1-1-2008

Delivering a pathology curriculum in an integrated medical course

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Keywords

Medical education, pathology teaching, curriculum development, learning content management

Disciplines

Medicine and Health Sciences

Publication Details

Carr, N. J., Olmos, M. & Bushnell, J. (2008). Delivering a pathology curriculum in an integrated medical course. Virchows Archiv: an international journal of pathology, 453 (4), 369-375.

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Abstract

Modern integrated medical curricula usually do not include a separate pathology course. Consequently, there is a risk that important pathological principles may be omitted. We aimed to ensure that pathology is properly represented by developing a core pathology curriculum, created in consultation with local pathologists. Appropriate information technology to track the delivery of this material within the integrated curriculum structure was developed using a learning content management system in which a metadata schema was constructed. This allows a sophisticated view of where and how pathology appears in the course and can also increase the visibility of the subject by demonstrating the central place of pathology in medicine. In conclusion, a core curriculum in pathology that can be tracked by information technology with sufficient power and flexibility is a solution to the potential loss of pathology from integrated medical courses. We believe the result is superior to a stand-alone pathology course.

Key words: medical education, pathology teaching, curriculum development, learning content management.

Pathology is a core subject, the link between basic science and clinical medicine [1]. Its importance to medical students is emphasised in the Australian Medical Council's goals and objectives of basic medical education [2], and is made explicit by the General Medical Council in the statement that medical graduates 'must know about and understand … abnormal structure and function, including the natural history of human diseases' [3].

However, there is widespread concern amongst pathologists that medical students learn insufficient pathology in modern medical courses [4-6]. In general, medical educators have moved away from traditional discipline-based curricula towards integrated curricula. Such courses are considered to help students see the clinical relevance of the basic sciences, to make links with other subjects and to learn the complex process of clinical decision-making [1, 7-10]. Nevertheless, the loss of the dedicated 'pathology course' in such integrated curricula is often considered a retrograde step resulting in students encountering insufficient pathology. Not only could students fail to learn pathology in sufficient depth, but also they might have insufficient experience of pathology to consider choosing it as a career [4-6].

The new medical curriculum at the University of Wollongong is an example of an integrated course. One of the challenges in creating the new curriculum was to address the problems of incorporating the teaching of pathology. This paper describes how appropriate information technology (IT) allows a core curriculum in pathology to be delivered and assessed. The IT database can be interrogated easily to demonstrate exactly how and when the pathology curriculum has been included in the course. In this way, a 'virtual pathology course' can be tracked within the integrated curriculum. We believe this addresses many of the fears that pathologists might otherwise entertain about integrated medical courses.

SETTING

The Graduate School of Medicine at the University of Wollongong is a new medical school which has an integrated curriculum leading to the award of the MB BS. It is based on 93 clinical problems around which the content is arranged (Fig. 1). The clinical competencies and underpinning knowledge that a newly-qualified doctor would need to deal with each problem are clearly defined in a 'blueprint' cross-referenced to the course learning outcomes. Pathology is fully integrated into the curriculum and there is no separate pathology course. From the perspective of pathology as a discipline, there are risks associated with this curriculum structure: if an important pathological principle happens not to be addressed directly by any of the clinical problems it may be missed out entirely. Anecdotally, this is one of the objections that pathologists often raise when an integrated curriculum is developed without a separately-identifiable pathology course.

We decided to develop a core curriculum in pathology so we could ensure that all important pathological principles would be included in the course. We wanted to link this pathology curriculum to our information management system so we could track exactly where the material was being delivered and assessed.

DEVELOPING THE CORE CURRICULUM

One of us (NJC) devised a core curriculum comprising a syllabus in general and systematic pathology based on a combination of what is included in standard undergraduate textbooks, previous experience in teaching pathology to undergraduates, and national guidelines [5]. The resulting draft was then circulated to practicing pathologists in the region for comment – not only histopathologists but also clinical and general pathologists. The initial draft was modified as a result of this feedback. A second circulation resulted in the working version of the core curriculum. We believe this process has produced a better result than if we had just taken a curriculum produced elsewhere and tried to use it. The reason is that each course is unique and some aspects of a core curriculum may be applicable to one course but not another. Our pathology

curriculum is tailored to our course, is up to date, and takes into account the opinion of local practicing pathologists.

In one study, circulating drafts of check-lists of pathology content to pathologists tended to result in an increase in the number of topics, and the authors of that study 'exercised vigilance in trying to ensure that imbalance of scope and emphasis did not occur [11].' Our experience was similar – topics and disease entities were added at each iteration of the circulated draft. We found that starting with a lean original draft was helpful in preventing a final version that was too large and unwieldy. Trying to be too comprehensive from the start may have resulted in a syllabus too long to be useful. Our aim was to produce a list of core material essential to understanding the pathology relevant to the 93 clinical problems that comprise the course, rather than a comprehensive list of all the pathology a medical student might conceivably encounter.

Part of the core curriculum is shown in Table 1. However, we do not suggest that what we have developed would be suitable for all medical schools, because it has been tailored to our particular needs. For example, microbiology and genetics have limited representation, because these fields are separate science entities in our course. On the other hand, we stray into the borderland with sociology and ethics in considering the definition and nature of 'disease', because this topic is not covered in the social sciences in our medical school.

INFORMATION TECHNOLOGY

The educational design of the course required a number of characteristics from the technology. In particular, in order to allow pathology content in the course to be identified, content must be tracked within the curriculum using a metadata schema, which is a system resembling the cataloguing of items used by libraries. Metadata is structured information describing the characteristics of an item; the individual elements together with their meaning form a schema. For example, the National Library of Medicine uses a metadata schema that includes such characteristics as keywords and MeSH headings that are used when searching the database [12]. Having constructed a metatdata schema for the course, the various components, including the pathology core curriculum, can be mapped to it as described later. Other requirements of the technology include: the ability to hold many large digital resources; user access to content via the metadata schema and the multiple taxonomies it generates; availability of content throughout the course; cohort-specific content persistence (e.g. a cohort in fourth year has access to the content they covered in their first year, not what the current first year cohort is covering), with minimum duplication; permission control over content, to allow specific subgroups access to specific content; and version control of content.

A learning content management system called Equella (The Learning Edge, Hobart, Australia) was selected to meet these requirements. It was extensively customised with the creation of XSL templates, reports and power searches. It was integrated with version 4 of Blackboard Vista (Blackboard Inc, Washington D.C., USA) through its PowerLink tool, as the online environment and portal to all content for students and staff.

A curriculum metadata schema was created, describing the clinical problems, learning outcomes, body systems, science specialties, and clinical specialties that each item is associated with. This overlays multiple taxonomies on the content and allows detailed searching and interlinking via each of these fields. For example, students and staff can search across the entire course for resources, readings, lecture slides etc. related to a particular specialty such as pathology. Further, navigation through the clinical problems' blueprints via these descriptors forms a 'curriculum web'. An example of how this can work in practice is shown in Fig. 1 and Fig. 2.

Student assessment is aligned with teaching via the learning outcomes that are stated for each learning activity. These outcomes are part of the metadata schema and represent the link between the pathology curriculum and assessment practices.

Since the 93 problem blueprints form the skeleton of our curriculum, navigating through these makes evident to students the integrated nature of the curriculum, as the blueprints are extensively interconnected through shared schema elements such as learning outcomes, specialties, and body systems [13]. For example, they can easily see how pathology is integral to understanding the many problems and is not seen as an isolated subject. Furthermore, since students use this curriculum web to navigate through to resources, the curriculum becomes a usable everyday framework rather than a course outline document that is received in week one and never consulted again.

Detailed reports and charts can be generated using the metadata to track coverage of the specialties, problems, learning outcomes, and body systems in the course. An example of one such chart is shown in Fig. 3. These visualisations are very helpful in identifying coverage patterns and exceptions, as well as comparing the images from year to year for evaluation purposes. They suggest not only *where* in the course pathology is covered, but *how*. For example, Fig. 3 shows that pathology is covered consistently throughout the phase, suggesting the specialty is well integrated into the curriculum. Similar visualisations can be generated to show the coverage of pathology across the clinical problems and learning outcomes.

Staff and students have evaluated the school's online learning environment, and the comments have been encouraging and favourable. A typical student comment: 'It is a tremendous asset to both students and faculty. Not only does it allow you to revisit material remotely, but more importantly it systematically organises it for you, allowing you to go back and access material from previous weeks or months in mere seconds.' Moreover, this online learning environment has won international awards. It recently received an ASCILITE (Australasian Society for Computers in Learning in Tertiary Education) award, and was the top-ranked Platinum Learning Impact Award recipient from IMS Global, which recognises the use of learning technology in context world-wide.

DISCUSSION

The fear that the absence of pathology as a separate subject in integrated curricula leads to insufficient pathology content in modern medical courses is widespread [4-6]. This paper has described a way in which these potential problems can be addressed by firstly developing a core curriculum and then using IT to tag the corresponding course content in a metadata schema to ensure the curriculum is properly delivered. We believe this two-fold approach is essential. Without a core pathology curriculum, the incorporation of pathology topics in the course as a whole might otherwise become a matter of chance. On the other hand, in an integrated curriculum, sophisticated IT is the only practical way of tracking the various components of the pathology core curriculum to ensure they appear in appropriate contexts.

There is another advantage to this system. Students use the metadata schema on a daily basis to find teaching material. Consequently, students to see the central place of pathology in medicine as they navigate the online environment. This can address the problem of lack of exposure of pathology in integrated curricula, since the loss of pathology courses may cause pathology to lose its visibility to students as a discipline, leading to problems of recruitment into the specialty [4-6]. Ensuring that pathology is properly represented in the curriculum by methods such as those described in this paper will at least allow students to adequately encounter the subject.

There are few other descriptions of core pathology curricula in the literature. In the field of oral pathology, the British Society for Oral and Maxillofacial Pathology (BSOMP) have published a minimum curriculum similar in style to ours [14]. They were prompted to do so because, like the GMC, the General Dental Council (GDC) have guidelines for teaching students expressed as generic outcomes that do not identify specific pathology topics. Their solution was to produce a consensus minimum through the BSOMP Teachers Group, and cross-reference the topics not only with the GDC guidelines but also the Quality Assurance Agency for Higher Education

benchmark statements for dentistry. BSOMP, when constructing their minimum curriculum, took it to 'include elements of … epidemiology, aetiology, genetics, microbiology and transmission, immunology, innate host defences, pathogenesis, structural changes at the macroscopic and microscopic levels, sequelae, complications and the interrelationship between disease processes, diagnosis, management and prognosis.' This list is similar in scope to ours, but we also included use of the clinical laboratory and the place of pathology in medical practice.

At the College of Medicine, University of Iowa, a core list of morphological entities was constructed. All the morphological entities from a standard text (Robbins Pathologic Basis of Disease) were listed and circulated to faculty members. The selection criterion was that a 'physician in training should recognize classical examples or a diagrammatic representation of the following lesions, and distinguish them from each other.' The result was a list of 608 lesions that were considered core entities [15]. We did not use this method on the basis that it emphasised recognition of appearances at the expense of deep understanding of important principles. There are also guidelines for oral pathology from the United States, although their content and validity have been questioned on the basis that they emphasise an excess of factual knowledge [16].

If pathologists wish to see pathology flourish in modern curricula, they need to engage in the process of change and become involved in curriculum development, rather than romanticising the past [5, 6, 17]. If they do not, they are likely to become increasingly irrelevant in the development of medical education. As Marshall et al succinctly put it: 'while the medical education train accelerates away, pathologists are at risk of being left on the platform arguing the benefits of steam [18].' We believe that pathologists have the opportunity to make a significant contribution to medical education in the era of the integrated curriculum by developing well-designed core curricula and tracking delivery using appropriate IT.

Conflict of interest statement - We declare that we have no conflict of interest.

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Table 1. This is an extract from the core curriculum. It comprises the General Pathology section.

General Pathology
1. Place of pathology in medical practice
Scientific basis of medicine
• Medicine in the "Western" tradition is based on scientific principles (i.e. testable hypotheses)
• Pathological processes are central to the scientific understanding of disease
• However, there are other ways in which people think about disease (e.g. patient-centred vs. doctor-centred concepts)
Using the laboratory *(also relevant to working in a multidisciplinary team)*
• Sending specimens to the lab
• Interacting with lab staff
• Writing request forms
• Lab request as professional consultation
Death and post mortem issues
• The autopsy: its role, indications, basic procedures and reconstruction
• Ethical/spiritual issues for practitioners and relatives
• Writing death certificates
• Public health data are derived from death certificates
Interpreting laboratory data:
• Concept of the reference range and normal distribution
• The laboratory disciplines (microbiology, immunology, haematology, clinical genetics, clinical chemistry)
• Common electrolyte problems – hyper/hyponatraemia, hyper/hypokalaemia, hypercalcaemia
• Abnormal lipid profile
2. Laboratory techniques:
Histology
Gross observations, tissue processing and staining
Electron microscopy
Immunohistochemistry
Cytology
Genetics
Cytogenetics – karyotyping; spectral karyotyping
In situ hybridisation (e.g. FISH)
PCR and principal applications
Southern blotting (also Northern?)
DNA microarray analysis and principal applications
Immunology
Immunoassay
- Western blotting
- ELISA
- Methods based on antibody precipitation
Microbiology

Microbiology culture and sensitivity
Principles of diagnostic methods (morphology, biochemistry, immunology, PCR)
Clinical Biochemistry
Enzyme Assays
Protein separation techniques (electrophoresis, chromatography)
Analytical techniques used for
- substances in body fluids (sugars, lipoproteins, hormones)
- drug testing
Haematology
Flow cytometry
Blood smear
3. Basic concepts in pathology
What is a "disease"?
Disease classification
• Why do doctors classify disease into diagnoses?
• Use of jargon in medicine
Causes and mechanisms of disease
• Aetiology vs. pathogenesis
• Immediate aetiology as agent of underlying sociopolitical cause
• Categories of aetiological agents (useful when dealing with a diagnostic dilemma): genetic, metabolic, toxic, vascular, physical, infectious, neoplastic, etc
Abnormal structure and abnormal function are related
• Abnormalities in structure can cause symptoms
• Abnormalities in structure are useful diagnostically (clinical examination, radiology, operative findings and macroscopic and microscopic pathology)
Congenital disease – definition; examples
• Agenesis
• Hypoplasia
• Ectopia
Screening for disease
• Principles and controversies
• Examples (cervical cytology, PSA, colon)
4. Responses of cells to changes in their environment
Hypoxic cell damage
Pathogenesis
• Causes of ischaemia
• Consequences for the cell
Reversible vs. irreversible injury
Morphological consequences of ischaemia
• Changes in organelles
• Infarction *(link to necrosis)*
Physical and chemical agents causing cell damage
Heat, cold, electricity, trauma, radiation, pressure
Drugs and toxins
Free radicals

Cell death
Necrosis
• Types, and significance when encountered in a path report *(link to infarction)*
Apoptosis
• Pathological and physiological causes
• Stimulation and inhibition of apoptosis
• Caspase cascade
• Basic morphology and its relation to intracellular processes
Autolysis
• Term used by pathologists
Potentially reversible structural adaptations of tissues
Hypertrophy and hyperplasia
• Definition
• Pathogenesis of illustrative examples
• Hyperplasia can predispose to neoplasia
Atrophy
• Definition
• Pathogenesis of illustrative examples
Metaplasia
• Definition
• Pathogenesis of illustrative examples
Abnormal accumulations
Definition, main causes and significance (when encountered in a path report) of:
• calcification
• haemosiderin
• fatty change
• lipofuscin
• amyloid
• crystals (gout)
5. Inflammation
Inflammation has evolved because it has survival advantage, but can produce disease out of proportion to the cause *(links with immunology and host defence)*
Chemical mediators
Endogenous
• Histamine
• Serotonin
• Cytokines
• Prostaglandins, leucotrienes and lipoxins
• Nitric oxide
Exogenous (all cascade systems)
• Kinins
• Complement
• Clotting factors *(link to haemostasis)*
• Fibrinolytic system

Acute inflammation
Definition
Cardinal signs
Vascular and cellular components
• The “acute inflammatory cell” and macrophages
• Recruitment of neutrophils to the site of inflammation
• Phagocytosis
• Intracellular killing
• Mast cells
• Haemodynamic changes
Morphology
• Pus, suppuration
• Inflammation of serous and mucous membranes
Gangrene
• Use of term by doctors
• Pathogenesis
• Morphology
Sequelae
• Resolution
• Granulation tissue and scarring *(link to wound healing and necrosis)*
o components of granulation tissue
o collagen deposition = fibrosis = scarring
• Abscess/empyema
• Fistula and sinus formation
• Chronic inflammation
Chronic inflammation
Definition and causes
Cells
• Macrophages
• Lymphocytes and plasma cells
• Eosinophils
Granulomas and giant cells
• Nature
• Significance when encountered
Wound healing
• Keloid
• First and second intention
• Factors inhibiting wound healing
• Fracture healing and potential complications
Systemic effects of inflammation
Systemic inflammatory response syndrome (SIRS)
Pyrexia, acute phase reactants, malaise, etc
6. Host defence and immunopathology
Innate vs. adaptive immunity *(link to immunopathology)*
Examples and how they may be breached:

• Mechanical barriers
• Secretion contents and currents
• Commensal bacteria
• Cells of the innate immune system
T-cells and B-cells
• Function
• Organisation into lymphoid tissue
• Antigen-presenting cells and the MHC
• Types of antibody and their main characteristics
• Cytotoxic, helper and suppressor T-cells
• NK cells
Response of the adaptive immune system to antigens
• Specificity
• Diversity
• Memory
• Recognition of self
Principles of: hypersensitivity types I-IV
Autoimmunity
• Principles
• Organ specific
• Non-organ specific
Transplant rejection
Immunodeficiency
• Inherited
• Drugs
• AIDS
• Diabetes and other systemic diseases
• Vitamin and mineral deficiency
7. Neoplasia
Definition; benign vs. malignant
• Metastasis
Classification of neoplasms by line of differentiation
• Tumour nomenclature
• Diagnosis by line of differentiation *(link to histopathological techniques)*
• Grading *(link to prognostic features)*
Basic epidemiology
• Common neoplasms and their incidence
• Leading causes of death
Neoplasia is due to genetic alterations
• Oncogenes and proto-oncogenes
• Tumour suppressor genes
• p53
• Inherited vs. acquired genetic abnormalities
Carcinogenesis
• Chemical agents
• Ionising radiation
• Viruses
• Loss of immune surveillance
As genetic alterations accumulate, morphological changes occur
• Dysplasia/intraepithelial neoplasia

Tumour markers and their use in diagnosis and management
Prognostic features
• Stage
• TNM system
• Grade
8. Oedema
Basic pathophysiology
Pulmonary oedema
Pleural effusion
Ascites
9. Haemostasis, thrombosis and embolism
Formation of thrombus
• Platelets
• Clotting factors and fibrinolysis
Lab tests of haemostatic function
Diseases in which clotting is abnormal
• Haemophilia
• DIC
Thrombosis
• Definition
• Virchow's triad
• Outcomes of thrombosis *(link to infarction)*
Embolism
• Different materials that may embolise
• Pulmonary thromboemboli *(link to DVT)*
• Systemic thromboemboli
10. Shock
Definition
Pathogenesis and distinguishing features of:
• Hypovolaemic shock
• Cardiogenic shock
• Septic shock
• Neurogenic shock
• Anaphylactic shock
Multi-organ failure *(links to ARDS, acute tubular necrosis, adrenal haemorrhage, Sheehan's syndrome, ischaemic enterocolitis, etc. etc.)*
11. Stone formation
Use example(s) to illustrate:
• Physical chemistry of precipitation
• Varieties of stone
• Pathogenesis
• Complications

FIGURE LEGENDS

Fig. 1. Top left: A list of the 93 clinical problems around which the curriculum is arranged. Clicking on one of these (47, Chest Pain) displays the Problem Blueprint shown to the right.
Right: Blueprint for problem 47.. It shows the learning outcomes covered under each of the four themes. It also shows the science specialties (including pathology), clinical specialties, body systems, and differential diagnoses to which this problem relates. Students can then move from this 'micro' view back to a 'macro' view listing other problems on various criteria. Clicking on the icons to the right displays resources and learning activities matching that learning outcome and the problem. Clicking on one of the specialties or body systems shows a list of problems related to it. For example, a list of other problems covering pathology as a specialty can be shown by simply clicking on the 'Pathology, Anatomical & Clinical'.
Below: A list of problems related to pathology (from another blueprint). Students could now click on another problem and move from the macro to the micro view into another blueprint, and so on.

Fig. 2. Learning activity search. This screen allows students and staff to navigate through the 'curriculum web'. The screenshot shows anatomical pathology already selected; the search is further refined by selecting components of the other descriptors. The search will lead to specific learning activities.

Fig. 3 Science specialty coverage visualisation. This display shows the coverage of science specialties for the first year in the course. The vertical axis displays the two-weekly body system curriculum blocks. Each fortnight is represented by a box, the brightness of which indicates the number of learning activities mapping to each specialty. For example, pathology (fifth column from the right) is particularly strongly represented in the fortnight designated 'CVSR 3-4' (the third and fourth weeks of the Cardiovascular/Respiratory body system block).

Fig 1.

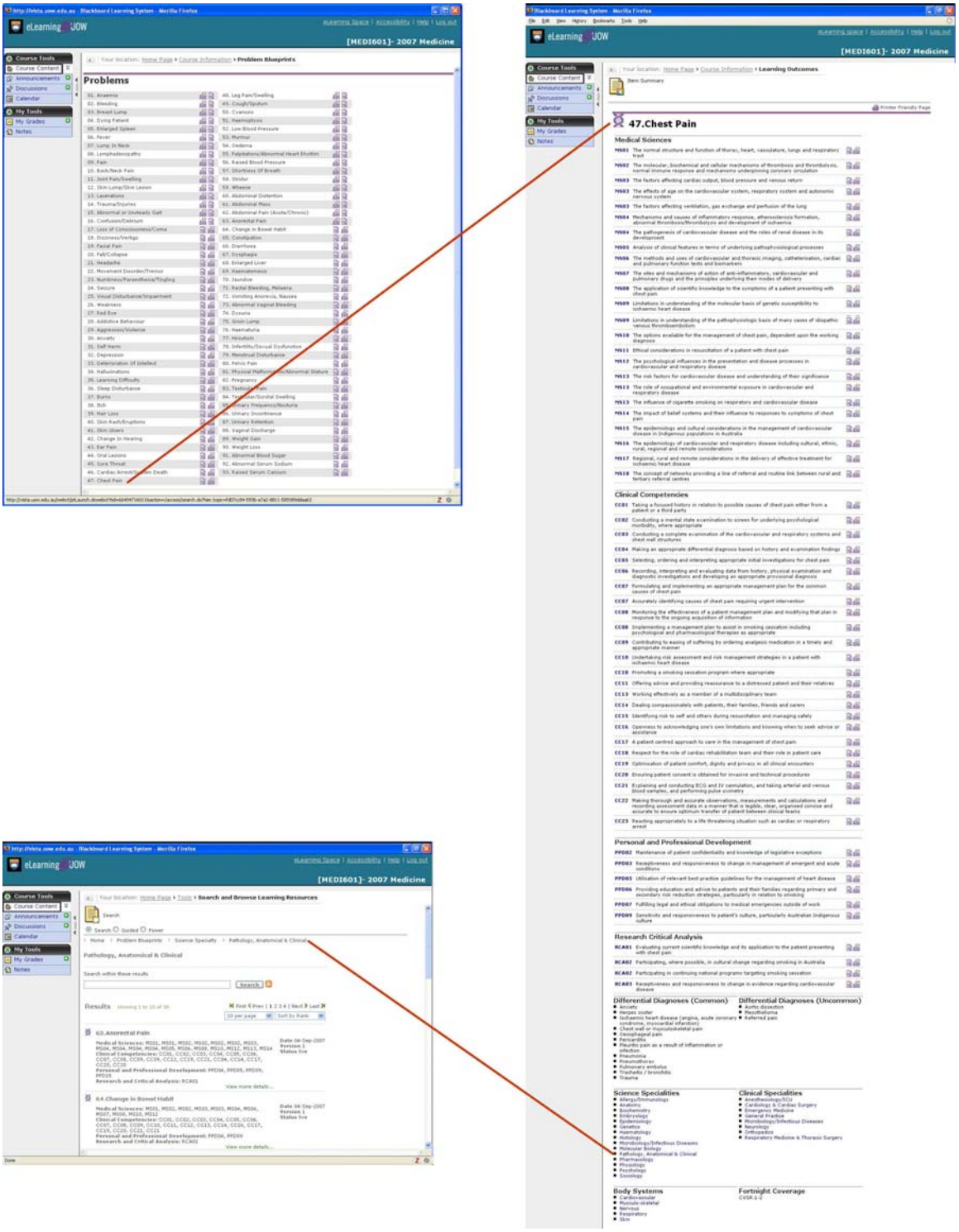

eLearning UOW
[MEDI601]- 2007 Medicine
Problems
47.Chest Pain
Medical Sciences
Clinical Competencies
Personal and Professional Development
Research Critical Analysis
Differential Diagnoses (Common)
Differential Diagnoses (Uncommon)
Science Specialities
Clinical Specialities
Body Systems
Fortnight Coverage

Fig 2.

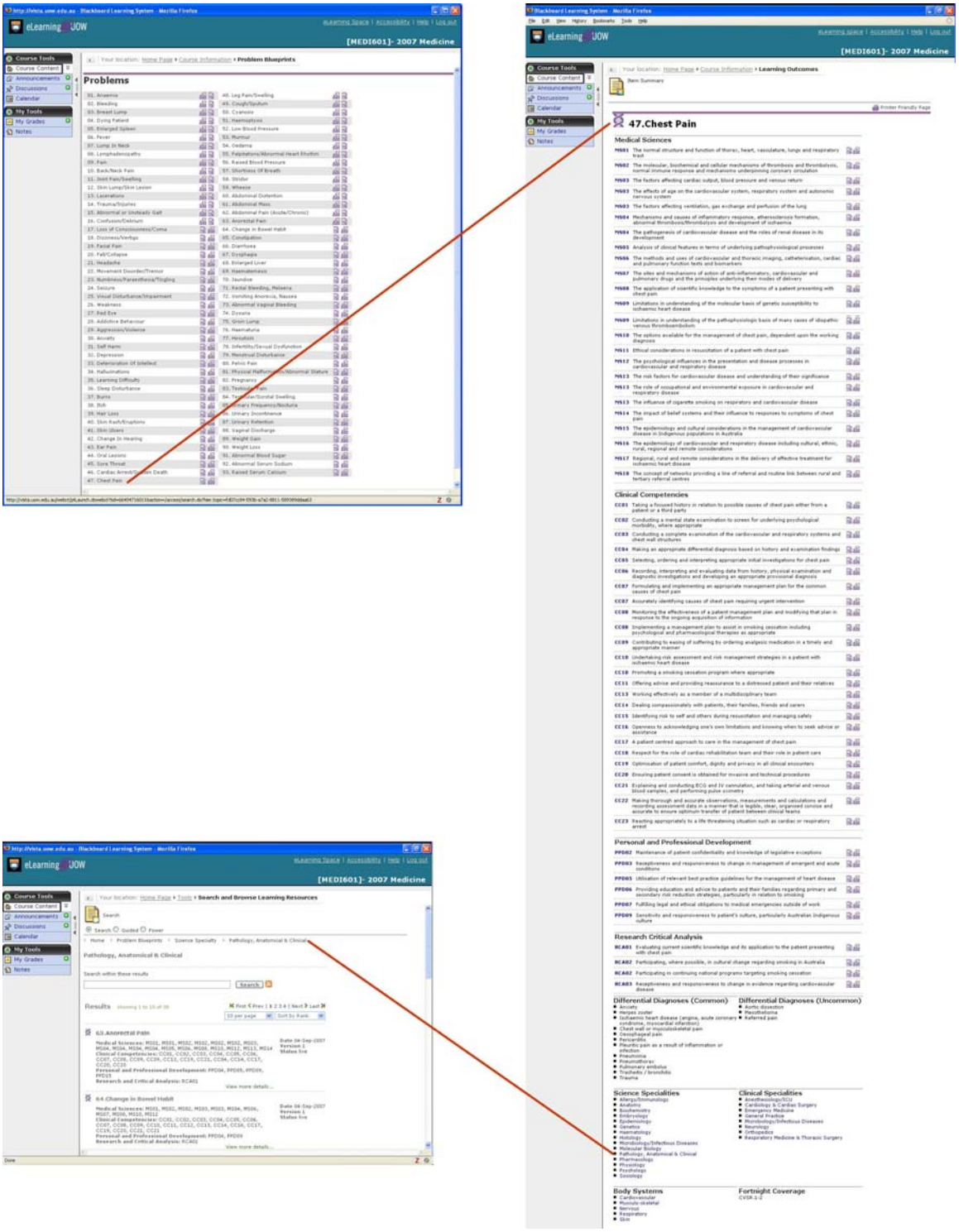
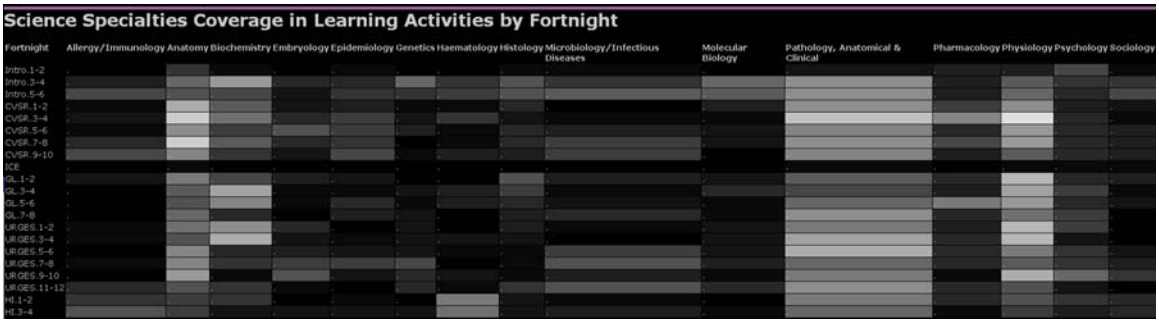

eLearning UOW
[MEDI601]- 2007 Medicine
Problems
47.Chest Pain
Medical Sciences
Clinical Competencies
Personal and Professional Development
Research Critical Analysis
Differential Diagnoses (Common)
Differential Diagnoses (Uncommon)
Science Specialities
Clinical Specialities
Body Systems
Fortnight Coverage
Search and Browse Learning Resources
Pathology, Anatomical & Clinical
63.Anorectal Pain
64.Change in Bowel Habit

Fig 3.


Science Specialties Coverage in Learning Activities by Fortnight
Fortnight
Allergy/Immunology
Anatomy
Biochemistry
Embryology
Epidemiology
Genetics
Haematology
Histology
Microbiology/Infectious Diseases
Molecular Biology
Pathology, Anatomical & Clinical
Pharmacology
Physiology
Psychology
Sociology
Intro.1-2
Intro.3-4
Intro.5-6
CVSR.1-2
CVSR.3-4
CVSR.5-6
CVSR.7-8
CVSR.9-10
ICE
GI_1-2
GI_3-4
GI_5-6
GI_7-8
URGES.1-2
URGES.3-4
URGES.5-6
URGES.7-8
URGES.9-10
URGES.11-12
HI.1-2
HI.3-4