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Original Paper

Contextualization of an Introductory Physiology Course to Address Student Disengagement during Remote Learning in Aotearoa

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Abstract

Extended periods of population lockdown during the Covid-19 pandemic required many university courses to be delivered completely online, and for a student, this can lead to feelings of isolation, disconnectedness, and disengagement. This article proposes a hypothetical modification to an undergraduate course in physiology to address possible student disengagement when studying remotely. Through contextualisation, the delivery of course content is made relevant to everyday life experiences in Aotearoa (New Zealand)—this approach may improve retention of material and sustain interest in the course. Four scenarios are presented which align physiology content with information sources that present a context relevant to the lived experience in Aotearoa. Each scenario's learning outcomes, course content, and assessment are constructively aligned, consistent with current pedagogical practices in course design. It is suggested that adopting this contextualisation approach may increase the likelihood of student course completion, reduce student attrition, and increase student engagement during periods of extended remote learning. Further, it is suggested that using contextualisation presents an opportunity to redesign a higher education course to focus more on the relevance of academic material to the real-world lived experiences of students.

Keywords

contextualization, student engagement, undergraduate, physiology education

1. Introduction

In many countries, the response to the Covid-19 pandemic was to introduce extended periods of population lock-down during which physical access to many social institutions was prohibited or severely restricted. Universities rapidly adapted to this lock-down by developing their online delivery of courses to a dispersed and isolated student population (Remtulla, 2020). University faculty created ways of delivering courses remotely using the internet (Iyer, Aziz, & Ojcius, 2020), and different software programmes like Microsoft Teams®, Zoom®, Google Classroom®, WebEx®, Moodle®, and Blackboard®. Although not new, these online technologies and digital learning management systems have now become the main-stream applications used in the remote delivery of online higher education (Liu et al., 2020). These online platforms allow both the synchronous delivery of learning experiences and the asynchronous accessing of course content by students. Learners are encouraged to make use of online study materials uploaded by their institution, for example, watching pre-recorded lectures, and participate in group discussions on multiple social media platforms. In addition, small group problem-based learning (PBL) and case presentations followed by discussion have also been used to engage learners with online content (Dumford & Miller, 2018). However, maintaining student engagement with online courses during remote learning remains a major challenge in higher education, and it is likely that novel approaches to course design will be required if online learning is to become the new normal.

The shift from "learner as the receiver" to "learner as the constructor of meaning" is defined as constructivism (Marlow & Page, 2005; Moore, 2008). This conceptual framework asserts that learners are constantly updating their knowledge based on their everyday experiences, and learners create meaning in relationship to these experiences. In the constructivist framework, the motivation for learning rests with the learner not the instructor, while the instructor's primary responsibility is to create conditions that support student engagement in the learning process. Contextual learning is based on this constructivist theory of teaching and learning. Contextualization refers to the educational process of relating content within a curriculum to an everyday setting or situation, and students can connect this content with the context in which it could be used (Baker, Hope, & Karandjeff, 2009; Llopart & Esteban-Guitart, 2017). The content within a curriculum is supported by relevant, authentic scenarios which resonate with learners' life experiences. An advantage of this type of instruction is that the attention of learners is captured through the presentation of relevant content within an explicit application. Using this approach, learners are more likely to retain information and recognize the relevance of this information in solving novel problems which arise in their everyday lives.

Students studying an undergraduate course in many disciplines related to human health will attempt to learn introductory concepts in human physiology. This material is typically delivered in large cohort first-year introductory courses which service other academic disciplines such as nursing, midwifery, and physiotherapy (LaDage et al., 2018; Higgins-Opitz & Tufts, 2014). Although physiology is a subject that is integral to the studies of many health disciplines, students often find it difficult, resulting in high failure rates, particularly among those students who study physiology in their very first semester at university (Ernst & Colthorpe, 2007; Michael, 2007; Tufts & Higgins-Opitz, 2009). Student engagement with large physiology service courses can also be problematic (Brown et al., 2018) although this can vary depending on the type and level of physiology course, with the lowest total engagement score for a lower-level course (Hopper, 2016). One could speculate that contextualization of physiology curricula in an introductory course could address student disengagement and improve knowledge retention, thus providing a better knowledge base for students progressing into specific health disciplines. Contextualising the content of a physiology course with everyday life experiences may improve student knowledge construction and result in deeper, more meaningful learning (Borges & Mello-Carpes, 2014). Contextualization of physiology curricula with events of everyday life has been shown to positively impact student learning and influence a student's decisions and practices beyond the classroom (Alves et al., 2021). This contextualization has been used as an integration strategy to embed understanding of physiology with other appropriate knowledge related to human health (Alves et al., 2021; Hillyer & Gordon, 2020). Thus, contextualisation may be a novel pedagogical strategy suitable for maintaining student engagement during extended periods of remote learning.

2. A Contextualized Physiology Framework Based on Lived Experience in Aotearoa—Four Example Scenarios

In this article, four example scenarios are presented which potentially offer a framework for contextualizing an introductory physiology curriculum suitable for an undergraduate physiology course in Aotearoa, New Zealand. Each scenario is contextualised by either an infographic produced in Aotearoa, or readily available public documentation produced in Aotearoa—these resources help to connect the course content with the everyday lived-experience of New Zealanders. Each scenario is presented with a brief introductory paragraph outlining the background physiology, followed by a tabulated plan which constructively aligns the academic content, learning outcomes, and assessment of the topic.

2.1 Scenario: The Physiology of the Nervous System

The nervous system is a communicating system in the body and is the centre of all mental activity (thought, learning, and memory). The nervous system acts through electrochemical impulses and neurotransmitters to cause muscle contraction and glandular secretion. Input from receptors informs the brain and spinal cord about both external and internal environments. Sensory receptors detect stimuli such as temperature, light, and sound from the external environment, while visceral receptors detect variations in blood pressure, pH, carbon dioxide concentration, and the levels of various electrolytes in the internal environment. Sensory input is converted into electrochemical signals (action potentials) that are transmitted to the brain and/or the spinal cord. Sensory input is integrated to create sensations, to produce thoughts, or to form memories. Decisions are made each moment based on this sensory input. Nervous system responses include sending signals to muscles, causing them to contract, or to glands, causing them to produce secretions—this is the motor function role of the nervous system.

Suggested in Table 1 is a plan which constructively aligns the content, learning outcomes, and assessment of the nervous system. Also, reference is made in table 1 to the Head Impact Assessment (HIA) Protocol (Figure 1) used in relation to head collisions incurred during the game of rugby. This infographic has relevance in Aotearoa due to the popularity of both rugby league and rugby union, and the extensive participation of both males and females in this activity.

Table 1. Constructive Alignment Plan for the Nervous System

Context	Physiology	Content	Learning Outcomes	Assessment
The Head Injury Assessment (HIA) Protocol is a process introduced by World Rugby to assist with identification and management of head impact events with the potential for a concussion.	Neurometabolic events of concussion include neuronal release of excitatory neurotransmitters and efflux of K^+, persistent Ca^{2+} influx, and reduced cerebral blood flow.	Ionic fluxes during an action potential. Synaptic communication, and excitatory and inhibitory neurotransmitters. Brain and spinal cord protection.	Understand normal function of the nervous system. Understand the role of neurotransmitters in the nervous system. .	Describe the anatomical organisation of the adult brain and spinal cord. Explain the role of excitatory neurotransmitters in action potential generation in a neuron.

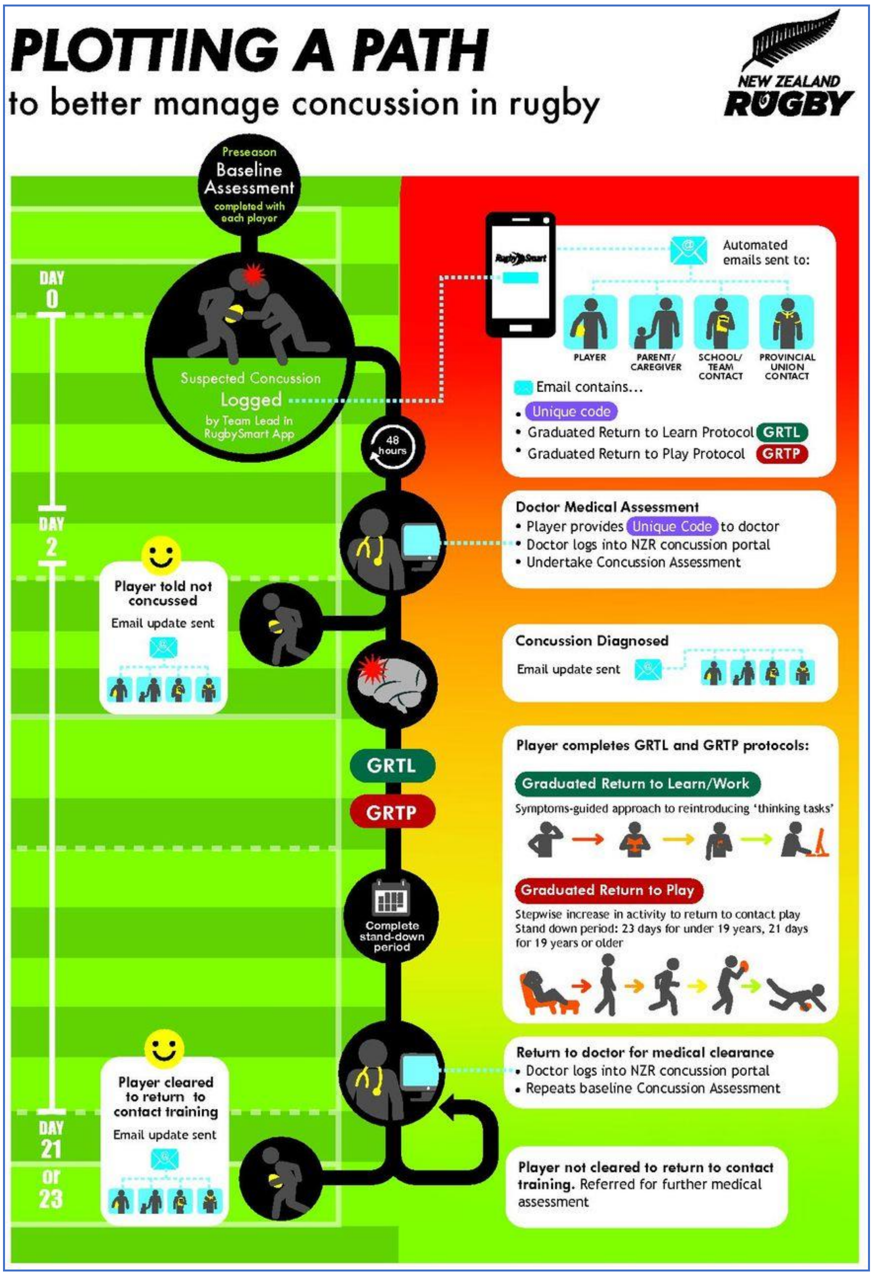

Figure 1. Infographic Supporting the Nervous System (Salmon et al, 2020)

2.2 Scenario: The Physiology of the Endocrine System

The endocrine system is a communicating system in the body acting through chemical messengers called hormones. The actions of the endocrine system are measured in minutes, hours, or weeks and are more generalized than the actions of the nervous system. Endocrine glands are ductless, and their secretory products (hormones) are carried by the blood throughout the entire body, yet they affect only certain cells. The specific cells that respond to a given hormone have receptor sites for that hormone. All the cells that have receptor sites for a given hormone make up the target tissue for that hormone. In some cases, the target tissue is localized in a single gland or organ. In other cases, the target tissue is diffuse and scattered throughout the body so that many areas are affected. Hormones bring about their characteristic effects on target cells by modifying cellular activity. Protein hormones react with receptors on the surface of the cell, and the sequence of events that results in hormone action is relatively rapid. Steroid hormones react with receptor sites inside a cell - this method of action involves synthesis of proteins; it is relatively slow. Hormones are very potent substances and very small amounts of a hormone may have profound effects on metabolic processes. Because of their potency, hormone secretion must be regulated within very narrow limits to maintain homeostasis in the body. Many hormones are controlled by some form of a negative feedback mechanism. In this type of system, a gland is sensitive to the concentration of a substance that it regulates. A negative feedback system causes a reversal of increases and decreases in body conditions in order to maintain a state of stability or homeostasis.

Suggested in Table 2 is a plan which constructively aligns the content, learning outcomes, and assessment of the endocrine system. Also, reference is made in Table 2 to the “Contraception—Your Choice” infographic (Figure 2) produced by New Zealand Family Planning. This infographic is produced by a non-profit organisation in Aotearoa which offers free reproductive health advice for rangatahi (youth) and supplies resources for health professionals working with whānau.

Table 2. Constructive Alignment Plan for the Endocrine System

Context	Physiology	Content	Learning Outcomes	Assessment
The oral contraceptive pill is a combination of oestrogen and progestogen (see figure 2). It alters the ovarian cycle to eliminate ovulation. medicines.	Endocrine signals use a diverse range of chemicals secreted by widely distributed, ductless glands. Receptor – hormone complexes trigger metabolic changes in target cells.	Hormone chemical structure. Location of endocrine glands and regulation of hormone release. Mechanisms of hormone action on target cells.	Understand the role of the endocrine system in controlling bodily functions. Understand the interaction between hormones and hormone release.	Describe the action of lipid-soluble, and water-soluble hormones on target cells. Explain the homeostatic control of body function by the endocrine system.

Contraception - Your Choice

Contact Family Planning for detailed information on any of these methods

NEW ZEALAND Family Planning

Method	What is it? How does it work?	Chance of getting pregnant	Health concerns	Advantages	Disadvantages
HORMONAL CONTRACEPTION					
DEPO PROVERA	• an injection of progestogen • stops ovaries from releasing an egg each month	• typically 3 in 100 but less than 1 in 100 if next injection given on time	• no serious concerns	• one injection lasts 12 weeks • doesn't interfere with sexual intercourse • usually no periods • useful for people who can't take combined pill	• irregular bleeding, no periods or occasional heavy bleeding • periods and fertility take an average of 6 months to return after stopping the injection • weight may change
COMBINED ORAL CONTRACEPTIVE PILL	• pill made of 2 hormones, oestrogen and progestogen • stops ovaries releasing an egg each month	• typically 8 in 100 but less than 1 in 100 if used perfectly	• very small chance of blood clots, heart attacks and strokes. More likely in people over 35 who smoke, are overweight or have a family history of these conditions • very slight increased risk of cervical cancer	• simple and easy to take • doesn't interfere with sexual intercourse • periods usually regular, shorter, lighter and less painful • less chance of cancer of lining of the uterus or ovaries • can be taken up to menopause if a healthy non smoker	• should not be used by people over 35 who smoke • must remember to take it daily • may have irregular bleeding
PROGESTOGEN ONLY PILL	• pill made of 1 hormone – progestogen • by thickening mucus in cervix and may stop ovaries from releasing an egg each month	• typically 8 in 100 but less than 1 in 100 if used perfectly	• no serious risk	• doesn't interfere with sexual intercourse • can be used at any age • can be used when breast-feeding • useful for those who can't take combined pill	• may have irregular bleeding

Figure 2. Infographic Supporting the Endocrine System (retrieved from:
https://www.familyplanning.org.nz/media/304332/fp_a3_cyc_chart_pamphlet_gtpmay2020.pdf)

2.3 Scenario: The Physiology of the Cardiovascular System

The cardiovascular system consists of the heart, which is a muscular pumping device, and a closed system of vessels called arteries, veins, and capillaries. Blood contained in the circulatory system is pumped by the heart around a closed circuit of vessels as it passes again and again through the various "circulations" of the body. The vital role of the cardiovascular system in maintaining homeostasis depends on the continuous and controlled movement of blood through the capillaries that permeate every tissue and reach every cell in the body. It is in the microscopic capillaries that blood performs its ultimate transport function, where nutrients and other essential materials pass from capillary blood into fluids surrounding the cells as waste products are removed. Numerous control mechanisms help to regulate and integrate the diverse functions and component parts of the cardiovascular system to supply blood to specific body areas according to need. These mechanisms ensure a constant internal environment surrounding each body cell regardless of differing demands for nutrients or production of waste products. As in the adult, survival of the developing embryo depends on the circulation of blood to maintain homeostasis and a favourable cellular environment. In response to this need, the cardiovascular system makes its appearance early in foetal development and reaches a functional state long before any other major organ system. The foetal heart begins to beat regularly early in the fourth week following fertilization.

Suggested in Table 3 is a plan which constructively aligns the content, learning outcomes, and assessment of the cardiovascular system. Also, reference is made in Table 3 to the Managing High Blood Pressure graphic (Figure 3) used by the New Zealand Heart Foundation as an information sheet on hypertension. This graphic has relevance in Aotearoa due to a high incidence of hypertension in the adult population, and the disparities in cardiovascular health evident in ethnic groups within Aotearoa.

Table 3. Constructive Alignment Plan for the Cardiovascular System

Context	Physiology	Content	Learning Outcomes	Assessment
Cardiovascular disease is the leading cause of death in NZ. Kiwi women are 5 times more likely to die from heart disease than breast cancer. Hypertension (see figure 3) is a "silent killer" and a risk factor for many co-morbidities.	Cardiovascular health is a main concern in Aotearoa. Heart disease, hypertension, and coronary artery disease are associated with atherosclerosis, myocardial infarction, arrhythmias, and heart failure.	Anatomy of the cardiovascular system, including structure of the heart and blood vessels. Blood composition and the regulation of blood volume.	Understand normal function of the cardiovascular system. Understand pressure regulation in the cardiovascular system.	Describe normal cardiovascular function and the regulation of cardiac output. Explain the regulation of arterial blood pressure in a healthy adult.

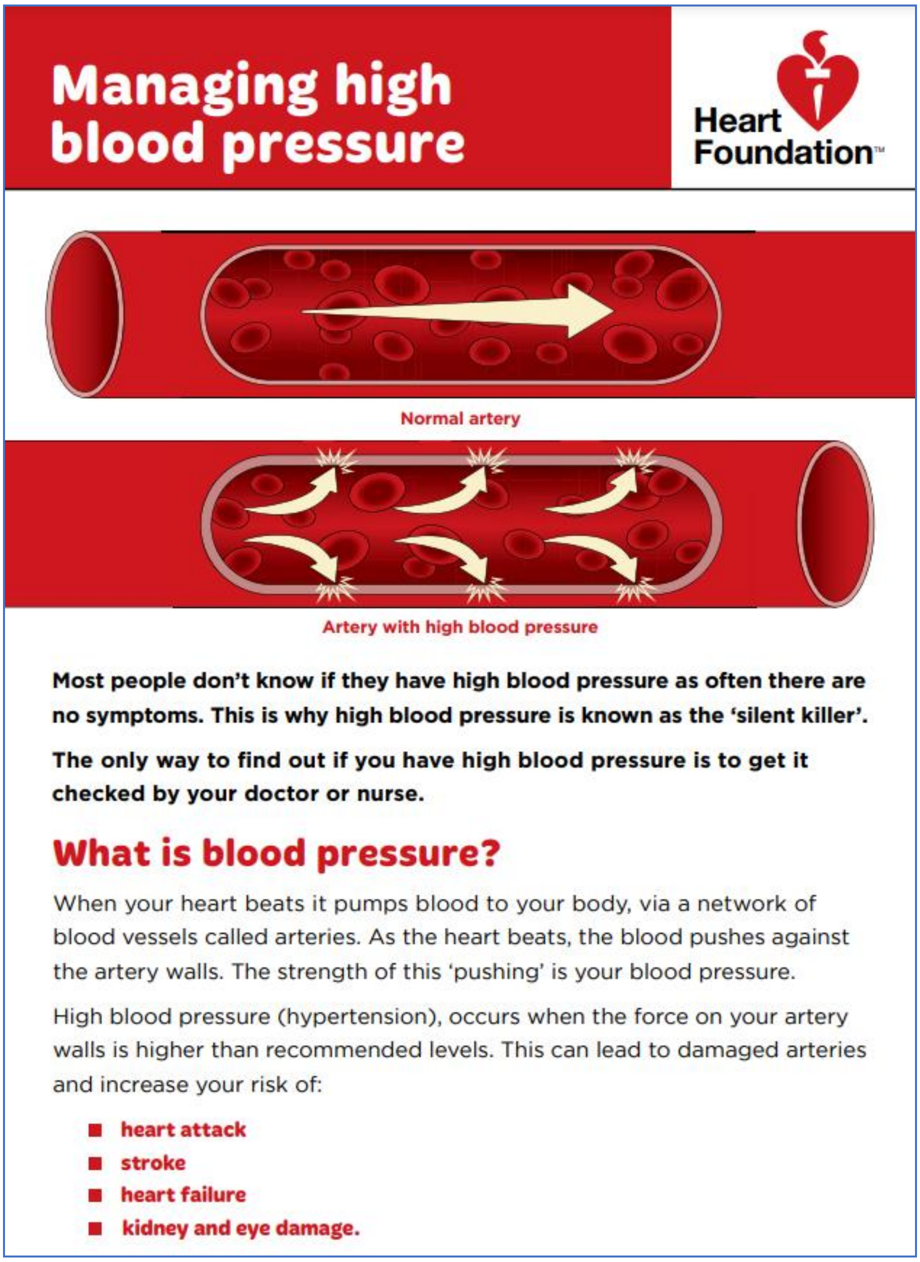

Figure 3. Infographic Supporting the Cardiovascular System (retrieved from: https://www.heartfoundation.org.nz/resources/blood-pressure-a5-pamphlet**)**

2.4 Scenario: The Physiology of the Urinary System

The principal function of the urinary system is to maintain the volume and composition of body fluids within normal limits—one aspect of this function is to rid the body of waste products that accumulate because of cellular metabolism. The urinary system maintains an appropriate fluid volume by regulating the amount of water and electrolytes that are excreted in the urine. Continuous filtering of blood plasma by the kidneys requires adequate blood pressure and renal blood flow. Filtration, and selective reabsorption and secretion, allow precise regulation of numerous plasma constituents.

Regulating the concentrations of various substances in the body fluids and maintaining normal pH of the blood plasma are essential functions of the urinary system. In addition to maintaining fluid homeostasis in the body, the urinary system controls red blood cell production by secreting the hormone erythropoietin. The urinary system also plays a role in maintaining normal blood pressure by secreting the enzyme renin.

Suggested in Table 4 is a plan which constructively aligns the content, learning outcomes, and assessment of the urinary system. Also, reference is made in Table 4 to a New Zealand Ministry of Health infographic on the treatment statistics for kidney failure in the NZ population (Figure 4). This infographic has relevance in Aotearoa due to the high costs associated with renal dialysis, and the increased likelihood of renal failure as a symptom of uncontrolled diabetes. The infographic also identifies the different incidences of renal failure and treatment of kidney disease in the ethnicities within Aotearoa.

Table 4. Constructive Alignment Plan for the Urinary System

Context	Physiology	Content	Learning Outcomes	Assessment
Kidney disease affects 5% of New Zealanders (see figure 4). Treatment for kidney disease may include surgery or dialysis. Māori and Pasifika have a higher incidence of dialysis compared to NZ European.	Renal anatomy and physiology of the nephron. Renal control of blood plasma homeostasis. Interaction between the urinary system and the cardiovascular system.	Renal autoregulation and the role of the juxtaglomerular apparatus in maintaining glomerular filtration rate (GFR). Neural and endocrine influences on renal control of plasma volume.	Understand the role of the urinary system in homeostasis. Understand the influence of renal function in maintaining blood pressure.	Describe normal renal function and the process of urine formation. Explain the role of the renin-angiotensin-aldosterone system in the maintenance of blood volume.

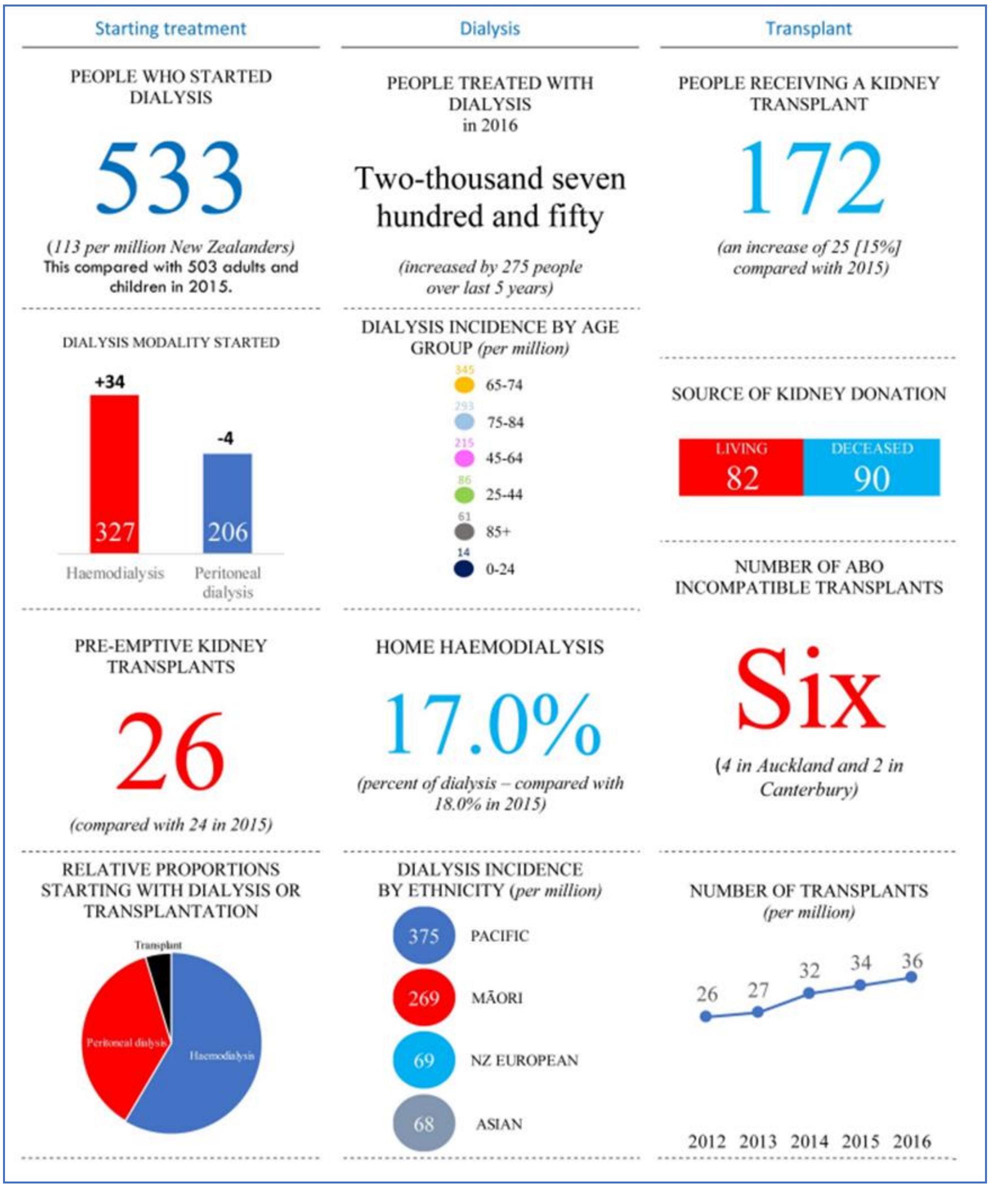

Figure 4. Infographic Supporting the Urinary System (retrieved from: https://www.health.govt.nz/system/files/documents/pages/2016-nz-nephrology-activity-report.pdf)

3. Discussion

Four scenarios which contextualise physiology content have been presented whereby freely available information is used to identify the relevance of the physiology to the everyday lives of New Zealanders. Scenarios on the two main controlling systems (nervous and endocrine systems), and two regulating systems (cardiovascular and urinary systems) have been selected as these are commonly used as foundational material for understanding human physiology (Michael, 2007).

Facilitating the student's ability to mobilize cultural, scientific, and technological knowledge to understand reality and to address everyday situations is an important aspect of contextualization pedagogy (Alves et al., 2021). Thus, the engaged learner who is prepared to invest their own time and effort is more likely to benefit from this approach than others (Esteban-Guitart, 2016). Although it is more usual to introduce students to physiological content describing normal, healthy functioning of the body before introducing them to disease processes, in the suggested scenarios, pathophysiology (defined as the disordered physiological processes associated with disease or injury) is used to emphasise the link between knowledge of the system and the population. Unfortunately, it is often an encounter with pathophysiology, for example, a family member or friend with a serious chronic health condition, that provides a connection between learning physiology and the lived experience in Aotearoa.

Learning takes place when new information is presented in such a way that learners can construct meaning based on their own experiences, and it is suggested that contextualization of physiology content can promote learning in this discipline (Borges & Mello-Carpes, 2014). An approach relating physiology to the daily life experienced by students can make the teaching process more motivational and significant and we suggest that this method of content delivery can address student disengagement during periods of extended remote learning (Remtulla, 2020). The contextualization of content can provide a "hook" into the established knowledge required at an introductory level of understanding in physiology but with an approach to physiology topics which relate to the students' daily life. Shared student experiences which resonate with common life scenarios can provide contextualization of fundamental basic science concepts, such as those learned in physiology. On campus, this has been achieved by creating spaces where students can learn through collaborative experiential learning and self-inquiry, for example, a high-fidelity simulation laboratory (Hillyer & Gordon, 2020), however, this is not possible during remote learning. The online environment for course delivery has limited utility in providing meaningful interactive spaces for collaborative experiential learning, and it is suggested that contextualisation of course content based around common experiences may represent an alternative pedagogical strategy which is more suitable for remote learning.

4. Conclusion

Traditional expository practices used in university course delivery may not be effective in the context of prolonged periods of remote learning (Roy et al., 2020). The current article suggests that contextualization of physiology content with everyday life experiences could be used as a strategy to maintain student interest and engagement. In addition to the content of a course in physiology being contextualized, the active involvement and cognitive engagement of students needs to be achieved by encouraging students to go beyond the superficial acquisition of content and interconnect physiological phenomena to their personal experience.

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