



Issues in Informing Science + Information Technology

An Official Publication
of the Informing Science Institute
InformingScience.org

IISIT.org

Volume 15, 2018

VIRTUAL PATHOLOGY LEARNING RESOURCE: A PROMISING STRATEGY IN TEACHING PATHOLOGY TO ALLIED HEALTH SCIENCE STUDENTS

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ABSTRACT

Aim/Purpose The objective of this study was to concept test a new instructional aid called Virtual Pathology Learning Resource (VPLR), which was used as a vehicle to communicate information and enhance teaching and learning of basic sciences (Anatomy, Physiology, and Pathology) to allied health science students at a South Australian university.

Background Pathology was traditionally taught using potted specimens to review disease manifestations independently. However, this approach was found inadequate and ineffective. VPLR is a new teaching platform comprising of digitised human normal and human pathology specimens (histology, histopathology), patient case studies, short answer and critical thinking questions, and self-assessment quizzes. Using authentic learning theory as an educational pedagogy, this learning resource was developed to enhance the teaching and learning of Pathology.

Methodology Cross-sectional study design was used. A survey, given at the end of the course, gathered qualitative and quantitative data concerning the perceptions and experiences of the students about VPLR and its components. The online tool SurveyMonkey was utilised so that students could respond anonymously to a web link that displayed the questionnaire. The perceived impact on students was assessed using an 18-item questionnaire seeking agreement or disagreement with statements about VPLR, multiple choice and open-ended questions querying the best things about VPLR, benefits to be derived, and areas for improvement. Descriptive and frequency analyses were performed.

Contribution The VPLR approach involved rich learning situations, contextualised content, and facilitated greater understanding of disease concepts and problems.

Accepting Editor: Eli Cohen | Received: January 12, 2017 | Revised: March 8, 2018 |
Accepted: March 26, 2018.

Cite as: Thalluri, J., & Penman, J. (2018). Virtual pathology learning resource: A promising strategy in teaching pathology to allied health science students. *Issues in Informing Science and Information Technology*, 15, 15-33.
<https://doi.org/10.28945/4026>

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Findings	In a sample of 103 Medical Radiation students, 42% of students (N=43) responded to the post-intervention survey. The majority of students reported highly positive effects for each component of the VPLR. The overall results indicated that this tool was a promising strategy in teaching Pathology as it assisted students' gaining knowledge of the science, facilitated connections between sciences, and allowed students to make better links with professional practice and skills.
Recommendations for Practitioners	As students found VPLR to be beneficial, it is recommended that the same approach is applied for the teaching of Pathology to other health science students, such as Nursing. Other universities might consider adopting the innovation for their courses.
Recommendation for Researchers	Applying VPLR to teaching other allied health science students will be undertaken next. The innovation will be appropriate for other health science students with particular emphasis on case-based or problem-based learning and combined with clinical experiences.
Impact on Society	In reshaping the way of teaching a science course, students are benefited with greater depth of understanding of content and increase motivation to study. These are important to keep students engaged and ready for practice. VPLR may impact on education and technology trends so that exploration and possibilities of initiatives are ongoing to help students become successful learners. Other impacts are the new forms of learning discovered, the renewed focus on group work and collaboration, and maximising the use of technology in innovation.
Future Research	Future directions of this research would be to conduct a follow-up of this cohort of students to determine whether the impacts of the innovation were durable, meaning the change in perceptions and behaviour is sustained over time.
Keywords	virtual learning, pathology, higher education, allied health science students, tissue specimens, case scenarios, medical radiation

INTRODUCTION

Pathology is an important aspect of the medical and allied health science programs. It is the science of the causes and effects of diseases, especially that branch which deals with the micro- and macroscopic structures of body tissues for diagnostic or forensic purposes. The examination of pathological specimens is essential while learning the disease processes. However, the use of specimens from the pathology museum is inadequate and limited. From previous studies and experiences, students indicated that they were seeking more relevance and a stronger link between sciences and healthcare settings and desire to be work ready (Dienstag, 2008). Feedback from previous students also revealed that there is a disconnect between theory and practice and that there is a wedge dividing what students study in the textbooks and what is expected of them at the workplace (Thalluri & King, 2009).

Consequently, various strategies have been undertaken to improve the teaching and learning approaches to help students become successful science learners. Studies show that relevance inspires and motivates students to learn sciences, which also enhances positive student experience (Levett-Jones et al., 2009). Introduction to collaborative, interactive, and integrated activities using case scenarios and pathology specimens is one way to address the issue of relevancy and motivation (Biasutti, 2011). Maximising the use of technology is equally important (Penman & Ellis, 2007). The initiative described in this study was titled Virtual Pathology Learning Resource (VPLR), designed to improve the teaching and learning of the science of Pathology. The VPLR designers envisioned it to provide

productive learning situations and contextualised content to facilitate greater understanding of disease concepts and problems.

In designing VPLR, authentic pedagogy was used to underpin the approach used to teach Pathology. This methodology involves active learning and constructivist perspectives, and the focus is not on teaching techniques or processes but the ‘standards of intellectual quality’ (Newmann, Marks, & Gamoran, 1996). Pedagogically speaking, authentic pedagogy situates learning in the context of future practice, enabling the learners to access sound knowledge that applies to the real world. It has its genesis from various pedagogical approaches, such as the theory of situated cognition and anchored instruction (Herrington, Reeves, & Oliver, 2014). Authentic pedagogy is an alternative instructional model which is underpinned by sound principles for the provision of sophisticated and realistic learning tasks.

This research aimed to explore the usefulness of the instructional package VPLR, consisting of case scenarios and pathology specimens, amongst others, in teaching some aspects of Pathology to first-year allied health science students, Medical Radiation students specifically. Using a cross-sectional study design, the impact of this teaching/learning approach on students was determined by administering a survey. This study is critical because it could assist lecturers to know how to motivate first-year allied health students to study sciences, and engage in and participate in learning activities in order to achieve academic success. The traditional didactic lectures, followed by tutorials, need improving to be able to yield better learning outcomes for science students.

Therefore, the research question is: What is the impact of VPLR in teaching Pathology science concepts to first-year Medical Radiation students? Corollary questions pertain to how do students perceive the components of VPLR, namely using case scenarios and biological specimens, and how do these influence students learning and course satisfaction?

BACKGROUND

The undergraduate medical and allied health science education has undergone dramatic curricular reforms with the most significant change being the replacement of didactic courses (Burton, 2005). The emphasis on collaborative learning (peer or group learning) has been identified (Laal & Ghodsi, 2012). These new developments have been shown to achieve a more in-depth understanding, longer retention of knowledge, and increased positive attitudes toward learning (Fitzgerald & Keyes, 2014).

Previously, realia or materials that were highly concrete forms of stimuli to convey information (Hainsworth & Keyes, 2014) were used to teach and facilitate the understanding of complex science concepts. A case in point was the use of potted pathology specimens to teach the macroscopic features of the disease. However, realia is no guarantee of effective teaching. The efficient use of specimens from the pathology museum was frequently limited. The reasons included inaccessibility for off-campus students, occupational health and safety issues, and constraints with large student numbers (Dowdell, 2017). In approaching the study of Pathology in this manner, students also found difficulty in identifying the relevance of the science to clinical cases and their medical imaging profession. Thus, maximising the learning opportunity through an independent review of the pot alone was deemed challenging (Dowdell, 2017) and, hence, needed elevating and refining.

Several interactive online lessons focusing on physical specimens were developed to improve the potted specimens (Dowdell, 2017). Given that inspection of the pots was integral to learning, Smart Sparrow, an adaptive e-learning software platform creating a vibrant and interactive environment (Van Es, Pryor, Belinson, Salisbury, & Velan 2015), was used to motivate students to review the physical specimens. Utilising the specimens as aids, problem-solving was encouraged to assist students to correlate clinical cases with pathological cells and tissues.

With further advancements in technology, virtual three-dimensional (3D) specimens of authentic pathological specimens on a computer display were introduced next. With a simple method, Kalinski

et al. (2009) digitalised specimens for high-quality digital images. Feedback of digitalisation was very positive. Hence, virtual 3D specimens expanded the application of digital techniques in Pathology.

The electronic learning platforms have expanded, overtaking the popularity of lectures, discussion groups, and laboratory sessions. A case in point was Marchevsky, Relan, and Baillie (2003), who reported replacing the laboratory sessions by four interactive, self-instructional sessions using web-based technology and case-based instruction. The infusion of current technologies transformed the course dramatically where the content has been digitalised and pathology specimens photographed with attached clinical information. In presenting the above approach, students' participation, attendance and satisfaction were all enhanced.

Kunselman and Johnson (2004) corroborated by stating that there is a need to increase the relevance of science learning tasks to meet the expectations of professions and to contextualise these tasks using authentic resources such as pathology specimens and technological-assisted devices. The integration of a case scenario approach fostered cross-disciplinary understanding, while authentic pedagogy provided relevant design guidelines for teaching (Herrington et al., 2014). The use of case studies was reported to be beneficial, significantly more effective than other methods of content delivery (Bonney, 2015). Case studies increased student perceptions of learning related to communication skills and the ability to make connections between biological concepts and various aspects of life.

As the higher education sector absorbs the internet and Web-supported learning, the opportunity presents itself for authentic learning environments to be utilised extensively to improve student learning (Herrington et al., 2014). The teaching and learning process involved in our VPLR is more than the use of realia. Collaborative and interactive activities such as case scenarios, short answer and critical thinking questions, case presentations, and self-assessment quizzes are incorporated in addition to specimen examination. These activities replaced most traditional didactic lectures followed by tutorials (Thalluri, Majumder, & Shepherd, 2012). The objectives of this article are to explain the VPLR rationale, processes, and evaluation. An example of how VPLR is used to teach Pathology to Medical Radiation students is presented.

VIRTUAL PATHOLOGY LEARNING RESOURCE (VPLR)

VPLR is a new teaching platform consisting of digitalised normal and pathological human specimens, patient case studies, short answer/ critical thinking questions and self-assessment quizzes (Thalluri et al., 2012). Following on from the innovations of Marchevsky et al. (2003) and Kalinski et al. (2009), our VPLR brought together the benefits of educational methods and instructional materials to improve understanding and professional skills.

In 2016, the VPLR was used during the weekly workshops, conducted after short lectures which served as a guide for self- and collaborative learning. The pathology specimens representing common medical conditions were selected to create an accessible and useful tool to help students link the theoretical basis of Pathology, Pathophysiology, and related courses such as Anatomy and Physiology with their future Medical Imaging profession.

Thalluri, Majumder and Shepherd (2012) described the innovation:

"High-quality photographs of the anterior and posterior views were taken and the images were processed using Adobe Photoshop and Adobe Flash software. Key anatomical structures were labelled using interactive techniques. Clicking on a structure name from the list adjacent to the image would highlight the structure on the photograph. Interactive links to the definitions of the key pathological concepts were integrated into the text of the clinical scenario."

Authentic case scenarios were selected from topics across the course content. These scenarios involved collaborative learning through case analyses and presentations, replacing the bulk of traditional lectures. Each of the case studies included a detailed description of the pathology identifiable on

the specimens. Relevant histological images and photographs of normal specimens were linked to the case studies. A list of logical reasoning questions and multiple choice questions covering essential concepts of Pathology and Pathophysiology accompanied each of the scenarios. These questions were designed to check the learning that transpired with the activities (Bastable, Gramet, Jacobs, & Sopczyk, 2014), as well as assist with collaborative learning.

METHODOLOGY

PARTICIPANTS

All first-year Medical Radiation undergraduate students (N=103) who were enrolled in the 2016 Pathology course were requested to fill in a questionnaire at the conclusion of the course via email and personal invite. Permission to evaluate the VPLR was obtained from the University of South Australia Ethics Committee.

RESEARCH DESIGN

Using a cross-sectional study design, the perceptions and experiences of students about VPLR were determined using a survey (Creswell 2003; Shields & Smyth, 2016). An 18-item questionnaire was developed and used for the above purpose. Demographic characteristics of students were sought in Questions 1 to 4, other items had statements participants were to agree or disagree about, each Likert item had five levels of response ('Strongly agree', 'Agree', 'Neutral', 'Disagree' to 'Strongly disagree'), while others required multiple choice answers. Questions 5 to 15 were used to obtain information concerning students' views on the VPLR, use of authentic case scenarios and digitalised specimens to link the relevance of basic sciences to future practice, and also to query about cross-disciplinary. Questions 16 to 18 were open-ended questions seeking the best things about VPLR, benefits to be derived, and areas for improvement (Drummond, 2007; Stead, 2005). (See Appendix for the survey.)

DATA COLLECTION AND ANALYSIS

The online tool SurveyMonkey (www.surveymonkey.com) was used to create the study so that students could respond anonymously to a web link that displayed the questionnaire. Descriptive and frequency analyses were performed, and data analysis consisted of sorting the data into tables and counting the frequency of responses (Creswell, 2003).

RESULTS

Forty-three (n=43) students of the 103 enrolled students completed the survey for a 42% response rate. About 30% of the participants were mature aged students (i.e., over 23 years of age, have not been studying at either Year 12 level or university/vocational level for at least seven years); 70% were school leavers (i.e., young persons who just left high school). 90% of the participants chose Medical Radiation as their first preference when applying to the university. The majority of students worked part-time, hours ranging from 1 to 10 hours (63%), up to 20 to 30 hours per week (8%).

The majority of students 'Agreed' to 'Strongly agreed' that overall they have a good understanding of Pathology (72%) as a consequence of VPLR and that the learning activities involved in VPLR improved their understanding (90%) (Questions 5 and 6). See Figures 1 to 2.

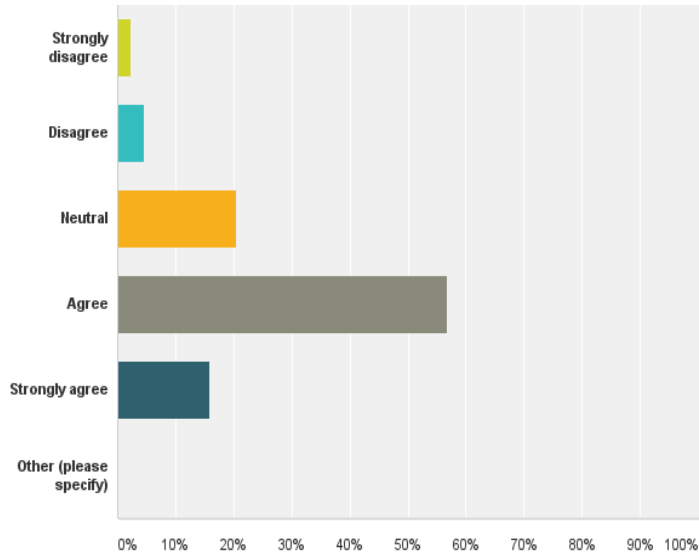


Figure 1. Good understanding of Pathology

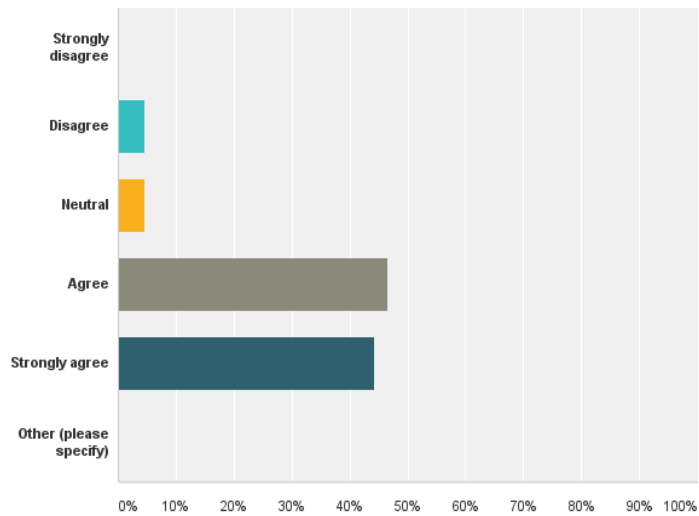


Figure 2. Learning activities improved my understanding

The majority of the students (97%) were able to make the linkages between the different sciences such as Chemistry, Anatomy, Physiology, Pathology, and Medical Imaging (Question 7). The opportunity for group work and collaboration assisted learning of diseases (70% 'Agreed' to 'Strongly agreed') as well (Question 8). See Figures 3 and 4.

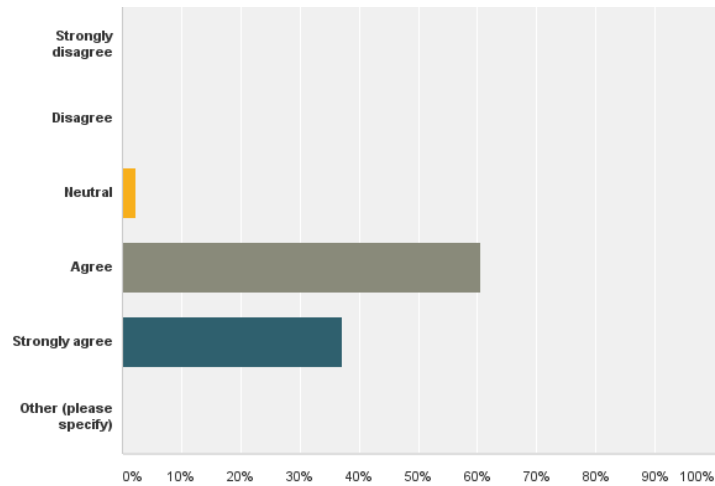


Figure 3. Case studies helped make connections between sciences

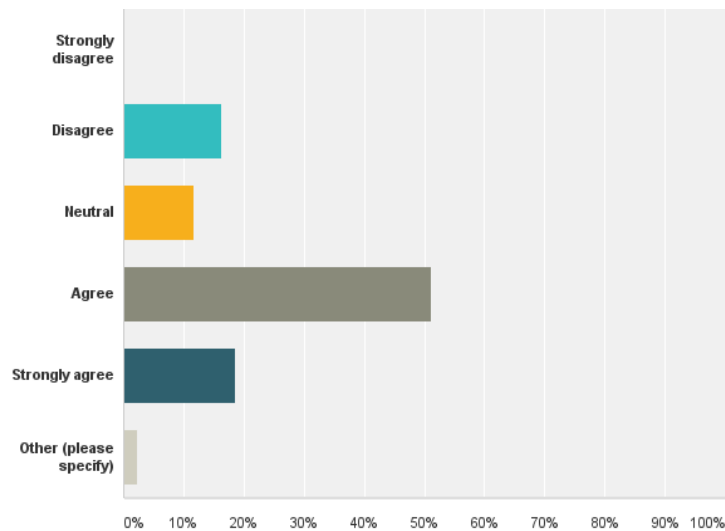


Figure 4. Group work and collaboration improved understanding

The VPLR approach helped students understand that learning the sciences was essential to understand medical images, according to 86% of participants (Question 10). This question was where relevancy to the profession was indicated. See Figure 5.

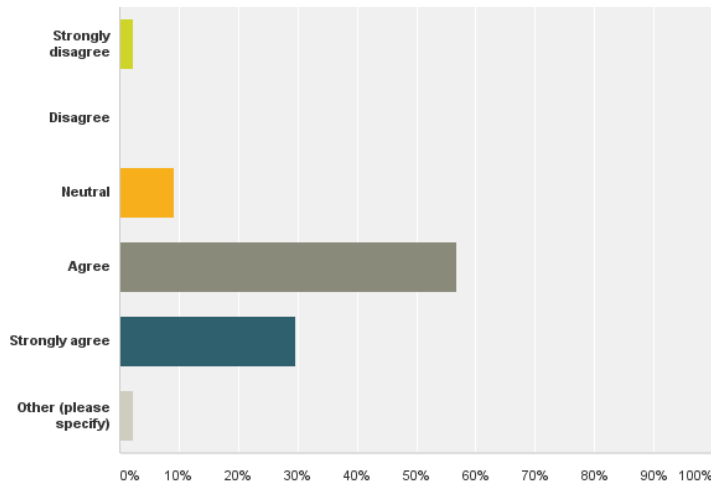


Figure 5. VRLP helped me to understand that learning science is essential to comprehend medical images

Multiple responses were required for questions 11 and 12. Question 11 sought the opinion of students regarding the factors that motivated them to learn Pathology. Question 12 gained students’ descriptions about VRLP. The impact of clinical context was examined in Question 14. The summaries of responses to these questions are tabulated in Tables 1, 2, and 3.

Table 1. Motivating factors to learn the course

Answer Choices	Responses
real life human pathology specimen resources	51.16% 22
integrated anatomy and physiology	72.09% 31
teachers showing the application and relevance to medical imaging	58.14% 25
peer learning while preparing for case presentation	30.23% 13
group clinical scenario case presentation in a holistic approach (linking basic sciences, pathology and imaging, radiation studies).	53.49% 23
use of medical imaging during case presentation (x-rays, radiation therapy, MRI and CT)	62.79% 27
any other Comment:	6.98% 3
Total Respondents: 43	

Table 2. Impact of Pathology specimen resources and real-life case scenarios

Answer Choices	Responses
make the sciences relevant to my future profession	81.40% 35
Want to learn sciences to understand medical images	55.81% 24
show stronger linkage between sciences and health care settings for Medical imaging	74.42% 32
make it interesting to study sciences (anatomy, physiology and pathology)	79.07% 34
can see why I need to study sciences	44.19% 19
any other Comment:	2.33% 1
Total Respondents: 43	

Table 3. Learning sciences with clinical context

Answer Choices	Responses
meaningful	23.26% 10
interesting	20.93% 9
motivating	6.98% 3
memorable	9.30% 4
fun	2.33% 1
useful for the future profession	2.33% 1
assist with conceptual learning	9.30% 4
assist how to make links with what I have learnt already (anatomy & physiology) and what I am learning now (pathology) and what I will be learning in the future (imaging studies)	18.60% 8
Other (please specify)	6.98% 3
Total	43

Questions 16 to 18 were open-ended questions seeking the best things about VPLR, benefits to be derived, and areas for improvement. The best things touched on several areas, and these were encapsulated in these quotations:

‘Integrated peer learning and real-life scenarios’

‘Learning to work with different people, making connections between other subjects that are all relevant to my degree.’

‘A whole rounded education and understanding it rather than just cramming stuff you don’t need to know (like other subjects).’

‘The case presentations allowed each group member to research many aspects of a disease thoroughly. Having the questions/discussions after each presentation meant that every group member should have been comfortable in discussing almost any aspect of the chosen illness.’

There were many benefits to be derived in using this instructional package. Students commented:

‘Being able to see that something I am learning will be useful in the future helps with motivation.’

‘The application to "real-life" clinical scenarios, which makes me want to learn and understand more because it is relevant and exciting.’

‘Becoming aware of the complexities of one disease did help with learning other pathology.’

The overall qualitative findings resonate with survey results indicating that the VPLR assisted students gaining knowledge of the science, and allowed connections with various sciences, real-life scenarios, and professional practice. Students volunteered strategies to improve the course also. One suggested ‘integrating more the real-life specimens into face-to-face lectures or workshops’, while another requested to put ‘more imaging context’.

DISCUSSION

The discussion focuses on the overall research question and corollary questions earlier posted and the answers to these drawing from the results and literature findings.

THE IMPACTS OF USING VPLR AND ITS COMPONENTS

The primary impact of VPLR in teaching Pathology to first-year Medical Radiation students was a better understanding of the science of Pathology. The learning activities facilitated this understanding. The components of VPLR, namely the real-life case studies, specimen resources, and opportunities for group work and collaboration, all contributed to the overall experience of VPLR. The reasons for improved understanding from the students’ perspective were because they could make the connections between the different sciences (Pathophysiology, Chemistry, Anatomy, Physiology) and Pathology, and that group work and collaboration that VPLR allowed assisted in understanding the disease processes also. Moreover, VPLR components pathology specimen resources and real-life scenarios enabled the students to make better links with complex problems in the Medical Imaging profession and the Medical Imaging skills involved in the practice. There were sufficient opportunities for repeated exposure to content and behavioural tasks so ‘skill inoculation’ could have happened (Fitzgerald & Keyes, 2014, p. 505). In allowing these connections to happen, VPLR enhanced interdisciplinary and inter-professional learning for medical and health sciences students.

Embedding of scientific content and real-life case scenarios when studying Pathology was essential. The real-life case scenarios and pathology resources were found to be useful for this cohort. This study showed that VPLR helped make the connections between case studies, pathology specimens, and future imaging practice. The relevance and strong, clear links to future workplace practice, and increasing interest in the study of sciences were also demonstrated. Hmelo-Silver, Duncan and Chinn’s (2007) understanding of extensive scaffolding in learning is relevant here and could explain the outcomes that transpired in this complex domain. Scaffolding allows students more ownership and active involvement in the learning process.

The case scenarios were an effective way to enhance learning, according to Kunselman and Johnson (2004). Integrating specimen aids with case scenarios allowed virtual learning to occur (Saleh, 2010). Potentially useful tools, the inclusion of questions about the case and the specimens could have assisted in correlation and analysis of the case and pathology. Similar observations were drawn from the use of VPLR in this study.

Tavakol and Reicherter (2003) also reported about problem-based learning, where students take charge of their learning by examining the case scenarios and biological specimens, conducting case discussions and presentations, answering questions, searching the literature, and teaching co-students. The method used by Tavakol and Reicherter led to the efficient integration of knowledge in sciences

and had positive and encouraging impacts on students and staff. What was achieved in their study could have been achieved also in using VPLR and its component parts.

BENEFITS TO STUDENTS

Drawn from both closed- and open-ended questions, the three benefits of VPLR were identified in terms of students' learning. These were: greater depth of understanding of content, increase motivation with study, and opportunity for group work and collaboration. A 'whole rounded education and understanding' and the need to 'thoroughly research' aspects of a disease provided opportunities for greater learning. Furthermore, VPLR also helped in equipping students to understand other diseases they might encounter in the future. The students were motivated to engage with the content, and the common reasons for the engagement were the integration of sciences, case presentations using medical imaging, and the linking of VPLR to medical imaging. One student remarked that VPLR provided 'integrated peer learning'. As relevance was identified and peer learning encouraged, motivation and interest to study increased. These may strengthen and reinforce deep learning and higher retention, as reported by Fitzgerald and Keyes (2014). (See also Tables 1 and 2.)

The benefits could flow on to staff members with the increased overall satisfaction of the course as indicated on their course and teacher evaluations. Students found studying sciences difficult from previous experiences teaching the course (Thalluri & King, 2009). The connection of the disease to the patient, the intricate processes involved in disease production, and the way the body reacts to disease and treatment require complex information, which could be stressful. In using VPLR, however, staff members were informed of an approach that students found to be meaningful, interesting and relevant (See Table 3). VPLR broke down learning into segments, preventing cognitive overloading, but provided the course content in various creative ways (Hmelo-Silver et al., 2007), thus, informing staff that combining clinical scenarios and technology-based instructional materials was a promising strategy to adopt for this course (Bennett, Agostinho, & Lockyer, 2016).

AREAS TO IMPROVE

When asked about how VPLR could be improved to better assist students in preparing for their future professional careers, students suggested that more integration of real-life specimens into face-to-face lectures or workshops should happen and more linking with imaging context. These responses indicated that students valued this type of engagement in place of more traditional teaching methods and tools.

LIMITATIONS

Three limitations were identified and these included small sample size, self-report, and questionnaire validity and reliability. Sample size could constrain the findings; a larger sample size would be collected from future student cohorts. Levels of perceptions about this teaching approach were self-reported; thus, responses could potentially be biased. The impact of VPLR could not be generalised without validated instruments and significance testing. These will be done in future offerings.

FUTURE DIRECTIONS

Critical reflection on the impact of teaching approaches in higher education is imperative. The teacher's method and style do matter. The emphasis is not only on the subject matter (how diseases happen) but for the students' formation of future professional skills (Solbrekke & Helstad, 2016). It is recommended that the future direction of this research would be to conduct a follow-up of this cohort of students to determine if the impacts of the innovation were durable, that means the change in perceptions and behaviour are sustained over time.

Applying VPLR to other allied health science students (nursing for example) will be undertaken next. VPLR will be appropriate for nursing students with particular emphasis on case-based or problem-

based learning and combined with clinical experiences. Nielsen, Noone, Voss, and Mathews (2013) similarly proposed the same approach for the clinical education of nurses.

CONCLUSION

The VPLR approach involved rich learning situations, contextualised content, and facilitated greater understanding of disease concepts and problems. Unique to our VPLR was the use of web-based technology (digitised and histological slides), case-based instruction (authentic case scenarios), short answer and critical thinking questions, case presentations, and self-assessment quizzes. The application of an appropriate pedagogy, instructional methods and tools, and new technologies transformed the course with highly positive and encouraging results.

This study set out to explore the value and evaluate the impact of VPLR, together with its parts in teaching some aspects of Pathology to a cohort of Medical Radiation students. Using a cross-sectional study design, the impact of VPLR and its learning resources on students was determined by administering a survey. Constrained by several limitations, VPLR is a promising teaching strategy as it was shown to improve understanding of Pathology, facilitate connections between sciences and Pathology, and allow students to make better links with professional practice and skills. The nature of instruction and human learning afforded by VPLR is appropriately summarised by Confucius: “Tell me and I will forget; show me and I may remember; involve me and I will understand” (Hmelo-Silver et al., 2007).

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APPENDIX: SURVEY TOOL

1. I am enrolled in:

- Radiation Therapy
- Nuclear medicine
- Diagnostic radiation

2. When I applied for a university degree, Medical Radiation program was my:

- first preference
- second preference
- third preference

3. I am a mature age student:

- Yes
- No

4. I work part-time:

- work 1-10hours
- 11-20 hours
- 20-30 hours

5. Overall, I have a good understanding of the study of Pathology as a result of VPLR.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree
- Other (please specify)

6. VPLR had learning activities that improved my understanding of the subject.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree
- Other (please specify)

7. The real-life case studies presented helped me make connections between anatomy, physiology, pathology and medical imaging (interdisciplinary approach).

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree
- Other (please specify)

8. The opportunity for group work and collaboration improved my understanding of the disease process.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree
- Other (please specify)

9. The pathology specimen resources together with real-life scenarios helped me understand complex problems in the medical imaging profession.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree
- Other (please specify)

10. The pathology specimens together with real-life case scenarios helped me to understand that learning science is essential in order to understand medical images.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree
- Other (please specify)

11. Being a Medical imaging/Medical Radiation student, the factors that motivated me to learn pathology (can choose more than one answer):

- real-life human pathology specimen resources
- integrated anatomy and physiology
- teachers showing the application and relevance to medical imaging
- peer learning while preparing for case presentation
- group clinical scenario case presentation in a holistic approach (linking basic sciences, pathology and imaging, radiation studies).
- use of medical imaging during case presentation (x-rays, radiation therapy, MRI and CT)
- any other Comment:

12. Pathology specimen resources together with the real-life case scenarios:

- make the sciences relevant to my future profession
- Want to learn sciences to understand medical images
- show stronger linkage between sciences and health care settings for Medical imaging
- make it attractive to study sciences (anatomy, physiology and pathology)
- can see why I need to study sciences
- any other Comment:

13. Group case presentation helped me to make links between anatomy, physiology and pathology with imaging and radiation studies (e.g. X-rays, radiation therapy, MRI and CT).

- Yes
- No
- Other (please specify)

14. Learning sciences with clinical context (choose more than one correct answer), make it:

- meaningful
- interesting
- motivating
- memorable
- fun
- useful for the future profession
- assist with conceptual learning
- assist how to make links with what I have learnt already (anatomy & physiology) and what I am learning now (pathology) and what I will be learning in the future (imaging studies)
- Other (please specify)

15. Group case scenario preparation and presentations provide:

- peer to peer learning
- opportunity to explore the relevance
- develop research skills
- teamwork skills
- confidence
- application
- deeper meaningful learning
- to understand why certain radiologic images are useful
- Other (please specify)

16. The best thing/s about the course is/are:

17. For me, the most important benefits I gained from the approaches used is/are:

18. Something that I think would improve on these approaches to learning and teaching is/are:

BIOGRAPHIES



Dr Jyothi Thalluri is a Senior Lecturer and has extensive experience in ‘service teaching’ Human Anatomy/Physiology, Neurosciences and Pathology courses to various allied health science programs in the Division of Health Sciences, UniSA. Jyothi has a keen interest in the learning and teaching dynamics associated with student academic, social and cultural diversity. She has a firm belief that students need various learning options and appropriate support, particularly when transitioning into university study. She has demonstrated an ongoing commitment to the implementation of many innovative initiatives, to engage, support and provide flexible and student-centred learning options. She has used these to enhance outcomes within a diverse range of student cohorts. Jyothi has won many teaching awards and has published several papers in peer-reviewed international teaching and learning journals.



Dr Joy Penman is currently a Senior Lecturer in Nursing and Midwifery at the Monash University. She has over thirty years teaching experience locally and abroad and many years nursing experience in various healthcare facilities. Joy has extensive experience in research and community engagement. In recognition of her contribution to these areas, she has been a recipient of multiple teaching, research and community service awards. Joy has been involved in various research projects. She is well published in peer-reviewed journals and books and has presented her work at national and international conferences.