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# Integration of Medical Images to the Teaching of Systematic Pathology: An Evaluation of Relevance

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**Abstract**

*A sound knowledge of pathological disease processes is required for professional practice within health professions. The project described in this paper reviewed the resources currently available for the delivery of systematic pathology tutorials. Additional complementary resources were developed and the inclusion of these additional learning resources in practical tutorial sessions was evaluated for their impact on student learning. Student evaluation of the learning resources was undertaken across one semester with two different cohorts of health profession students using questionnaires and focus group discussion. Both cohorts reported an enhancement to their understanding of pathological disease processes through the use of the additional resources. Results indicate student perception of the value of the resources correlates with staff perception and is independent of prior experiences.*

**Keywords**

*Medical imaging, systematic pathology, professional practice*

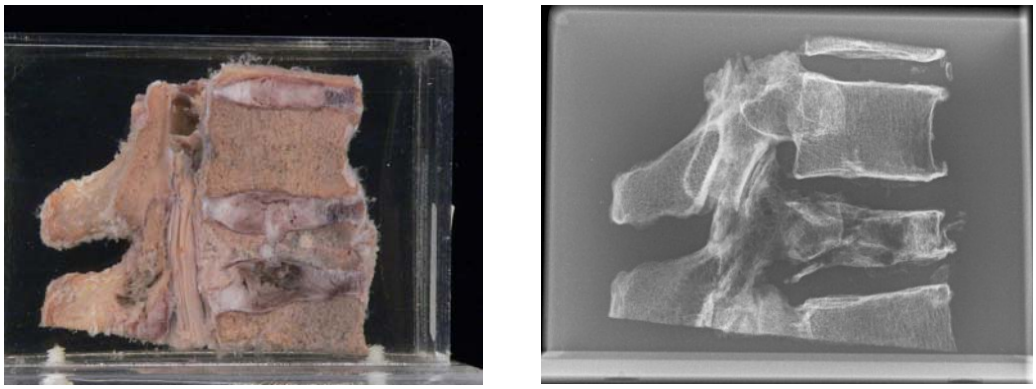
## Introduction

Review of the literature indicates student learning is enhanced when students perceive relevance of the topic to their future roles. The connection of academic content to a context which is familiar to students enhances the learning experience. The academic unit of systematic pathology included tutorial sessions with direct visualisation of preserved specimens. Radiographs of the pathology specimens were produced. These radiogaphs of the specimens where then included as a complementary resource for the muskulo skeletal tutorial session. The radiographs of the specimens were thought by academic staff to provide authentic relevance to *in vivo* pathology. Student evaluation of the impact of these images was undertaken by seeking student feedback across an academic semester with two different cohorts.

Due to timing of unit delivery, evaluation was conducted over two cohorts. A focus group session was conducted with a Medical Radiations Technology student cohort (Cohort 1). Evaluation with a cohort of health profession students with little prior contact with radiographs was undertaken using evaluation questionnaires comparing an enhanced module with a standard module (Cohort 2). The divergent experiences of the cohorts provided a comparison of the student perception of relevance and context of the integration of the images. Despite the different background knowledge of the two cohorts, both groups evaluated the integrated radiographic resource tutorials with similar results. Both cohorts reported an enhancement to student understanding of pathological disease processes through the use of the resources. This is a positive outcome because it indicates the student perception of the value of the integrated resources correlates with staff perception and is independent of prior experiences.

## Background

Systematic Pathology is a second year unit within the Medical Radiation Technology program. The pathology unit is also delivered in second year within the Vision Science program. Both student groups undertake studies in a modular approach and make use of preserved specimens from the pathology collection for tutorial sessions. Students currently visually examine the preserved specimens for evidence of pathological change. Given that many *in vivo* pathological changes are demonstrated by medical imaging, this research project included imaging of the pathological specimens to produce radiographic images. It is the integration of these pathological radiographic images as an additional resource into the tutorial practical sessions which was evaluated. As demonstrated in Figure 1, the pathology specimen (**A**) is complemented by the radiographic image (**B**) – the radiographic image demonstrates features of the specimen not typically well seen in direct visualization.



(**A**) (**B**)

*Figure 1* (**A)** Preserved pathological specimen of collapsed vertebral body with corresponding radiographic image of the specimen (**B**)

## Relevance

The inclusion of medical radiographic images in the practical sessions for systematic pathology provides a context to the study of the pathological specimens, that is, it presents the specimen in the form that the students will encounter in their real world practice. Contextual learning has been described as an environment where "students discover meaningful relationships between abstract ideas and practical applications in the context of the real world" (Texas Collaborative, 2007, para. 5). Dirkx and Prenger (1997) described the value of contextual learning by stating that "by integrating academic content with situations or issues that are meaningful to students, instructors can help adults acquire skills more rapidly than through approaches that focus only on subjects" (p. 2). As *in- vivo* demonstration of pathology is typically through radiographs, the inclusion of images to the tutorial resources was anticipated to provide real world relevance, and understanding, to pathological changes present in the pathological specimens.

Relevance of a learning activity to a professional outcome, impacts on student learning. In a study to review the relationship between the aspects of the learning environment and approaches to study, Trigwell and Prosser (1991 p.263), reported the academic environment which encourages deep learning includes "demonstration of the relevance of the course and attempts to make it interesting", among other factors. The authors also concluded it is important the relevance is perceived by students not just the lecturer. Tessmer and Richey (1997 p.93) similarly concluded "If learners do not see the relevance of the impending instruction, learning or transfer may be impeded by a lack of motivation".

Kember, Ho and Hong (2008), in a study of relevance and motivation in student learning, described intrinsic relevance as being where students considered concepts in terms of their own knowledge framework. They concluded that "if teachers wish to motivate their students' learning they need to find ways to show the relevance of topics included in their courses" (p. 255). In a review article based on health and physical education programs, Moore (2009) discussed the educational goal of increasing student learning. The author described the need for "academic rigor, vocational relevance and curricula relationships in programs that students see as real" (Moore 2009 p.46). Moore described relevance as a means of motivating and engaging students. "Students are most motivated and learn best when they are immersed in an environment that causes them to realize why they should learn" Guilford (2005 p 138). In a study of a series of modular, context based lectures, Guilford investigated student evaluation of teaching cell biology in the context of human pathology. The authors reported improved student focus and motivation with the integration of disease process and cell biology, in the delivery of this academic unit.

These authors identified the need for student perception of the relevance of the course of study. While the academic staff may see relevance in the unit activities, it is the student perception of this relevance which is significant. In Medical Radiations, for Medical Imaging and Radiation Therapy practitioners the relevance of pathology study is self evident. However for students with limited first-hand experience of the clinical environment, the connection between pathology studies and the profession is less clear. Establishing a clear relevance to the professional role is therefore important to promote the context of the study of pathology.

Marshall (2005) stated that "knowledge is no longer thought of as divided into discrete domains, but is seen in terms of an integrated system" (p. 228). Similarly Efland (2002 p.103) describes integration across subjects: "If the aim of education is to fully activate the cognitive potential of the learner, ways have to be found to integrate knowledge from many subjects to achieve a fuller understanding than would be provided by content treated in isolation". The inclusion of radiographic images into pathology tutorials integrates knowledge from two discrete subject areas within the program.

In a recent study of strategies for student-centred learning in large classes, Moulding (2010) described factors students perceived as most useful including "well-integrated design, relevance to the real world and teacher enthusiasm" (p.164). Herrington (2006) also stated that authentic learning environments should "provide an authentic context that reflects the way the knowledge will be used in real life" (p. 4). In the context of the pathology tutorial sessions, in vivo pathology would normally be visualized radiographically, so provision of radiographic examples mirrors the real environment or context, of the knowledge of pathological change. The inclusion of these resources provides relevance to the real world.

As described by Kember, Ho and Hong (2008) "the failure to establish relevance in professional courses had a double-edged sword effect. … If it was not clear how what they were taught was relevant to future needs, it was easy for morale to diminish" (p. 260). Without establishing relevance to the professional outcome, students could lose motivation and enthusiasm for the unit. Cardell (2005) "relevance is learner driven, but must be teacher provided for optimal learning" (p. 23). The additional resources provide an improved context and relevance to the pathology tutorials as perceived by the staff for the unit. As the above researchers have indicated, it is the student perception of relevance, which is significant for an authentic learning environment.

## Methodology

The research setting for this study was, as noted, a second year unit within the Medical Radiation Technology program, entitled Systematic Pathology where radiographs of pathological specimens were integrated into the pathology tutorial sessions. Evaluation was undertaken across an academic semester with two different cohorts of health profession students to determine if the integration of images had an impact on student learning.

It is important to note that the pathology program is delivered in a modular format – each body system is delivered as a module of lecture theory and related practical /tutorial session during the semester. This allows for comparison of evaluation of the standard delivery pathology module with the evaluation of module with the inclusion of the additional learning resources. The students in the cohorts, to be named Cohort 1 and Cohort 2 for convenience, studied the same content.

Cohort 1, the group with prior experience with radiographs, effectively acted as a review group. At the end of the semester, a focus group (*n*=5) was convened in which students were asked to reflect on the unit they had completed and review the newly developed integrated resources. They were asked to comment on the impact they perceived these resources would make in the future to student learning.

Cohort 2 (*n*=25) undertook the unit of study in the second semester. They completed two surveys with a series of questions with responses to be ranked on a Likert scale. The surveys compared the enhanced module , that is, using the radiographic images, with a standard module. Students were surveyed on their pathology tutorial without integrated resources and then after the module with the integrated resources.

## Results

The divergent experiences of the cohorts provided a comparison of the student perception of relevance and context of the integration of the images into their studies. Analysis of the feedback provided by both student cohorts demonstrated a consistently positive impact through the use of the integrated resources. This is a positive outcome because it indicates the student perception of the value of the integrated resources correlates with staff perception and is independent of prior experiences. There were two data collection instruments: survey and focus group.

### *Focus group*

Students from Cohort 1 were invited to participate in a focus group to review the then newly-developed resources for the unit. Students were asked to consider the unit as it had been previously delivered and review the additional resources of radiographic images. As students voluntarily participated in these focus groups, the response rate was low (*n*=5). However the students – to be referred to as Students 1-5 - enthusiastically engaged in discussion and provided valuable feedback of their evaluation of the pathology unit.

Students were generally content with the pathology unit in its original form. The practical sessions were thought to work well and the opportunity for group interaction was perceived well. Improvements that were suggested included reducing the group sizes so there was more direct access to a tutor (although students did recognise the potential resource implications) and modification to the weekly revision quizzes. Most students commented on the large amount of unit content and associated workload.

Review of the focus group session demonstrated some key themes identified by students in relation to the additional resources. Broadly these themes are: (1) Connection; (2) Relevance; and (3) Student interest.

### *Connection*

Students valued the radiographic resources as an aid to link the theory of pathology to the practical specimens. The inclusion of radiographic images provided a familiar context for medical radiations students to understand the content of the pathology unit, and students reported a greater understanding of the pathology specimens. As noted in the following statements, students were positive in their perception on the impact on learning by these resources:

- *These resources helped me make a correlation between the definition and physical appearance of disease.* (Student 1)

- *On reviewing these x-ray images I had a far more thorough understanding of the pathologies as I was viewing them in a media form I am familiar with.* (Student 3)
- *The pathological samples are better understood when they are reinforced by radiographic images.* (Student 5)

An unexpected connection recognised by students within the focus group discussion, was the connection between the anatomy and pathology units. Anatomy practical sessions utilise anatomical models. The use of pathological specimens for the pathology tutorials was perceived as a positive contribution to the understanding of anatomy. Student 2 noted that:

- *In anatomy we have learnt what things normally look like but just from plastic models. With the pathology pots we can see what the organ looks like in a real specimen as well as the changes that have occurred due to pathology.*

### *Relevance*

All of the students in the Cohort 1 Focus Group expressed enthusiasm for the impact of the radiographic images on the relevance of the pathology specimens. By providing a radiographic focus, the significance of pathology within the medical radiations program is reinforced to students, for example:

- *The images are exceptionally useful. They 'justify' the courses existence in the degree program.* (Student 4)
- *These image resources give the unit relevance to our future profession.* (Student 3)

### *Student Interest*

All of the students in the Cohort 1 Focus Group agreed that the additional radiographic images increased the interest in the pathology unit. This may be because the images presented a familiar context for the pathology or, stimulation of interest due to the classic radiographic appearance of the pathology. Student comments included:

- *I think it's a great idea to incorporate images into the pracs, it makes them much more interesting.* (Student 2)
- *The x-rays increase student interest in the unit and make the practical sessions more attractive.* (Student 1)
- *These resources have new and interesting appearances. I think more students would attend practical sessions by choice if they are included.* (Student 3)

An additional unexpected benefit recognised by students was the opportunity to view radiographic images of pathological change. The concentration of images demonstrating pathological process with the matching specimen provides a library of pathology images for image interpretation.

- *Having foundation knowledge in appearance of pathological process in x-ray images will be of significant relevance.* (Student 3)

### *Survey*

Figure 2 represents the findings from a key question in the pre- and post- surveys completed by Cohort 2 (*n*=25). The question asked for a Likert scale response (Strongly disagree – Strongly agree). The evaluation statement was: The resources for the practical session enhance my understanding of pathological disease processes.

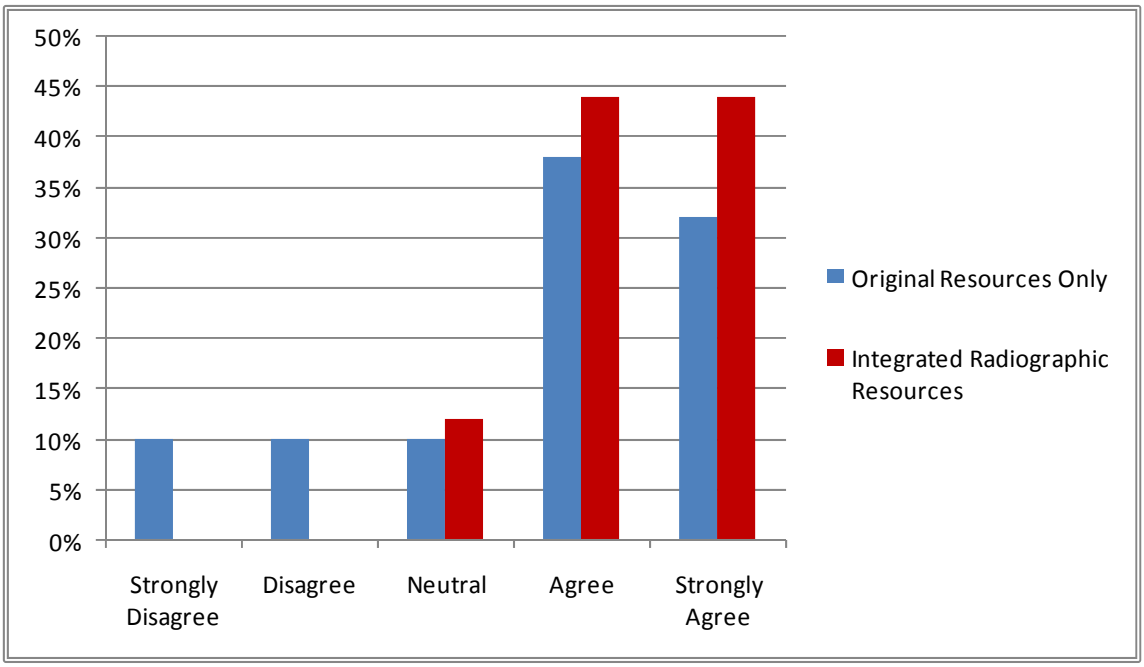



*Figure 2.* Response to evaluation statement (Cohort 2 pre- and post- surveys)

Results indicated an overall increased agreement with this statement. Twenty percent of students had either disagreed or strongly disagreed with this statement for the original resources, while, significantly, there were no disagreements with this statement following the integration of the radiographic resources. The majority of results from the post-survey were "agree" and "strongly agree." These results are particularly encouraging as this cohort (Cohort 2) had no formal prior contact with radiographic imaging and yet perceived the integrated resources enhanced their understanding of pathological processes.

## Discussion

In the comparison of an original pathology tutorial module to a module with the integration of radiographic images by Cohort 2, results demonstrated an overall improved agreement with all evaluation statements. This is particularly so for evaluation statement – "The resources for the practical session enhance my understanding of pathological disease processes" (see Figure 2). For all of the evaluation statements, the integrated resources module demonstrated a reduced percentage of students who strongly disagreed or disagreed.

From the evaluation of the initial tutorial (Figure 2), it can be seen that a small number of students reported a negative response to the evaluation statement. While the responses to the evaluation questionnaire were voluntary and anonymous, students who had contributed to the original evaluation were asked to contribute to the follow-up evaluation. As the reported negative perception to the tutorials is reduced in the post integration survey, this is an indication of genuine improvement in student perception of the tutorials.

Cohort 2 also provided general comments on the tutorial sessions. These general comments included the direct statement *"the images improve learning"*. This comment is particularly powerful as Cohort 2 which undertook these evaluations, have limited prior knowledge of radiographic imaging.

Kember , Ho and Hong (2008), Tessmer and Richey (1997), Trigwell and Prosser (1991) and others, have demonstrated there is a relationship between student interest, student- perceived relevance of a topic, and student learning . Interestingly, a student general comment from the post survey in Cohort 2 was *"the images did make it more interesting but there is little relevance to the course overall."* This comment indicates the student perception of the resources was they aroused interest in the pathology tutorial but did not assist to demonstrate relevance of pathology to the professional outcome of the program. This comment provides useful feedback of the need to establish greater relevance of pathology to the course Cohort 2 participants were drawn from.

## Conclusion

The focus group discussion (Cohort 1) produced positive feedback regarding the inclusion of radiographic images into the pathology tutorials. This cohort produces and reviews radiographic images of anatomical phantoms as part of their academic program. As second year students, clinical experience is limited, yet all have experience of hospital-based patients. Students described the radiographic resources as improving the correlation between the theory and the practical of pathology. This is the environment described by authors where "students discover meaningful relationships between abstract ideas and practical applications in the context of the real world" (Texas Collaborative, 2007, para. 5).

The medical radiations cohort (Cohort 1) also reported an increased understanding of the significance of pathology studies following review of the resources. This is important as the linkage between pathology and the profession is the basis for establishing relevance of the unit within the program. Students reported the radiographic images integrated into the tutorial session gave relevance to the study of pathology.

For these students, the use of radiographic images for demonstration of pathology provided resources in a medium that was familiar to them. Students reported a positive impact on their learning experience through the use of radiographs. An additional benefit recognised by students was the exposure to a range of pathological radiographic appearances through the use of integrated resources. The students described this increased visualisation as an opportunity to improve their knowledge of radiographic image interpretation.

The cohort of health profession students (Cohort 2) involved in this study had little prior interaction with radiographic images or hospital- based patients with a range of pathologies. Despite minimal background knowledge of radiographic appearances, they still reported an overall increased agreement with the evaluation statements for the tutorials with integrated images and responded positively. This could be due to the development of a context for the learning of pathology – radiographic images are predominately how *in vivo* pathology is diagnosed.

## References

Cardell, M. (2005). Relevance: Cornerstone for constructing meaning. *School Library Media Activities Monthly*, *21*(5), 23-25.

Dirkx, J. M., & Prenger, S. M. (1997). *A Guide for planning and implementing instruction for adults: A theme-based approach.* San Francisco, CA: Jossey-Bass.

Efland, A. (2002). *Art and cognition: Integrating the visual arts in the curriculum.* New York: Teachers College Press.

Guilford, W. (2005). "Shrink wrapping" lectures: Teaching cell and molecular biology within the context of human pathologies. *Cell Biology Education, 4*(2), 138-142.

Herrington, A., & Herrington, J. (2006). What is an authentic learning environment? In A. Herrington & J. Herrington (Eds.), *Authentic learning environments in higher education* (pp. 1-13). Hershey, PA: Information Science Publishing.

Hodges, B. (2008). Service learning: Creating visibility and advocacy for health education. *American Journal of Health Education, 39*(1), 44 -50.

Kember, D., Ho, A., & Hong, C. (2008). The Importance of establishing relevance in motivating student learning. *Active Learning in Higher Education.* Retrieved from: http://alh.sagepub.com/content/9/3/249

Marshall, J. (2005). Connecting art, learning, and creativity: A case for curriculum integration. *Studies in Art Education*, *46*(3), 227-241.

Moore, J. (2009). High school health and physical education: Reinforcing the 3Rs. *Techniques:Connecting Education and Careers, 84*(3). 46-47.

Moulding, N. (2010). Intelligent design:Student perceptions of teaching and learning in large social work classes. *Higher Education Reserch & Development, 29*(2), 151-165.

Tessmer,M., & Richey, R. (1997). The role of context in learning and instructional design. *Education Technology Research and Development* , *45*(2), 85 -115.

Texas Collaborative for Teaching Excellence. (2007). *What is contextual teaching and learning?* Retrieved from: http:// www.texascollaborative.org/WhatIsCTL.htm

Trigwell, K., & Prosser,M. (1991). Improving the quality of student learning: The influence of learning context and student approaches to learning on learning outcomes. *Higher Education*, *22*, 251-266.

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