Public Examinations Board 1971, p.216) again gives recognition of a special examination: *'A special leaving level paper will be set for candidates of those schools which have received the approval of the Public Examinations Board to adopt the Web of Life method of teaching the present syllabus'*. It continues with an important statement commenting for the first time about teaching method: *'This paper is covered by the Leaving Biology syllabus but requires a different approach, which is outlined in the Australian Academy of Science (Canberra) reference text, 'Biological Science – The Web of Life' (ed. Morgan), with the accompanying Teacher's guide and student manuals I and II.'* The syllabus statement comments for *Web of Life* that *'The matriculation level paper on this syllabus will require candidates to answer questions designed to test their ability to interpret given biological situations.'* Two types of Leaving Examination papers were wet, one titled 'Web of Life Paper' and the other traditional. This was the last year a traditional exam would be set. A common matriculation paper was again set with a similar structure and weighting to that in 1970.

An inquiry teaching strategy for senior school biology, together with *Web of Life* as the prime resource, is finally advocated by the syllabus statement in 1972 (Public Examinations Board 1972, pp.79-80). Although it generally reads as for 1971 it states: *'One of the following books is suggested …'* as text books compared with reference books and then lists *Web of Life*, 'Nuffield Biology' and 'Modern Biology' (Otto and Towle 1965), with an additional list of reference books, then by default it recommends *Web of Life* by the statement: *'N.B. The Web of Life is the only one of the above texts which has been written for Australian students.'* and by a further statement about the matriculation level external examination common for all biology students: *'The biology course must go beyond the simple presentation of factual information and should be structured to include the following objectives: …'*. It then lists eight objectives adapted from Australian Academy of Science documents and covering the importance of inquiry; respect for evidence, data, biological concepts, thinking critically, confidence in conclusions, communication and skills. This is the first occasion when the syllabus distinguishes texts from reference books. An inquiry teaching strategy and *Web of Life* course resources were now advocated by the Public Examinations Board as the preferred Biology course in Western Australia. Also, it is important to note that in November 1972 there was only one type of biology examination, a 'Web of Life' type paper for all students, and set at two levels, Leaving and Matriculation, each of about 40 and 30 pages respectively. No longer would an examination be set for a traditional biology course.

If schools had any remaining doubt about the Public Examination Board's commitment to the *Web of Life* as a resource and inquiry as a strategy it is made pointedly clear in the 1973 syllabus statement. Neutrality has gone. The introduction goes direct to the eight generalisations listed above, presents them as five statements and then states: *'The*

foregoing teaching strategies should be used to develop the following themes:' (Public Examinations Board 1973, p.46). It later states '*This syllabus is common to leaving level and matriculation level examinations.*' This syllabus statement is the first occasion the three texts listed in 1972 are again listed but this time without other references. External examinations were as for 1972. The 1974 and 1975 syllabus statements repeated the commitment, the only difference being that in 1975 the controlling authority for all school syllabuses was the Board of Secondary Education and the Tertiary Institutions Service Centre conducted one level of external Tertiary Admissions Exam which, for biology: '*… will comprise a series of objective and extended answer questions to test the objectives enumerated above, the overall coverage and depth of understanding of the syllabus content and candidates' scientific skills.'* (Tertiary Admissions Examination Manual 1975, p.41). Inquiry teaching and learning in biology appeared to be embedded in the West. The veracity of inquiry after the trials in 1968 and 1969 and the major in-service course in November 1969 depended on effective state-wide implementation and ongoing support.

Spreading the *Web* in the West 1970 – 1971

State-wide implementation commenced in 1970 with the Year 11 intake in all Government and most non-Government schools. It was essentially a 'centre to periphery model' planned by Betjeman at the end of 1969 and well regarded at the time if managed appropriately. It was lead from the centre by the Education Department, then to geographical regional groups of schools, to school consortia within the larger metropolitan regions and then to biology staff groups within individual larger schools. The great majority of biology teachers attended the major in-service the previous year and were well prepared. The strategy next was to utilise and strengthen 'grass-roots' collegiate support by sharing experience, challenges and responses for manageable pieces (chapters) of the *Web of Life* program; a 'one day at a time' strategy with apparent low risk and pressure. Meetings were planned for half-day face-to-face discussion, modelling student groups in the *Web of Life* classroom. Problems were tabled then 'show and tell' was used to demonstrate possible responses and identify consequences with respect to achieving course philosophy. Groups were planned of sufficient size to provide a range of experience, commitment and ideas. On all occasions regional groups included Betjeman and a regional co-ordinator selected by invitation because of their commitment to course philosophy. In the metropolitan area groups of two to four schools formed school consortia planning and sharing for each chapter programs, activities modified for local use and assessment resources. Some country schools were 'postal' members of school consortia. SMs Biology from metropolitan schools who demonstrated strong commitment to course philosophy mentored other country schools with inexperienced biology teachers. A central newsletter filled gaps and maintained a consistent inquiry message. A 'catch-up' in-service, a mini-version of the original major five-day in-service, was run over two days late in 1971 for those biology teachers new to schools. It was paramount in the total strategy that inquiry as a means and an end was kept at the forefront of all discussion.

On his return from America Pearson (Curriculum Officer Science and previously SM Biology at Perth Modern School) was appointed Superintendent of Biological Science from 1970. Betjeman transferred as SM Biology to Bentley SHS and taught *Web of Life*. Trial teachers Puzey, Teale and Clarke continued at their schools with their second intake of Year 12 *Web of Life* students. Criddle promoted to SM Biology at Hampton SHS and

there implemented *Web of Life* as part of the state-wide program. The next year Puzey promoted to Deputy Principal at another school and Teale then promoted to SM Biology at Governor Stirling SHS. These trial teachers were still exploring aspects of inquiry teaching and learning and continued to provide important advice and support to many schools throughout the period of state-wide implementation.

The Education department appointed Betjeman 0.4 FTE as Advisory Teacher Biology for 1970 and 1971 and he travelled the State two days each week supporting *Web of Life* and acting as a de-facto Field Officer for the Australian Academy of Science. His role included managing the state-wide implementation, publishing a *Web of Life* newsletter several times each year, and being an advocate and mentor for the course philosophy helped by critical support from trial teachers and other committed colleagues. The progress of the *Web* in Australia was reviewed by the Australian Academy of Science at a residential conference in May in Adelaide. Betjeman attended and reported on the Western Australian scene (Lucas 1970). At about that time he was appointed by the Australian Academy of Science to the Editorial Committee of the *Web of Life Project*, a role he continued for ten years working on the second and third editions, and later to the Academy's multi-media biology teacher in-service project. His influence was further strengthened when in February 1974 he was appointed Superintendent of Biological Science. The close association with the various *Web* projects and his position in the Education Department enabled support to be maintained for inquiry, for biology teachers in Western Australia to be kept well informed and for some to participate in ongoing development of the *Web*.

After the flurry of effort for state-wide implementation the challenge then was to maintain teacher motivation and to build competency in teaching by inquiry.

Embedding the *Web* in the West : 1972 – 1985

Inquiry teaching is not easy. It puts different demands on teachers. It takes time to build teaching skills for inquiry. Inquiry classrooms are not like most classrooms; students are expected to talk, write and generally to move around the room much more than for other subjects. Student seating is different with small and large student groups facing each other and the blackboard or front of the room is no longer the focus of attention. Some students might be harder to engage and control but most will be more motivated and enjoy the experience. Inquiry classrooms are often noisy and to the uninformed appear uncontrolled. For such a situation to be well managed obviously requires thorough planning and preparation. It requires a confident teacher who understands the teacher behaviour, and students who understand the student behaviour, that facilitates inquiry. It requires both teachers and students to understand the value of inquiry skills.

'Teachers had to get their heads around the (course philosophy) and appreciate the importance of the students actually having to think their way through what they were doing … The process was so important to this whole philosophy and so different from the teaching /learning style dominated by the teacher who passed on the pearls of knowledge from the rostrum in the classroom. Teachers suddenly needed to do a completely different type of preparation. Our classical knowledge was still very valuable but if the teacher did not actually do the prep set for the student they could find themselves in all sorts of bother during discussions.' (Personal communication, Criddle, May 2005)

'Students explored their understandings at a conceptual level rather than at the simple factual recall level that had been expected of me (as a student). The biology content had become a vehicle for teaching students about themselves, about how they learned and about taking responsibility for their learning – much more of a preparation for life than my course (as a student) had been.' (Personal communication, Patterson, May 2005)

'Web of Life … encouraged students to become actively involved in the learning process. They were actively encouraged to work in groups to discuss guide questions and problems, do practical work and discuss 'Invitations to Inquiry'. I became the 'guide on the side' where I actively tried not to lead the group discussion, but simply be part of it. This gave students the opportunity to become involved in the learning process. My role as a teacher was to work with the groups to pull all the ideas together, clear up any misconceptions and generally make sure students had grasped the major ideas and concepts involved. This type of learning was meaningful to the student because they had been actively involved in the learning process.' (Personal communication, Wilson, June 2005)

The course philosophy, including teacher understanding of the educational psychology research and evidence that supports a model of inquiry, is a key factor in acceptance by teachers of inquiry as a means and an end. All teachers could not sustain the effort needed to run successful inquiry classrooms. Dowd and Dekkers (1980, p237) stated: '*…Web of Life philosophy and principles of instruction are not extensively utilized by many teachers. A number of reasons could be put forward to account for this situation.'* They conclude (p.241) that: '*… the level of inquiry orientation in most classes (*in the study*) is relatively low.'* but never-the-less better in classrooms where teachers are trained and committed to course philosophy. They reinforced a need for ongoing support that helps better inquiry outcomes and recommend (p.243) in-service, support networks and explicit inquiry philosophy in course materials. Without sustained support an inquiry approach would fail. A range of support was provided over the next decade or so to keep teachers motivated, resolve problems and to maintain focus on inquiry.

Early support targeted students. Inquiry could be more successful both as a means and an end if students understand the behaviours that facilitate inquiry. Teachers and their classes very early in the course had explicit reflective discussion about inquiry. Aspects of the discussion were repeated every month or so. Appropriate interplay between teacher and students is a key factor in the success of inquiry. Many schools in Western Australia used the work of Best (1972, pp.64-68) that was modified originally by Betjeman as a student checklist of fifty selected items for explicit discussion. *Web of Life* course resources did not address the roles of students and teachers explicitly or frequently enough.

Other student support used in the West was the student newspaper 'Biology in Action' (Australian Academy of Science 1981-1991) to keep course content current and to motivate students through relevancy, and the 'Biology Resource Book' (Education Department of Western Australia 1976) used to further stimulate and support student discussion through interesting photographs, newspaper cuttings, figures and diagrams and relevant personal issues on biological topics. Isolated students were another major challenge to be addressed. Distance or circumstance isolation meant that to the extent possible inquiry teaching and learning had to be achieved without the desirable, perhaps essential, face-to-face discussion for much of the course. A massive curriculum

development effort was invested to produce suitable resources and at a time (1970) when information technology was embryonic.

Inquiry by distance education appears to be a contradiction and it may well be when so much emphasis is put on face-to-face discussion. As much use as possible was made of the student's local environment and those students that could met occasionally as small groups at regional centres for some face to face discussion. Laboratory work that could not be done with the use of postal kits was redeveloped as second hand data exercises (Personal communication, Criddle, July 2005). The reasonable success of isolated students using specially prepared *Web of Life* resource kits questions the extent to which external exams measure inquiry skills or the extent to which students develop inquiry skills independently of *Web of Life* face-to-face strategies. Initially it took more than three years of adaptation to achieve something that reflected the intent of course philosophy. It was fortunate that one of the trial teachers, Criddle, was very familiar with course philosophy and was able to help work on distance education resources from 1975 to 1976. Over the years continual redevelopment has occurred lead by other teachers (Sydney-Smith, Vidovich and Wilson) experienced in Web of Life and with access to increasingly more sophisticated information technology.

'In 1991 we rewrote our Biology Courses at (the School of Isolated and Distance Education). Because we were so impressed with the Web of Life philosophy and the resources, we asked permission from the Academy to base our units around the Web of Life, including the texts, laboratory manuals and 'Invitations to Inquiry'. The Academy kindly granted us permission and this is acknowledged in all our written units … The text is still used in 2005 but supplemented with other texts and electronic resources. The teaching approach is still oriented as much as is possible to an inquiry approach and Web of Life resources are adapted to support it. … It is a credit to the Academy that these resources have stood the test of time. We incorporate phone conferences into our lessons to generate those vital discussions between students, their peers and teachers. … We will continue to use the (current) Biology course until it is replaced with (our) new Biology Course of study due to be implemented in 2007.' (Personal communication, Wilson, June 2005).

The physical design of biology rooms and laboratories had to be made more conducive to inquiry strategies and to serve a more flexible use for science generally. Most science laboratories had fixed central student benches with services, peripheral storage benches and a teacher demonstration dais dominating the front of the room. The design made the teacher and the blackboards the focus of lessons and sent entirely the wrong message to biology students. A very effective interim response was to provide temporary 'drop-in' tabletops across the ends of benches to form small discussion groups and larger circles seating students face-to-face thus increasing the effectiveness of language in learning. They psychologically set the scene for more effective student reflection and discussion critical to inquiry. Secondary school and laboratory design underwent significant changes during the 1970s to support a subject-based curriculum and more flexible laboratory areas (Betjeman 1974, 1975 and 1993 and Betjeman and Crosbie 1993). Laboratory design achieved greatest operational flexibility by replacing all fixed student benches with movable modular table-benches and locating all services to the periphery. That move also maximised laboratory potential for inquiry strategies to be supported into the future.

Three years the initial burst of support for state-wide implementation, Teale was appointed as Advisory Teacher Biology for 1975 to 1977. He basically repeated the role of Academy Field Officer and was able to provide individualised support visiting all schools and biology teachers. Pragmatic operational ideas assembled with the experience of the first few years of the *Web* were published as an induction and discussion resource for new biology teachers and to maintain an inquiry approach (Education Department of Western Australia 1976). Teale later helped with the third edition of *Web of Life* and was appointed as Acting Superintendent of Science from July 1983 to the end of 1985 while Betjeman was seconded to special projects.

Teachers were further supported, and their motivation to pursue inquiry maintained, by the publication of revised versions of the course (Morgan et al 1973 and 1981).

'I have strong feelings for the Web of Life and always felt it should have been up-dated … we had many years of searching through inferior texts (resources) and finally decided on one. However if the Web was re-written and updated, we would be back to it like a flash.' (Personal communication, Horne, April 2005)

Staff are mobile and there is a gradual renewal of biology teachers between schools and into the profession. This was a period of major growth in the biology student population and the supply of qualified or experienced biology teachers could barely meet the demand. The main source of inquiry training from the late 1970s to the 1980s was through pre-service education.

'In late 1969, I attended one of the first in-service courses on Web of Life and was convinced of the value of the curriculum package. In the following years, I used that framework and the first 68 pages of the Web of Life Teachers Guide Part 1 for my programme of "lectures" for all pre-service Biology teacher training.

I used the Teachers Guide as a resource to introduce the philosophy of inquiry based teaching. I used a directed reading format and generated Guide Questions and Problems on (the Guide) in order to stimulate discussion about the Aims of the course and the inquiry based approach. I helped them identify the nature of Major Ideas and Single Propositions … followed with an examination of the student text, identifying the style of presentation … and its emphasis on ongoing inquiry and the continuous revision of ideas that is the basis of science.

In the early years at Secondary Teachers College we had a large enrolment in science teaching. In several years I had 50 trainee Biology teachers and some of them were also training in Chemistry or Physics. Later on the enrolment in all these classes fell away with the result that the separate subject specific courses had to go and the (then) university offered a single course within which I provided alternative study tasks for the various school subjects. Connected with this, there was also a reduction in the number of lecture hours and a rearrangement of the content in relation to other courses in the programme. However, inquiry based teaching became more and more relevant in all science subjects at every school level so many of the techniques and procedures which had been stimulated by Web of Life Biology were applicable to training in all science teaching and I continued to use the earlier format in my own presentations. (Personal communication, Hodgkin, July 2005).

New biology teachers entering schools received all their inquiry training as part of tertiary pre-service experience. Group in-service about inquiry philosophy after graduating was negligible. Sparse one-on-one discussion with an Advisory Teacher or an experienced committed colleague was the only support to understand inquiry as a means and an end. Any decline in support would result in a decline in motivation and a regression in inquiry behaviours. Support that addressed individual teachers needs, was flexible in its implementation and focussed on inquiry would satisfy in-service needs into the late 1980s in Western Australia. The Academy's in-service project, 'Teaching and Learning: The Biology Classroom', was to provide special support for biology teachers and to help maintain course philosophy (Morgan et al c1979). It was directed to teachers with two to five years of experience, multi-media, modular, manageable in small time segments totalling ten hours and assumed teacher access to a biology class which would be used as a source of first hand experience for the various in-service activities. It was obvious that a teacher's own classroom was their best laboratory for in-service. Aspects of the program were developed and trialled in the West (Betjeman was on the project's editorial committee and in the West worked with Teale, Vidovich, Woodman, Harrison and Wilson) and its potential value praised by a wide cross section of biology teachers. The project commenced in mid 1976 and was ready for final editing and use early in 1979. The unpublished resources were used in a variety of settings throughout Australia, including pre-service (Betjeman used them in 1978 delivering Curriculum and Instruction Unit 534 at Curtin University) and in-service. Due to impending structural change in the state system in Western Australia it was desperately needed to support inquiry and the biology course. Had it been developed to publication it would have delayed the slow demise of the *Web* in the West. It was potential critical support at a critical time but opportunity lost.

When an inquiry approach to teaching and learning of biology was first considered in the West Finch and Smith were strong tertiary advocates for its adoption by schools. As some *Web of Life* students entered the University of Western Australia to continue with the biological sciences, both recognised in comments to Betjeman in 1974 that those students were well grounded in major understandings of biology and more willing and able to participate in seminar discussions than other students.

'This brings to mind the comments of a number of ex-students with whom I had contact during later years. Many of them, and I do mean many, told how the Web of Life had contributed to their success at University. They applied the investigation and thinking skills, which were honed at years 11 and 12 to all their Uni studies and enjoyed considerable benefits from Web of Life through this. Several commented that their life styles and the way they tackled life problems went back to the inquiry approach. I can identify with this as I used these skills through the rest of my life.' (Personal communication, Criddle, June 2005)

The original focus on inquiry in biology created wide professional debate about effective science teaching and learning. Inquiry became the prime strategy advocated in Western Australia for science teaching from K to 12 (Betjeman and Crosbie 1979) and the basis of a general science teaching and learning model promulgated by the Superintendents of Science (Betjeman 1979). *Web of Life* had a significant multiplier effect on school science in the West.

A focus on subject teaching and learning in both primary and secondary schools was about to be overtaken by major System change in the mid 1980s in which support for subject areas was greatly reduced. Research persistently shows that without support innovation and energy eventually fails.

The Web unravels

End of System subject support:
Specific subject in-service significantly decreased throughout the System over the period from 1980 to 1990 as a great majority of professional development funds were redirected to leadership training and to total System restructure for a different corporate purpose away from co-ordinated curriculum development towards school development. This meant that biology teacher support (and for all science and other subjects) regressed. A lack of ongoing subject support is a major cause of the gap between intended and actual inquiry in classrooms. It was identified as a problem back in the mid 1970s (Lucas 1980 (2), p.171), it continued as a problem into the 1980s (Sydney-Smith and Treagust 1992, p.293) and is more of a problem today (Goodrum et al 2001).

The Subject Superintendency was closed down in Western Australia at the end of 1986. System subject support basically ceased from that date for at least ten years as corporate priorities shifted to the school as a unit for quality assurance and accountability. There was some regional support for subject areas but it was small and parochial in relation to that which previously existed. Biology teachers, and all secondary and primary teachers with subject interests and expertise, were left to their own devices to maintain currency in their respective subject fields. The constant promotion of inquiry as both a means and an end in biology was difficult to sustain before the System shift; from 1987 a drift away from inquiry was inevitable.

The Academy reviews the future of the *Web*
Twenty years after the *Web* was published its use was on a slow decline. Discussion within the Academy was considering whether or not the *Web* should be redeveloped and how current biology knowledge could be kept up to students. In 1986 Betjeman was invited by the Council of the Australian Academy of Science to join the School Biology Project Committee (Personal correspondence, Betjeman, 1986 (1)). He participated in a one-day workshop in Canberra (Australian Academy of Science 1986) that case studied *'… current biological knowledge, for their biotechnological and social implication that are most relevant to school students, and to seeking an appropriate way of assisting teachers to bring these into classroom work in effective ways.'* (Personal correspondence, Betjeman, 1986(2)). The Academy did not proceed with an update of *Web* resources. Teachers in Western Australia eventually had to look elsewhere.

Inquiry recedes
Some teachers in Western Australia use internet resources for current biology (Biozone International 2005). Some still use favourite *Web* activities by photocopying resources. Most current resources are traditional texts with or without laboratory guides that may or may not foster inquiry skills. Few resources target broad biological concepts and few present a teaching and learning philosophy structured into the resources.

The extent to which inquiry remains as a means and an end in Western Australian biology classrooms is not clear. In the opinion of many senior experienced teachers they perceive it to be much less than when the *Web* resources supported that goal.

'Inquiry is certainly not promoted. … across the State I suspect there has been a drift away from inquiry-based learning. It has been a long time since I last heard this strategy presented as a guiding principle for the teaching of biology.' (Personal communication, Patterson, May 2005)

'In my experience there has been a drift away from inquiry back to more chalk and talk, especially amongst younger teachers. The oldies like myself who were involved with Web of Life in the early days were much less likely to abandon the inquiry method. ... The drift away from inquiry continued through the 90s.' (Personal communication, Newton, May 2005)

'I seriously feel that the demise of the philosophy has been a reflection of both the ethics of teachers, who simply were not prepared to do something different from day to day and year to year, … (and) the increase in the overall responsibilities of teachers in the school system (leading to) less subject preparation.' (Personal communication, Criddle, July 2005*)*

The decremental drift from teaching and learning by inquiry in the 1990s was primarily a result of reduced central support and committed leadership for senior secondary biology.

Reflection

The *Web of Life* course provided, even encouraged, opportunity for innovation, substitution and local adaptation restricted only by the creativity, experience and commitment of teachers. But if it was once '*too successful*' (Lucas 1980 (2), pp.172-173), too much a biology curriculum monopoly and too stifling of teacher innovation, that it is not the case now. In Western Australia where is the current clarity of detail for biology curriculum outcomes and where is the classroom teacher behaviour that reflects a sound and agreed understanding of pedagogy? Are we now, years after *Web of Life* was a monopoly and seen by some as hindering teacher initiative, any better at what and how we teach biology to secondary school students?

Biology student numbers

Judging success of the *Web* in the West in terms of student enrolment is questionable. Science enrolment statistics during the history of inquiry biology in Western Australia have been considered by others (Anderton 1975, Carras and Jennings 1979, Dekkers and de Laeter 1981, Betjeman and Crosbie 1986). During the period 1970 to 1985 student retention rates into senior secondary were increasing generally at about 2 to 3% per year. The relationship in the West between student enrolment and inquiry biology is uncertain. The evidence for the West indicates that over the period from 1970 to 1985 senior secondary biology numbers increase for about five years then plateau for another five before a notable decrease.

Support for *Web of Life* was strong from its state-wide introduction in 1970 to 1980 with decreased support to 1985 and very little beyond. The facts are for the three quinquennial periods from 1970 to 1985 total student population retention rates for Government SHSs went from 30% to 47%, 56% then 70%. For the same period SHS Year 11 Biology absolute numbers went in 1970 from 3800 to 4159, 3700 then 2672; for SHS Year 12 from about 2800 to 3000, 2789 then 2665; Biology as a proportion of their SHS Year 8 peer group from 22% to 26%, 21% then 15%; and as a proportion of the SHS Year 11 total population from 42% to 54%, 37% then 21%. Biology students that completed the two-year course from all school sources and sat for the external examination at the end of Year 12 were about 3000 to 4419, 4509 then 4278 (in 1982 and 1983 the numbers dropped to 3570 and 3721). Biology class size aggregated for Years 11 and 12 in 1981 was a mean of 18.13 and standard deviation of 5.47; slightly larger but not dissimilar to other science subject class size statistics (unpublished information from Superintendent of Science 1986). At all times total Biology numbers are well above (120% to 50%) those for other sciences, an exception late in the period being for Human Biology.

It is easy to conclude that Human Biology did have an effect on Biology numbers. It is interesting to note that some students were selecting Human Biology as an alternative to Biology; a choice unique to Western Australia and introduced parallel to *Web of Life* from 1970 (Public Examinations Board 1971, p.216, Education Department of Western Australia 1977 and Fensham 1981, p.6). It had the traits of a traditional course. It was not supported by resources that integrated current understandings of teaching and learning with human biology content although it claimed to be sympathetic to an inquiry strategy. For some students it appeared to have more relevancy. For others it appeared less demanding and avoided the rigour of inquiry or the perceived greater difficulty of the Biology external exam. For some teachers it was an opportunity also to avoid the rigour of inquiry. Some students studied both courses. Many teachers taught both courses. As retention rates into senior school increased some course counsellors encouraged 'less academic' students to select it. Human Biology students, from all school sources, that completed the two-year course and sat for the external examination at the end of Year 12 from 1971 rose dramatically in number from less than 150 to 1314 (1975), 2690 (1980) then 4499 (1985). Human Biology numbers, around 2800, reflect the plateau of Biology from 1975 to 1980 but then explode past Biology from1984.

The *Web* did cater well for the range of student needs. Different versions of a biology course selected from *Web* resources was not an unusual practice for different classes within the same school; even for different student groups within the same class. Many teachers selected different activities to accommodate different student needs. Using more individualised or small-group programs and at the same time managing the complexities of an inquiry classroom was too demanding for most teachers. Such potential within the course resources was only ever 'tested' by biology teachers but never fully realised.

Explanation of the rapid increase of biology students in absolute numbers from 1970 to 1980 is unresolved. Did inquiry biology and the effects (including support) it had on teachers and schools attract students and keep numbers higher than they otherwise might have been, or for those students wishing to select a science were the physical sciences seen as less attractive, or was Human Biology too new and still developing or simply were biology numbers a reflection of increasing student retention into senior secondary? Did

biology numbers plateau and eventually drop because of the demands of inquiry teaching and learning with perhaps an added effect of Human Biology as an alternative?

The cause and effect relationship between *Web of Life* and student numbers is speculative. No causality is proven. It has been argued by others for Western Australia that syllabus changes (inquiry ecosystem biology) have not had a significant influence on secondary school enrolments in biology for 1963 to 1977 and that success in terms of student enrolment was due to retention factors only. Such a conclusion appears shallow because: *'… (the Web of Life* course) *appears to have successfully accommodated the wider range of student abilities and interests.'* (Dekkers and de Laeter 1981, p.90) and *'… interest in the subject appears to be a major reason why a large proportion of Biology students study this subject only.'* (Sleet and Stern 1980, p.27 and Table 4 p.28).

Since the state-wide adoption of *Web of Life* in 1970 at least 125,000 students have studied a complete course of inquiry ecosystem biology.

The importance of ongoing support

The most common criticism that is levelled at the *Web of Life* era is that adequate teacher support was lacking a decade after initial teacher in-service. Teacher factors are the key to ongoing success, not resource factors (Abd-El-Khalick 2004, p.409). The gap between real and ideal science teaching and learning is recognised as a continuing concern by Goodrum et al (2001, p.viii) who identify, again, ongoing teacher in-service support as a prime reason.

This is not a criticism of the *Web of Life*, although the inquiry philosophy of the course could have been much better explained and reinforced throughout course materials, rather it is a criticism primarily of its implementation by State systems. It is the result of both competition for scarce in-service dollars and an increasing expectation by State education systems that teachers should be responsible, and are able, to maintain their own professional development. To sustain a shift to inquiry, with the consequent intellectual and time demands that successful inquiry teaching and learning requires of teachers, meant that ongoing support was crucial. Dowd and Dekkers (1980, p.237) observed that teacher attitude, teacher training, teacher values and teacher understanding of course philosophy are critical factors in successful inquiry in *Web of Life* classrooms. They conclude (p.241) that although the level of inquiry was low it was better in classrooms where teachers are trained and committed to it. They suggest that better inquiry requires support by in-service, networking and explicit treatment of inquiry. The better the support, the less the decremental drift from inquiry.

As described earlier in this paper, strong and appropriate support was provided in Western Australia for a decade after its adoption. It is an inevitable consequence to observe after the mid 1980s the gradual dilution of inquiry strategies in the biology classroom. Support was reduced and decremental drift from inquiry increased.

'Communication between schools is not as it once was. The number of Biology classes in schools is quite small these days and the opportunities for groups of subject teachers to get together are almost non-existent. Neither is there the cross fertilisation of ideas promoted by a Subject Superintendent as once happened. My perception is that there has been a drift

away from the inquiry approach as teachers have sought more direct ways of teaching students …' (Personal communication, Patterson, May 2005)

Despite the efforts of the Science Teachers Association of Western Australia and others keen to maintain professional standards of biology teachers, senior secondary biology today is lacking strong links between resources, support and pedagogy. There has been a drift away from a central shared model of what makes 'good' biology teaching to variable individual teacher models. Focus has shifted to student 'outcomes' for science but sadly lacks adequate emphasis on best practice teaching and learning strategies to achieve them.

The importance of Inquiry

The fundamental importance of inquiry for ideal science teaching in Australian schools is validated in a major review by Goodrum et al (2001): *'Theme 2: The teaching and learning of science is centred on inquiry. Students investigate, construct and test ideas and explanations about the natural world.'* They define inquiry as a broad concept (p.145), much more than laboratory work, involving understanding through *'… minds-on as well as hands-on …'* activities and that students *'… reason and think critically about evidence and explanation to develop their understanding in science and to communicate scientific arguments.'* (p.146) on school and everyday issues. Inquiry in *Web of Life* was always intended as a broad concept and much more than laboratory work. The nature of the activities in the resources and the way in which they inter-relate demonstrate that. Inquiry was always important also as an end (a student outcome), not as a means only. The ability to master inquiry enables a person to be 'scientifically literate', defined by Goodrum et al (2001, pp.11-12): *'Scientific literacy means that a person can ask, find, or determine answers … has the ability to describe, explain, and predict … to read with understanding … to identify scientific issues … to evaluate the quality … to pose and evaluate arguments … to apply concepts and processes.'* Scientific literacy is a broader concept than inquiry but inquiry is a fundamental requirement for scientific literacy.

Inquiry is important but it is still not done well enough. Many modern resources for K to 12 science courses are activity based and many use aspects of inquiry but it is the teacher's behaviour that determines the extent of inquiry as a means and an end.

The importance of a focus on major biological understandings

The expanding knowledge of biology has always been a problem for biology teachers. What is more important for biology students to achieve – a wide range of superficial knowledge or more depth of a limited range of knowledge or understandings about key biological ideas? The first and second have no limits because biological knowledge expands. The latter forms a big picture for biology; it helps make sense of, and is further developed by, the many small pieces of knowledge. Attention to understanding major biological ideas provides a means of obtaining some order from an apparent chaos of expanding facts. The strategy of the *Web* was to build first hand experience and evidence into single propositions then single propositions into major ideas; explained by Ausubel (1958, pp.559-577) as concept formation by subsumptive obliteration.

Lucas (1995, pp.196-198) argues for a shift in science education research away from the collection of unconnected small topics to over-arching issues and concepts. He calls for a focus on *'… concepts and ideas that interact to explain phenomena.'* and to move *'… beyond the collection phase of this research tradition, …'* and research where *'… sub-*

themes to be examined are part of a deliberate map of a larger theme.' and *'… to go beyond accumulation …'*. This is an interesting parallel with the choice between a biology course in which students accumulate specific biology knowledge and one that constructs major biological understandings. If a big picture helps to minimise confusion by detail then such an approach has application in all areas of education. To some extent this supports the *Web of Life* philosophy that focuses student attention through selected content to major biological ideas.

'What the Web of Life course did was to go beyond the content... Students explored their understandings at a conceptual level rather than at the simple factual recall level … The challenge for biology teachers in the 2000's is to convey the understandings that are held as fundamental, while engaging students to follow the enormous explosion in biological knowledge. The pace of change is so rapid that it threatens to overwhelm.' (Personal communication, Patterson, 2005)

The application of 'major ideas' to help students to understand current biological issues and to make sense of new biology knowledge is a key factor in students' perceived usefulness of senior biology. They lose usefulness if they are too broad. If they are too numerous they are too narrow. Perhaps different collections of ideas are more useful to different groups of students. Mapping appropriate broad ideas remains a current challenge for senior secondary biology curriculum design.

Closing Comment

Inquiry remains a global goal: *'Good science teaching and learning has come to be distinctly and increasingly associated with the term inquiry.'* (Abd-El-Khalick 2004, p.398). Inquiry is both a means (a teaching strategy) and an end (a learning outcome) in science courses throughout the western world. Although there is a gap between what ought to happen and what does happen in classrooms: *'... the notion of inquiry in science education is one of the few overarching themes that cut across pre-college science curricula in countries around the globe.'* (p.399).

Inquiry remains a means and an end for all school education in Western Australia. Science is one of eight learning areas each describing intended student outcomes to be developed at four overlapping phases of development across 13 years of formal education from K to 12 (Curriculum Council of Western Australia 1998). The phases of development are early and middle childhood (typically Years K to 3 and 3 to 7) and early and late adolescence (typically Years 7 to 10 and 10 to 12). The Science Learning Area describes nine groups of outcomes; five groups about 'Working Scientifically' and four about 'Understanding Concepts' (one of which is titled 'Life and Living' and includes biology outcomes typical of a senior secondary Biology course) and there are links with overarching outcomes common to all eight learning areas. The 'Working Scientifically' group of outcomes lists 'Investigating', 'Communicating Scientifically', 'Science in Daily Life', 'Acting Responsibly' and 'Science in Society'. The 'Working Scientifically' group of outcomes is described in eight levels (really nine levels including a Foundation Level in addition to Levels 1 to 8) to judge student development as they move K to 12. The basic tenet of 'Working Scientifically' outcomes across all four phases of education Years K to 12 is that: *'science has many methods of investigation, but all are based on the notion that some*

form of evidence is the basis for defensible conclusions.' (p.218) and that scientific understanding is continually extended and refined in the light of new evidence. It explains that: *'The Working Scientifically outcomes address the skills of scientific inquiry and the ways people use scientific information.*' (p.221) and *'Students review and evaluate their investigations and the implications of their data as an integral part of the science inquiry process.'* (p.222) and *'Students develop inquiry skills by trying to find answers to questions.'* (p.239). The Science Learning Area is describing inquiry as a broad intellectual endeavour (not simply as skills used to design controlled experiments, make observations and arrive at conclusions) and is advocating inquiry both as a teaching strategy and as a student outcome.

Current school science education in Western Australia thus advocates inquiry as a means and an end, as did *Web of Life* more than three decades ago.

For clarity of purpose in teaching biology at senior secondary level there will need to be a finer level of definition than that provided by the broad outcome statements for the eight levels of development for 'Investigating Scientifically' and 'Life and Living'. The Curriculum Council has provided some definition by way of 'Progress Maps' (Curriculum Council of Western Australia 2005, p.6, pp12-21 and pp.66-75) that detail the learning outcomes to constitute any senior secondary biology course in Western Australia. What is selected as course resources, specific content or teaching/learning strategy to develop those outcomes is entirely open. Individual schools will determine the real curriculum for individual schools. There is potential for wide diversity of senior secondary biology courses between schools and individual teachers within any school. This situation, by default, advocates a view that biology teachers (all teachers) have the time and ability to keep on top of their subject knowledge and understandings in addition to contemporary research about science teaching and learning – a professional ideal but an unlikely scenario. Some individuals will - many will not. Biology teachers as a group might find it too difficult to do. Research on the essential link between subject support and quality subject outcomes has not changed its message since the *Web* began. A strong link between subject in-service, well crafted resources and subject teachers in group discussion is essential for better achievement of inquiry as a means and as an end.

Only with teacher understanding of inquiry and appropriate external influences (exams and support) will decremental drift away from inquiry ideals be reversed.

The *Web of Life* inquiry course for senior secondary students was a curriculum monopoly for many years. Future biology curriculum endeavours would find it hard to do better. Goodrum et al (2001) reviewing the status and quality of teaching and learning of science in Australian schools conclude that there is a need for a national approach that combines both curriculum resources and teacher in-service '*… there is a wasteful duplication of effort in preparing curriculum resources and resources for the professional development of teachers.'* (p.viii) and *'… there is a lack of national focus in science education…'* (p.164).

There is opportunity in Western Australia, and elsewhere, for both biology teachers and students to do inquiry better. There is also a need to record more recent history of biology teaching and learning. Forty-five years after the introduction of *The Web* in the West inquiry remains both a relevant and powerful biology (science) teaching strategy and a

significant intellectual outcome for students to master and apply. It might be time to weave another *Web*.

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was Master in Charge Biology Christchurch Grammar School teaching biology before he retired in 1996.

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About the author :
After graduating in Geology and Zoology from the University of Western Australia the author became a secondary school biology and chemistry teacher. Early in his teaching career he completed a Masters degree in marine geology that played a significant role in his appreciation of the importance of inquiry and of the relationship between broad ecosystems and sub-microscopic evidence necessary for a scientific understanding of the living world. He completed a second Masters degree that endeavoured to assist science teachers in using classroom information for improving their teaching effectiveness. In addition to his first hand experience as a senior biology teacher, he was an editor and author for the second and third editions of *The Web of Life* and the Academy's *Teaching and Learning: The Biology Classroom* Project, a member of the Australian Academy of Science School Biology Project Committee, a Science Advisory Teacher to all schools throughout Western Australia and later as Superintendent of Science K-12 in the Education Department and District Superintendent. His experience of inquiry teaching and learning and the *Web* spans more than twenty years in Western Australia from its origins in the 1960s to its recession. The author provided System level leadership and support for the implementation of *The Web of Life* inquiry biology for senior secondary students in Government and non-Government schools throughout Western Australia. Such unique experience helps to validate this paper.

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