Designing multidisciplinary courses using alignment models

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Abstract

There is growing demand for multidisciplinary science courses at universities, in keeping with vocational demand for integrated knowledge and applications. Course design is influenced by many factors, frequently subjective and idiosyncratic. I contend that a strategic objective approach should be used to develop new courses. This paper gives a template example in the form of an action-learning project used to create a new third-year undergraduate course on the ecology of disease for students in biological and biomedical sciences. Teacher and student opinions on content and process were canvassed through questionnaires, personal interviews and focus groups to identify desirable outcomes and maintain unity of vision. It was envisioned by stakeholders as a holistic interdisciplinary course consolidating preclinical concepts and incorporating analytical tools. Course goals and objectives were identified through needs assessments, core content through concept mapping, resource issues through components analyses, desirable graduate attributes through outcomes analyses, and best teaching and learning practices through procedural analyses. A constructive alignment model was used to link curriculum objectives with relevant instruction activities and assessment criteria addressing skills, attitudes, concepts and knowledge.

1. BACKGROUND (description of context)

Curriculum review should be entrenched in all courses and programs in modern universities. Client demands and perceptions vary with time and changes must be planned, resourced and actioned. Over many decades, The University of Queensland has nurtured its reputation as a research-intensive university. Faculties recruited academic staff with strong research performance in specific disciplines. This was conducive to the formation of several small boutique departments with light teaching loads, many third level courses having enrolments of less than twenty students. Over the last several years, economic rationalization and a competitive market-place led many Faculties to review their operations and restructure; in particular, to identify core activities and allocate resources accordingly. In my Science Faculty, twelve Departments (custodians of conventional disciplines) were progressively amalgamated into three Schools (aligned with emergent multidisciplinary fields). The Faculty undertook intensive curriculum review and implemented a rolling reform of all undergraduate courses. The rationale for change was to better utilize finite resources, reduce wastage, promote areas of strength, and support staff during workload intensification. Faculty reduced the number of courses offered by 40%, developed programs and course plans in consultation with prospective employers, and encouraged staff development activities. It was determined that most traditional scientific disciplines could be based on a selection of foundational courses as many contemporary disciplines had overlapping boundaries and shared technologies. This fostered interdisciplinary collaboration which was also perceived to be vital for the establishment of centres of excellence. Core courses were introduced at junior levels and multidisciplinary fields of study (including dual majors) were encouraged at senior levels.

One proposal was that an umbrella course on the ecology of disease be developed to span disciplines and strengthen links between Schools which had established strengths in different areas (microbiology in one School, pathology in another and ecology in a third). It was proposed to bring these aspects together into one course to provide a strong holistic focus for contemporary study. The University had identifiable strengths in the topical fields of 'Infectious Diseases' and 'Ecology' and wished to promote them throughout the pan-Pacific education market. There was also a perceived need to reconstruct Nature; that is, to bring specialist disciplines back together into a holistic course relevant to the biomedical community. Practitioners wished students to reinforce their preclinical conceptions prior to vocational immersion, particularly 'pre-med' students seeking entry to the Graduate Medical Course. Curiously, medical teachers wanted greater emphasis on animal diseases while biologists wanted to extend coverage to human diseases. Both wanted a quantitative science incorporating analytical tools for epidemiology and disease prediction.

The course was tailored for undergraduate biomedical and biological science students as well as postgraduate students undertaking coursework Certificates, Diplomas or Masters degrees (total annual enrolment of 120 students). It was offered within four degrees and eleven named fields of study (majors) and was affiliated with relevant professional, industry and government agencies to demonstrate relevance, application, utility and prospective employment. The course area is topical, contemporary and undergoing rapid growth as evidenced by the recent creation of a central Institute for Molecular Bioscience in partnership with industry and government as well as nationwide support for three Cooperative Research Centres in the fields of Ecology, Water Quality and BioSecurity.

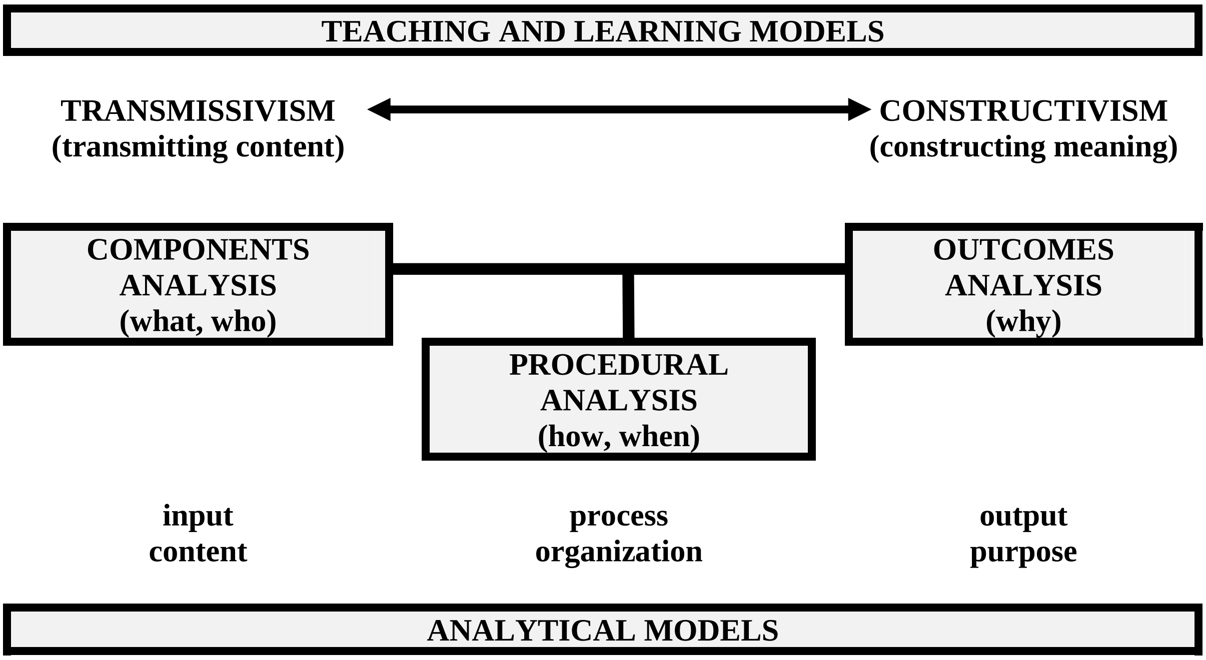
2. <u>PROJECT DEFINITION</u> (statement of problem)

The objective of the project was to design a new preclinical course on the ecology of disease for biomedical and biological sciences using contemporary educational models to identify and link course content, delivery and assessment. The problem was to avoid superficial coverage while maintaining unity of vision in the diverse multidisciplinary environment.

The need for a course on the ecology of disease was identified by Faculty predominantly on the basis of internal factors (such as resource rationalization, content logic, interdisciplinary networking and perceived client demand) and to a lesser extent on external factors (such as vocational demand, community benefit and society need). Various curriculum development models recommend that this process be formalized and that parametric "needs assessments" be conducted with stakeholders (Walker, 1971; Oliva, 1976). Walker (1990) lists the five major conceptions of curriculum as: courses offered for study; educational activities; intended learning; students experiences; and learning outcomes. Teaching and learning must be considered together, if not in parallel then in series.

2.1 <u>Investigative rationale</u>

Teaching and learning models range from transmissivism (whereby knowledge is transmitted to students) to constructivism (whereby students construct meaning) (cf. Dawson, 1994). These polar models were used to identify three areas requiring analyses. From the teaching perspective, I conducted a "*components analysis*" to define course content (What?) and identify teaching staff (Who?). From a learning perspective, I conducted an "*outcomes analysis*" to identify desirable attributes students will acquire (Why?). The connecting link is operational so I conducted a "*procedural analysis*" to identify best practice (How and When?). These three areas essentially represent *input*, *output* and *process*. I believe these areas are comparable with those identified by Walker (1990) in his definition of curriculum as "referring to the *content* and *purpose* of an educational program together with their *organization*."



Research on the content, purpose and organization of a specific course cannot be achieved by any single methodology due to their disparate natures (dominated by objects, attitudes and actions, respectively). Multiple approaches must be used to acquire, analyze and interpret data.

3. <u>DATA ACQUISITION</u> (methods)

The three basic principles of experimental design are that an intervention be conducted, that controls be included for comparison, and that experimental bias be negated by randomization. The latter two are difficult to implement in design studies. Education is about affecting change and it would be ideal to measure the degree of change in students before and after an educational intervention, or alternatively in one group of students given specific learning opportunities compared to another group denied those opportunities. Courses should also be selected at random from a larger population and data collected after random allocation to treatment or control groups. These tenets could not be enforced in this study. Information was gathered from both teacher (n=10) and student (n=50) groups who were prospective participants in the course. Teachers (5 novice and 5 experienced) were nominated as content specialists by cognate Schools while students (25 undergraduates and 25 postgraduates) were volunteers who were interested in taking the course thereby probably imparting an inherent bias due to motivation levels. The student group was not homogenous and included level 2 students who had not previously studied allied courses and recent graduates who had completed related level 3 courses. The teacher group was also heterogeneous and ranged from senior staff expert in course content and accomplished in delivery through to novice lecturers new to tertiary teaching. The experiences, opinions, attitudes and expectations of the participants were therefore varied which was considered vital for multi-perspective representation.

Data was acquired by triangulation using questionnaires, personal interviews and focus groups. Information was gathered in the two broad categories of course content and process; including concepts, core content, supportive anecdotes, syllabus, class types, activities, resources, self-directed learning, problem-solving, graduate attributes, assessment criteria, feedback and course evaluation. All participants were given a questionnaire containing open and closed questions to generate qualitative and quantitative data on process and content. The questionnaire format was used as a rudimentary agenda for all interviews. Each participant was personally interviewed to gauge their opinions on content, objectives, activities and assessment. Focus groups (2 groups of 5 teachers and 6 groups of 8-9 students) were established to promote discussion and develop consensus on specific issues. Qualitative data was categorized and narrative summaries composed whereas quantitative data was analyzed to determine strongest correlations. Few significant differences in choices were observed between junior and senior academics nor between undergraduate and graduate students so the four categories were collapsed into two; namely, teachers and students. Surprisingly, few differences were observed between these two groups but when they did occur, they were quite revealing with regard to teacher expectation and student anticipation. The frequency of responses are presented separately for teachers and students and the significance of any differences indicated at the 5% probability level (Student *t*-test).

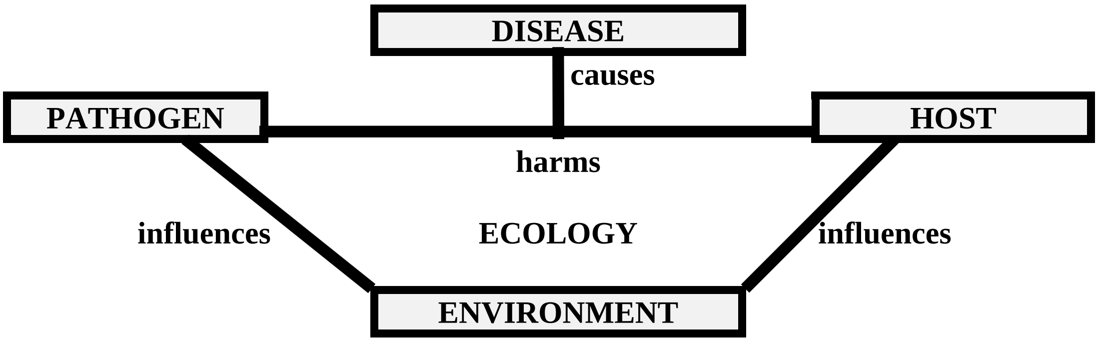
4. COMPONENTS ANALYSIS

Scientists seldom have difficulty in documenting content particularly in their area of expertise. However, it is often done in an intuitive fashion which is not transparent to others. For this reason, course content was examined through the process of concept mapping as advocated by Novak & Gowin (1984). Teachers and students were asked to develop individual concept maps and focus groups were asked to develop consensus maps for consideration by the design team.

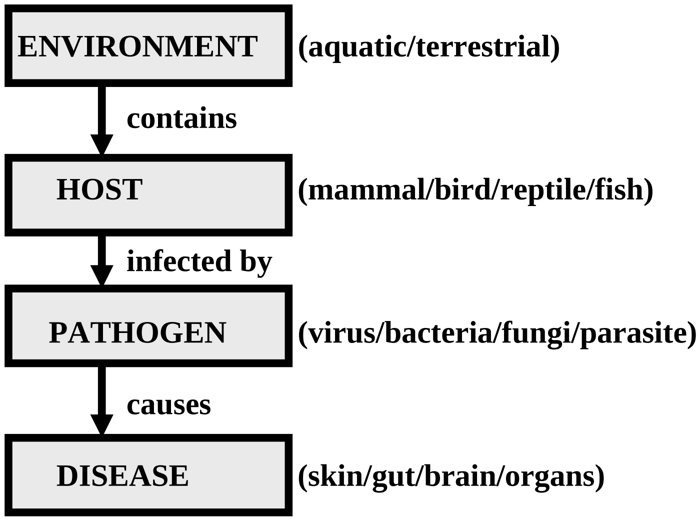
4.1 Concept maps

Most respondents defined the ecology of disease as the scientific study of the interactions between pathogenic microorganisms, their hosts and the external environment to explain disease occurrence and distribution. It was perceived as an integrative multidisciplinary course attempting to reconstruct natural relationships from relevant microbial, organismal and environmental sciences. Three major consensus maps (pyramidal, linear and interlocking models) were derived showing different linkages between the three foundational elements of hosts, pathogens and environment. Pathogens were considered to interact with their hosts causing disease while environmental interactions affected morbidity, mortality and transmission patterns.

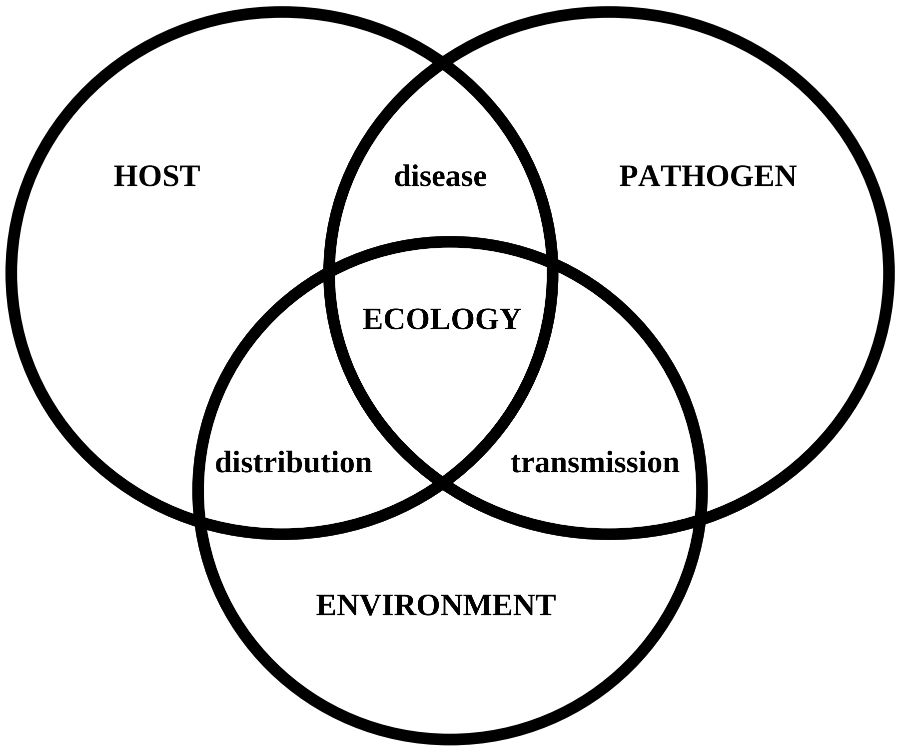
Pyramidal model



Linear model



Interlocking (Venn) model



4.2 <u>Core Components</u>

Teacher and students perceptions of content scope and sequence were solicited in the questionnaire and further clarification sought in the interviews and focus groups. Specific examples were requested for each key component and the responses were ranked according to their frequency in the following tables.

- **Pathogens**

All major assemblages of pathogenic micro-organisms were identified as core course material with 60-95% of respondents identifying bacteria, viruses and parasites. Teacher and student responses were similar for these assemblages but significantly different for arthropods (90% of teachers wanted to include insects compared to 42% of students, and 50% of teachers wanted to include arachnids compared to 20% of students). Upon questioning, teachers said they wanted to include both assemblages because they were not only pathogens in their own right but could also carry other pathogens. In contrast, students had focussed on primary pathogens and not considered vectors.

What **pathogens** should be included in the course?	TEACHERS n=10	STUDENTS n=50	TOTAL n=60
1. Bacteria	10 (100%)	47 (94%)	57 (95%)
2. Viruses	9 (90%)	40 (80%)	49 (82%)
3. Helminths	7 (70%)	31 (62%)	38 (63%)
4. Protozoa	7 (70%)	29 (58%)	36 (60%)
5. Insects	9 (90%)	21 (42%)	30 (50%)*
6. Fungi	6 (60%)	22 (44%)	28 (47%)
7. Arachnids	5 (50%)	10 (20%)	15 (25%)*
8. Algae	1 (10%)	9 (18%)	10 (17%)
9. Rickettsia	2 (20%)	6 (12%)	8 (13%)

*Asterix indicates significant difference between groups at 5% probability level.

- **Hosts**

Both teachers and students identified humans and other mammals as primary hosts (80-100% of responses) with other vertebrate and some invertebrate classes ranked much lower (24-56%). The only significant difference between teacher and student groups was in their consideration of insects as hosts. Teachers ranked them higher than students (80% compared to 46%) mainly because they were vectors of disease while students tended to focus on wildlife assemblages.

What **hosts** should be included in the course?	TEACHERS n=10	STUDENTS n=50	TOTAL n=60
1. Humans	8 (80%)	46 (92%)	54 (90%)
2. Mammals	10 (100%)	44 (88%)	54 (90%)
3. Amphibians	4 (40%)	28 (56%)	32 (53%)
4. Insects	8 (80%)	23 (46%)	31 (52%)*
5. Birds	6 (60%)	21 (42%)	27 (45%)
6. Fish	4 (40%)	19 (38%)	23 (38%)
7. Crustaceans	3 (30%)	12 (24%)	15 (25%)
8. Reptiles	3 (30%)	11 (22%)	14 (23%)

- **Environments**

Most respondents indicated a preference for terrestrial environments, both metropolitan and rural. Aquatic environments and climatic zones were ranked lower. Significant differences between teacher and student groups involved teachers recognizing tropical and temperate zones more frequently than students (80-90% compared to 44-62%) and teachers considering parasitic modes of existence more frequently than students (40% compared to 6%).

What **environments** should be included in the course?	TEACHERS n=10	STUDENTS n=50	TOTAL n=60
1. Terrestrial	10 (100%)	43 (86%)	53 (88%)
2. Metropolitan	9 (90%)	43 (86%)	52 (87%)
3. Rural	9 (90%)	41 (82%)	50 (83%)
4. Marine	7 (70%)	39 (78%)	46 (77%)
5. Wilderness	7 (70%)	39 (78%)	46 (77%)
6. Freshwater	9 (90%)	36 (72%)	45 (75%)
7. Tropical	9 (90%)	31 (62%)	40 (67%)*
8. Coastal	8 (80%)	26 (52%)	34 (57%)
9. Temperate	8 (80%)	22 (44%)	30 (50%)*
10. Parasitic	4 (40%)	3 (6%)	7 (12%)*

- **Diseases**

Attempts to identify specific diseases in the questionnaire and at interview were not successful. Participants were asked to list five examples but most (88%) could only list one or two. Careful examination revealed that the majority of these answers (83%) concurred exactly with the type examples provided in the question. Both teachers and students experienced difficulty with this question and wanted more time than was available to contemplate their answers. The response rate was considered too low and the answers too biased or superficial so as to render any analysis meaningless. When asked how this apparent impasse could be resolved, all teacher and student focus groups concluded that appropriate contemporary examples involving primary pathogens should be selected by the lecturers each year. The examples should be topical, current and controversial.

- **Interactions**

Respondents identified 24 different types of interactions they thought relevant to the course. Both teachers and students wanted to examine disease transmission (84-90%), particularly as it related to disease distribution (78-90%) and economic significance (80%). Significant differences were observed between teacher and student responses in several areas, especially those involving specialized or vocational terms (such as abundance, prevalence, incidence, epidemiology). Teachers were more familiar with these terms and consequently identified them more frequently than did the students (70-80% compared to 28-44%). Instead, students (82%) wanted to examine disease diagnosis but many teachers (50%) regarded this as premature, beyond the scope of a preclinical course and too complicated. More teachers than students (50-60% compared to 14-18%) wanted to look at disease outcomes in terms of morbidity and mortality whereas more students than teachers (84% compared to 50%) wanted to consider treatment options. In general, students identified more with practical applications while teachers concentrated on foundational theories.

What **interactions** should be included in the course?	TEACHERS n=10	STUDENTS n=50	TOTAL n=60
1. Transmission	9 (90%)	42 (84%)	51 (85%)
2. Distribution	9 (90%)	39 (78%)	48 (80%)
3. Economic significance	8 (80%)	40 (80%)	48 (80%)
4. Treatment	5 (50%)	42 (84%)	47 (78%)
5. Pathogenicity	8 (80%)	38 (76%)	46 (77%)
6. Management	7 (70%)	39 (78%)	46 (77%)
7. Diagnosis	5 (50%)	41 (82%)	46 (77%)*
8. Control	7 (70%)	37 (74%)	44 (73%)
9. Prevention	6 (60%)	32 (64%)	38 (63%)
10. Vector biology	9 (90%)	26 (52%)	35 (58%)
11. Virulence	7 (70%)	27 (54%)	34 (57%)
12. Immunity	6 (60%)	26 (52%)	32 (53%)
13. Abundance	8 (80%)	22 (44%)	30 (50%)*
14. Infectivity	7 (70%)	22 (44%)	29 (48%)
15. Resistance	5 (50%)	24 (48%)	29 (48%)
16. Epidemiology	8 (80%)	20 (40%)	28 (47%)*
17. Susceptibility	5 (50%)	21 (42%)	26 (43%)
18. Prevalence	8 (80%)	18 (36%)	26 (43%)*
19. Prediction modeling	5 (50%)	21 (42%)	26 (43%)
20. Incidence	7 (70%)	14 (28%)	21 (35%)*
21. Viability	5 (50%)	15 (30%)	20 (33%)
22. Symptomatology	4 (40%)	14 (28%)	18 (30%)
23. Mortality	5 (50%)	9 (18%)	14 (23%)*
24. Morbidity	6 (60%)	7 (14%)	13 (22%)*

4.3 <u>Core Platform</u> (module framework)

Due to the multidisciplinary nature of the course and the diverse concepts represented, it could easily be in danger of becoming fragmented by inappropriate sequencing or scheduling of content. Participants were therefore asked to select one overarching theme to form the basis for content presentation. Most respondents, however, indicated multiple choices, with up to 5 selections in some instances. The mean number of selections made by teachers was 3.4 and that for students was 3.9. Nevertheless, the unifying concept selected by both teacher and student groups was that of mode of transmission (80-86% of respondents). Further questioning at interviews and focus groups identified five dominant categories: air-borne; water-borne; food-borne; vector-borne; and venereal transmission. Most respondents selected mode of transmission as the preferred framework for course modules because they considered it to represent a central integrative concept unifying disparate core components. No significant differences were observed between teacher and student groups in the frequency of any of their choices although more teachers than students selected hosts (70% compared to 56%) and more students than teachers selected pathogens (74% compared to 50%).

What **concept** should form the basis for lecture modules:	TEACHERS n=10	STUDENTS n=50	TOTAL n=60
1. Mode of transmission	8 (80%)	43 (86%)	51 (85%)
2. Pathogens	5 (50%)	37 (74%)	42 (70%)
3. Diseases	5 (50%)	32 (64%)	37 (62%)
4. Hosts	7 (70%)	28 (56%)	35 (58%)
5. Sites of infection	3 (30%)	20 (40%)	23 (38%)
6. Geographic location	3 (30%)	15 (30%)	18 (30%)
7. Environments	3 (30%)	10 (20%)	13 (22%)

5. OUTCOMES ANALYSIS

Educational imperatives for the course include extrinsic social factors such as vocational competencies as well as intrinsic student-centred attributes such as active learning, autonomy and accountability (Elliott, 1998). Learning outcomes have been allocated to three major domains of education (Bloom, 1956-1964); namely, cognitive (knowing), affective (attitudes) and psychomotor (doing). Six categories are recognized in the cognitive domain (knowledge, comprehension, application, analysis, synthesis and evaluation) and five in the affective domain (receiving, responding, valuing, organizing and characterizing) (cf. Walker, 1990). While no formal categories have been proposed in the psychomotor domain, generic learning behaviours, manipulative skills and technical competencies have been identified as desirable. Participants in this project were asked to differentiate between specific outcomes based on course content and generic outcomes based on learning processes and attributes.

5.1 Specific learning outcomes (content-based)

Teachers and students identified ten specific learning outcomes covering both theoretical aspects and practical applications. Most students (90%) wanted to learn to diagnose diseases but teachers regarded this as an unrealistic expectation for a generalist preclinical course. Teachers wanted students to be able to examine and explain disease outbreaks using mathematical models so they could bring together relevant parameters in a holistic fashion. However, students wanted to focus on applied outcomes such as diagnosing infections, recommending control, planning surveillance and assessing risks and hazards.

Specific learning outcomes:	TEACHERS n=10	STUDENTS n=50	TOTAL n=60
1. Diagnose diseases	3 (30%)	45 (90%)	48 (80%)*
2. Categorize diseases	6 (60%)	41 (82%)	47 (78%)
3. Recognize transmission	6 (60%)	39 (78%)	45 (75%)
4. Explain outbreaks	8 (80%)	34 (68%)	42 (70%)
5. Recommend control	5 (50%)	33 (66%)	39 (65%)
6. Predict distribution	6 (60%)	25 (50%)	31 (52%)
7. Apply maths models	7 (70%)	20 (40%)	27 (45%)*
8. Plan surveillance	4 (40%)	20 (40%)	24 (40%)
9. Assess hazards	3 (30%)	20 (40%)	23 (38%)
10. Deduce interactions	2 (20%)	15 (30%)	17 (28%)

5.2 **Generic learning outcomes** (process-oriented)

A range of higher order learning outcomes have been listed as desirable graduate attributes in The University of Queensland Teaching and Learning Enhancement Plan (2000-2002). The list includes communication skills, information technology (IT) competency, problem solving, critical thinking, scholarship and interdisciplinary perspective. This list was made available to focus groups to prompt discussion. Teachers and students generally agreed that the best generic outcome was to gain a holistic perspective of the topic (70-76% of respondents). However, significant differences were observed between teacher and student groups. Teachers placed a strong emphasis on internal/intrinsic factors such as critical thinking (80% of teachers compared to 28% of students) and problem solving (70% of teachers and 40% of students) while students placed more emphasis on external/extrinsic social factors such as citizenship and community concerns (30% of students compared to none of the teachers) and ethical considerations (54% compared to 20%).

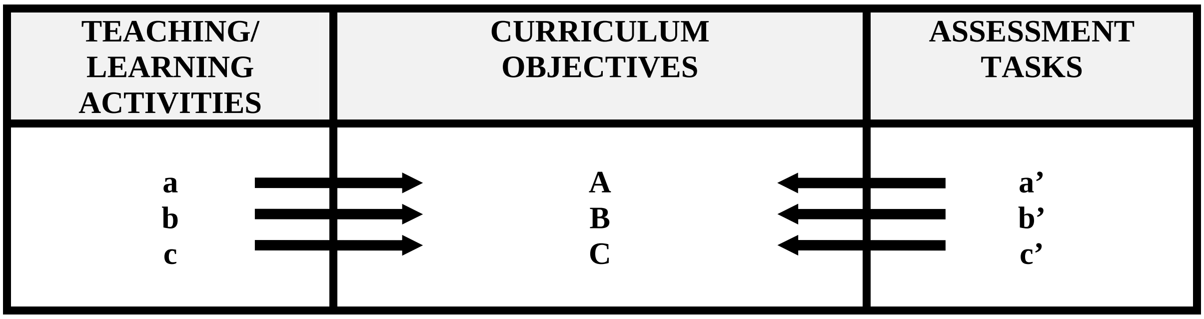
Generic learning outcomes:	TEACHERS n=10	STUDENTS n=50	TOTAL n=60
1. Holistic perspective	7 (70%)	38 (76%)	45 (75%)
2. Participation	5 (50%)	31 (62%)	36 (60%)
3. Communication	6 (60%)	27 (54%)	33 (55%)
4. Ethical implications	2 (20%)	27 (54%)	29 (48%)*
5. Multimedia competency	4 (40%)	23 (46%)	27 (45%)
6. Problem solving	7 (70%)	20 (40%)	27 (45%)*
7. Critical thinking	8 (80%)	14 (28%)	22 (37%)*
8. Scholarship	5 (50%)	15 (30%)	20 (33%)
9. Scientific writing	4 (40%)	14 (28%)	18 (30%)
10. Citizenship	0	15 (30%)	15 (25%)*

6. PROCEDURAL ANALYSIS

Numerous models have been proposed for curriculum development (objectives versus process models), providing instruction (scope, sequence, schedule models), conducting assessment (measurement and standards models), undertaking evaluation (intuitive versus systematic approaches) and performing educational research (process, product, learning and causal paradigms) (cf. Oliva, 1992). Traditional theory-practice models gave rise to a number of objectives models which specify educational aims and subdivides them into behavioural objectives (statements of intended learning outcomes). (cf. Elliott, 1998). Several prescriptive models have been described whereby objectives are selected from students, society and/or course matter (Taba, 1962; Tyler, 1949; Oliva, 1976; Saylor *et al*., 1981) and some descriptive models have advocated deliberation to resolve curriculum issues (Walker, 1971). Critics of objectives models suggest that this standardization of learning outcomes engenders student passivism and promotes individualistic learning. They advocate process models which view discovery learning as cultural induction and more conducive to the development of social competencies and affective dispositions (Stenhouse, 1975). Both types of models profess to being able to respond to social change through reform.

I considered the design of this new course to depend on developing clear vision statements particularly since several disciplines are represented which may have divergent views. This mandated the use of an objectives model but consideration was given to operational parameters. Strategic design models (cf. Foster, 1993) consider mission (purpose), goals (attributes), objectives (operational), structure (organizational) and evaluation (criteria). Goals are given as statements of purpose in general terms without criteria of achievement whereas objectives are stated in specific measurable terms (cf. Walker, 1990). These models are similar to the systematic model of Oliva (1976) but lack preliminary contemplation of philosophical and psychological principles of education. Strategic models are also compatible with business planning models familiar to many administrators (an advantage for future promotion and marketing exercises).

However, curriculum has various meanings in relation to action. Five categories have been defined as envisioned, developed, enacted, assessed and learned curriculum (Butler, 2000). This project was concerned with the planning categories (envisioned and developed curriculum) whereas research on operational categories (enacted, assessed and learned curriculum) is scheduled as part of regular review processes. The translation of curriculum from theory (planning) to practice (operation) involves interactions between many component parts, including instruction, assessment and evaluation. Different relationships between curriculum and instruction have been described in dualistic, interlocking, concentric, cyclical and spiral models whereby content and action exhibit no, partial, total, continuous or periodic dependence respectively (Oliva, 1992; Harden & Stamper, 1999). Integrative approaches have recently been taken a step further with the formulation of the constructive alignment model (Biggs, 1999) which brings together curriculum, instruction and assessment.



This model aligns curriculum objectives with teaching and learning activities as well as relevant assessment tasks. Objectives are defined in clear measurable terms, activities are chosen to realize those objectives, and assessment criteria address particular objectives. This makes the system transparent to both teachers and students and fosters engagement and reflection.

I adopted the constructive alignment model as the basis for reconciling teaching and learning activities and assessment tasks with course objectives. Partial alignment models have previously been used in physical, biological and earth science curriculum development, including the FAST model (Foundational Approaches in Science Teaching) aligning interdisciplinary foundational concepts and methodologies with formal and informal evaluation mechanisms (Brantley *et al.*, 1983). Evaluation, however, is not assessment. It focuses on program efficacy rather than student performance. Student assessment may be formative (process-oriented) or summative (content-oriented). In the past, heavy emphasis has been placed on summative assessment tasks to measure learning rather that formative assessment to support learning. Summative assessment has traditionally been facilitated by 'measurement' models which rate individual performance against population normal distributions rather than by 'standards' models which criterion-reference higher cognitive level performances (Taylor, 1994). Five hierarchical levels of understanding are recognized within Bloom's SOLO (Structure of Observed Learning Outcomes) taxonomy (cf. Biggs & Collis, 1982; Biggs, 1999); i.e. prestructural, unistructural, multistructural, relational, and extended abstract. Desirable learning outcomes should involve higher order understanding and assessment tools should evaluate cognitive, metacognitive and social competencies and affective dispositions (Dochy *et al.,* 1999). In this project, I used the SACK alignment model (acronym for Skills, Attitudes, Concepts and Knowledge) which was developed to link curriculum, instruction and assessment with the cultural and learning experiences of students (Sappier, 1996). Participants were provided with tables listing various instructional activities and assessment tasks and they were asked to indicate their top two choices relevant to each of the following categories:

- Skills (performance);
- Attitudes (perceptions);
- Concepts (principles); and
- Knowledge (information).

6.1 <u>Teaching and Learning Activities</u>

The results of the questionnaire were collated, ranked according to their frequency and are presented in the following tables together with narrative summaries of details and explanations gleaned from the personal interviews and focus groups.

- **Skills**

Teachers and students agreed that practical sessions were the best activities for teaching and learning practical skills. Both groups preferred 'wet' laboratory practicals over 'dry' labs or 'computer' labs so that they could actually perform techniques rather than simply observe them or simulate them in computer models. Both groups also mentioned that the practical tasks should reflect reality and not be artificial or outmoded activities. Teachers in particular voiced concern over the high cost of running laboratories, but their concerns were focussed mainly on salary costs for casual tutors rather than consumable or equipment costs.

Teaching and learning activities: **SKILLS**	TEACHERS n=10	STUDENTS n=50	TOTAL n=60
1. Practicals	10 (100%)	48 (96%)	58 (96%)
2. Computer labs	7 (70%)	25 (50%)	32 (64%)
3. Excursions	2 (20%)	19 (38%)	21 (36%)
4. Peer-study groups	0	6 (12%)	6 (10%)
5. Problem-based learning	1 (10%)	2 (4%)	3 (4%)

- **Attitudes**

Both teacher and student groups sought clarification about what was meant by this category. I provided a basic definition about the affective domain considering feelings which the SACK model has loosely interpreted as attitudes or perceptions. I cited the example of attitudes towards abortion to prompt students in particular to consider reasoned responses rather than just emotive responses. However, in providing definition and examples, I felt that I had compromised the process and biased the results. Nonetheless, both teachers and students identified activities that were based on discussion; students opting for tutorials and teachers for problem-based learning exercises. Both groups wanted an informal non-threatening environment to discuss individual, group, community and society attitudes towards infectious diseases, particularly those that are considered controversial and linked to behaviours viewed as different, inappropriate or even unacceptable (e.g. ablutions, promiscuity, homosexuality). Teachers expressed concern that tutors should be trained to avoid being judgmental, opinionated or patronizing.

Teaching and learning activities: **ATTITUDES**	TEACHERS n=10	STUDENTS n=50	TOTAL n=60
1. Tutorials	6 (60%)	30 (60%)	36 (60%)
2. Problem-based learning	8 (80%)	25 (50%)	33 (54%)
3. Seminars	3 (30%)	12 (24%)	15 (26%)
4. Peer-study groups	1 (10%)	15 (30%)	16 (26%)
5. Readings	0	9 (18%)	9 (16%)
6. Excursions	0	5 (10%)	5 (8%)
7. Practicals	0	4 (8%)	4 (6%)
8. Lectures	2 (20%)	0	2 (4%)

- **Concepts**

A range of activities were selected as being appropriate for establishing foundational concepts. Most participants, however, preferred activities promoting discussion rather than didactic presentations. Both teachers and students wanted open dialogue to establish, test and revise fundamental concepts. Teachers preferred expert tutorial format for ease of preparation whereas students selected seminar style presentations. When I noted that seminars involved less discussion than conventional tutorials, the student focus groups stated that the seminars should be student-controlled not teacher-controlled. They wanted an environment where students could present differing conceptions rather than have academics simply espouse party doctrine. They also wanted the activities to be well structured with defined topics and resources rather than more *ad hoc* like peer-study groups. Both teachers and students saw value in all participants having to make formal presentations so communication, participation and equity issues could be addressed.

Teaching and learning activities: **CONCEPTS**	TEACHERS n=10	STUDENTS n=50	TOTAL n=60
1. Seminars	2 (20%)	37 (74%)	39 (66%)
2. Tutorials	8 (80%)	23 (46%)	31 (52%)
3. Lectures	3 (30%)	20 (40%)	23 (38%)
4. Problem-based learning	5 (50%)	11 (22%)	16 (26%)
5. Peer-study groups	1 (10%)	4 (8%)	5 (8%)
6. Practicals	0	5 (10%)	5 (8%)
7. Readings	1 (10%)	0	1 (2%)

- **Knowledge**

The most frequent activity selected for knowledge acquisition was that of lectures. Both teacher and student groups preferred didactic dissemination of information rather than discussion or self-directed learning. I challenged the focus groups to explain (defend) their choice and all responded that they considered lectures to still be the most effective format for the presentation of specific information. However, all groups listed a variety of conditions predisposing good lectures; most pertaining to physical resources, audiovisual aids and presentation skills. There was consensus that air-conditioning was paramount, class sizes should be limited to 50-100 students, and mid-morning lectures were desirable. Most students preferred computer-assisted presentations whereas some lecturers considered them soporific. Students equated computerized presentations with professionalism and preparedness and they wanted access to the electronic material over websites. Above all, however, the key feature identified for all good lectures was the personal dynamism of the individual lecturer; those who were animated, enthused, coherent and well prepared were regarded as the best advocates for their fields of study.

Teaching and learning activities: **KNOWLEDGE**	TEACHERS n=10	STUDENTS n=50	TOTAL n=60
1. Lectures	10 (100%)	41 (82%)	51 (84%)
2. Seminars	2 (20%)	32 (64%)	34 (56%)
3. Tutorials	2 (20%)	15 (30%)	17 (28%)
4. Readings	3 (30%)	10 (20%)	13 (22%)
5. Problem-based learning	2 (20%)	0	2 (4%)
6. Peer-study groups	0	2 (4%)	2 (4%)
7. Computer labs	1 (10%)	0	1 (2%)

- **Summary of teaching and learning activities**

Both teachers and students were quite eclectic in their selection of teaching and learning activities, favoring combinations of transmissivist and constructivist approaches to provide variety and presumably cultivate different learning outcomes. Activities ranged from teacher-controlled lectures, student-controlled seminars, peer-controlled problem-based tutorials, and tutor-controlled practical sessions. Practicals were aligned with skills acquisition, lectures with knowledge transfer, tutorials with sharing perceptions, and seminars with concept comprehension. Emphasis was placed on activities promoting skills practice, interactive discussion and problem-solving.

Teaching and learning activities	**Skills**	**Attitude**	**Concepts**	**Knowledge**
Readings	0	18%	2%	22%
Lectures	0	4%	38%	84%
Seminars	0	26%	66%	56%
Tutorials	0	60%	52%	28%
Problem-based learning	4%	54%	26%	4%
Peer-study groups	10%	26%	8%	4%
Practicals	96%	6%	8%	0
Computer labs	54%	0	0	2%
Excursions	36%	8%	0	0

6.2 Assessment tasks

Respondent selections from the list of assessment tasks were counted, ranked according to frequency and are tabulated below together with explanations derived from the interviews and focus groups.

- **Skills**

Nearly all teachers and students considered practical examinations to be the most suitable assessment tasks for evaluating skills. However, teachers and students differed markedly in their conception of a practicum. Many teachers envisioned a single summative exam addressing descriptive and analytical components while students preferred progressive assessment via a series of practical tasks, analyses and written reports throughout the semester. Students valued technical performance and competence more highly than teachers.

Assessment tasks: **SKILLS**	TEACHERS n=10	STUDENTS n=50	TOTAL n=60
1. Practical exam	10 (100%)	49 (98%)	59 (98%)
2. Practical report	7 (70%)	34 (68%)	41 (68%)
3. Research project	2 (20%)	11 (22%)	13 (22%)
4. Case study	4 (10%)	6 (12%)	7 (12%)

- **Attitudes**

There was long discussion over the most appropriate task for assessing student attitudes and perceptions. Two schools of thought emerged; one advocating verbal assessment and the other written assessment. Over half of the respondents thought students should be able to articulate views and opinions about specified cases in an oral (*viva*) examination while the remainder thought that students should express and compare views dispassionately in written essay assignments or literature reviews. Both teachers and students had reservations about the fairness of oral exams, particularly for shy or reserved students and those from non-English speaking backgrounds. However, they felt that an oral exam would better reveal personal views and opinions whereas written assignments fostered stereotypic responses aligned with recent publications. Students felt that interpersonal communication skills should be encouraged while teachers had reservations about the logistics of conducting oral examinations. I asked them to estimate the time involved in marking essays compared to conducting an oral examination and most respondents agreed that the latter appeared to be more efficient with regard to time management.

Assessment tasks: **ATTITUDES**	TEACHERS n=10	STUDENTS n=50	TOTAL n=60
1. Case study	5 (50%)	31 (62%)	36 (60%)
2. Essay assignment	3 (30%)	27 (54%)	30 (50%)
3. Research project	2 (20%)	22 (44%)	24 (40%)
4. Literature review	5 (50%)	15 (30%)	20 (34%)
5. Scientific writing exercise	0	5 (10%)	5 (8%)
6. Practical report	4 (40%)	0	4 (6%)
7. Practical exam	1 (10%)	0	1 (2%)

- **Concepts**

Students and teachers identified written works as the most appropriate methods of assessing conceptual understandings. Tasks selected included reviews of the contemporary literature, scientific writing exercises and essay assignments. Both groups believed students should be able to document abstractions, compare conceptions and make generalizations. Teachers wanted students to explore alternate theories developed over time while students wanted to be contemporary and focus on current issues. The assessment tasks selected required considerable lead time for students to find resources, explore options and synthesize their answers. Most students requested access to starter resources whereas some teachers regarded the process of finding appropriate material to be instructive. Despite the recent information technology revolution, both teachers and students viewed the internet with caution. Students were often resource-limited and lacked the hardware or software supporting internet sites. Many teachers regarded the internet as a medium for mediocrity being saturated by unedited and trivial material. They were concerned that students wasted hours surfing the web for material and that they often failed to use filters to sort material.

Assessment tasks: **CONCEPTS**	TEACHERS n=10	STUDENTS n=50	TOTAL n=60
1. Literature review	4 (40%)	28 (56%)	32 (54%)
2. Scientific writing exercise	4 (40%)	19 (38%)	23 (38%)
3. Case study	1 (10%)	21 (42%)	22 (36%)
4. Essay assignment	4 (40%)	16 (32%)	20 (34%)
5. Research project	2 (20%)	11 (22%)	13 (20%)
6. Written exam (essay)	3 (30%)	5 (10%)	8 (14%)
7. Written exam (short answers)	2 (20%)	0	2 (4%)

- **Knowledge**

The respondents identified written examinations as the most suitable assessment tasks for examining content knowledge. Students preferred short answer questions which tested diversity of knowledge whereas teachers preferred essay answers to test depth of knowledge. Students also preferred multiple examinations staggered over the semester rather than a single end of semester examination. Most teachers weighted written examinations at 50% or greater of the final mark whereas students suggested equity between all modes of assessment. They were reluctant to be assessed predominantly on a single performance.

Assessment tasks: **KNOWLEDGE**	TEACHERS n=10	STUDENTS n=50	TOTAL n=60
1. Written exam (short answers)	6 (60%)	38 (76%)	44 (74%)
2. Written exam (multiple choice)	4 (40%)	21 (42%)	25 (42%)
3. Written exam (essay)	7 (70%)	10 (20%)	17 (28%)
4. Essay assignment	0	9 (18%)	9 (16%)
5. Practical exam	3 (30%)	7 (14%)	10 (16%)
6. Scientific writing exercise	0	6 (12%)	6 (10%)
7. Literature review	0	4 (8%)	4 (6%)
8. Practical report	0	3 (6%)	3 (4%)
9. Research project	0	1 (2%)	1 (2%)
10. Case study	0	1 (2%)	1 (2%)

- **Summary of assessment tasks**

Multiple modes of assessment were selected by participants with most preferring progressive summative assessment with detailed documented feedback. Curiously, few mentioned formative assessment although many subsequently indicated they regarded it as integral to modern courses. Practical examinations were aligned with skills demonstration, oral examinations with assessing attitudes, essay-style literature reviews with testing conceptions, and traditional written theory examinations with knowledge depth and diversity. Most assessment tasks selected required higher order understanding involving multistructural, relational and extended abstract hierarchies. Assessments were weighted differently by teacher and student groups with teachers favoring written examinations and students preferring projects and practicals. Most participants were familiar with measurements models of assessment and actively discussed marking and grading. Few, however, contemplated standards models involving assessment criteria aligned with learning objectives. Although criterion-referenced assessment was finally endorsed as university policy in 1997, it has been slow to be instituted and continues to be plagued by misunderstandings and misconceptions by both teachers and students. The next challenge faced in the development of this course will be to specify assessment criteria for each learning objective and define appropriate standards of performance.

Assessment tasks	Skills	Attitude	Concepts	Knowledge
Written exam (essay)	0	0	14%	28%
Written exam (short answers)	0	0	4%	74%
Written exam (multiple choice)	0	0	0	42%
Essay assignment	0	50%	34%	16%
Literature review	0	34%	54%	6%
Scientific writing exercise	0	8%	38%	10%
Research project	22%	40%	20%	2%
Practical report	68%	6%	0	4%
Practical exam	98%	2%	0	16%
Case study	12%	60%	36%	2%

7. INTEGRATED ALIGNMENT MODEL

The constructive and SACK alignment models were combined into one template and the data gathered from participating teachers and students incorporated into an alignment matrix. The resultant model concentrated on the relationships between course objectives, instructional activities and assessment tasks which were most obvious from the data collected. While considerable quantitative data was collected in the questionnaire, it was largely uninterpreted and required elaboration and clarification by discussion with the participants. Most consensus information originated from the focus groups which were able to discuss specific issues and produce ranked responses. Personal interviews with individual participants were time-consuming and generated little new information although they were extremely beneficial in team-building and allowed specific individualistic aspects to be explored and clarified. In the following summary table, I have not weighted or ranked any conclusions reached but have simply allocated them to pertinent categories or domains recognized within educational theory. The resultant model therefore represents a consensus design by prospective teachers and students aligning core content with appropriate instructional activities and relevant assessment tasks. It is based on perceived best practice and offers an objective template for new course design, particularly involving multidisciplinary fields.

CONSENSUS INTEGRATIVE ALIGNMENT MODEL

TEACHING/ LEARNING ACTIVITIES	CURRICULUM OBJECTIVES	ASSESSMENT TASKS
← **PRACTICALS** **(wet/dry labs)** tutor-controlled (contextual examples)	**SKILLS [psychomotor domain]** 1. identify pathogens 2. diagnose diseases 3. apply maths models **diagnostic/analytical skills**	→ **PRACTICUM** **(solve problems)** multistructural (describe, list, analyze)
← **TUTORIALS** **(problem-based)** peer-controlled (clarify, reflect)	**ATTITUDES [affective domain]** 1. appreciate overview 2. value participation 3. ethical implications **perceptions**	→ **CASE STUDY** **(viva)** extended abstract (hypothesize)
← **SEMINARS** **(+ discussion)** self-controlled (topical anecdotes)	**CONCEPTS [cognitive domain]** 1. explain outbreaks 2. define boundaries 3. recommend control **comprehend principles**	→ **ASSIGNMENT** **(mini-review)** extended abstract (generalize)
← **LECTURES** **(+ readings)** teacher-focus (selected content)	**KNOWLEDGE [cognitive domain]** 1. categorize diseases 2. know transmission 3. deduce ecology **integrated knowledge**	→ **EXAM** **(short answers)** relational (compare, contrast)

8. REFERENCES

Bloom B.S. 1956-1964. *Taxonomy of Educational Objectives.* McKay Co. Publ., New York.

Biggs J.B. & Collis K.F. 1982. *Evaluating the Quality of Learning – the SOLO Taxonomy.* Academic Press, New York.

Biggs J. 1999. What the student does: teaching for enhanced learning. *Higher Education Research and Development* **18**: 57-75.

Brantley L. *et al.* 1983. Evaluation guide – Foundational Approaches in Science Teaching (FAST). Curriculum Research and Development Group, University of Hawaii

Butler J. 2000. *The Curriculum Design Process*, ED501 module, University of Queensland.

Dawson C. 1994. Students' prior knowledge and teaching approaches: transmissive and constructivist teaching. *Science Teaching in the Secondary School*, Longman Publ., London. pp. 47-55.

Dochy F., Segers M. & Sluijsmans D. 1999. The use of self, peer and co-assessment in higher education: a review. *Studies in Higher Education* **24**:331-350.

Elliott J. 1998. *The Curriculum Experiment. Meeting the Challenge of Social Change*. Open University Press, Buckingham

Foster G. 1993. Strategic course design. HERDSA Green Guide No. 15, Tertiary Education Institute, The University of Queensland.

Harden R.M. & Stamper N, 1999. What is a spiral curriculum? *Medical Teacher* **21**:141-143

Novak J.D. & Gowin D. 1984. *Learning How to Learn*. Cambridge University Press, Cambridge.

Oliva P.F. 1976. *Supervision of Today's Schools.* Harper & Row Publ., New York.

Oliva P.F. 1992. *Developing the Curriculum*. Third edition, Harper Collins Publ., New York

Saylor J.G., Alexander W.M. & Lewis A.J. 1981. *Curriculum Planning for Better Teaching and Learning*. Holt, Rinehart & Wilson Publ., New York

Stenhouse L. 1975. *An Introduction to Curriculum Research and Development*, Heineman Publ., London.

Taba H. 1962. *Curriculum Development. Theory and Practice*. Harcourt Brace Javanovich Publ., New York

Taylor C. 1994. Assessment for measurement or standards: the peril and promise of large scale assessment reform. *American Educational Research Journal* **31**:231-262.

Tyler R.W. 1949. *Basic Principles of Curriculum and Instruction*. University of Chicago Press, Chicago

Walker D.F. 1971. The process of curriculum development: a naturalistic model. *School Review* **80**:51-65.

Walker D. 1990. *Fundamentals of Curriculum*. Harcourt Brace Javanovich Publ., New York