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Universal Design for Learning and Anatomy Healthcare Education

Thesis presented by

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Declaration

This is to certify that the work I am submitting is my own and has not been submitted for another degree, either at University College Cork or elsewhere. All external references and sources are clearly acknowledged and identified within the contents. I have read and understood the regulations of University College Cork concerning plagiarism and intellectual property.

Signed: A. Dempsey Date: October 2022

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List of Publications

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- Dempsey AMK, Nolan YM, Lone M and Hunt E. (2022) 'Examining motivation of first-year undergraduate healthcare students through the lens of Universal Design for Learning (UDL): A single institution study', To be submitted

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List of Abbreviations

3D: Three Dimensional

CAST: Center of Applied Special Technology

EU: European Union

IMI: Intrinsic Motivation Inventory

IMMS: Instructional Materials Motivation Survey

LMS: Learning Management System

MCQ: Multiple Choice Questionnaire

MSLQ: Motivated Strategies for Learning Questionnaire

NI: Northern Ireland

OSF: Open Science Framework

OT: Occupational Therapy

PBL: Problem-based learning

PRISMA-ScR: Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews

QR: Quick Response

ROI: Republic of Ireland

SD: Standard Deviation

SDT: Self-Determination Theory

SLT: Speech and Language Therapy

UCC: University College Cork

UCD: University College Dublin

UDA: Universally Designed Assessment

UDC: Universally Designed Curriculum

UDI: Universally Designed Instruction

UDL: Universal Design for Learning

UK: United Kingdom

UL: University of Limerick

Abstract

Inclusive learning environments and educational experiences for all individuals have been identified as priorities in recent educational policies in the Republic of Ireland (ROI) and Northern Ireland (NI). Driven by these policy mandates, curricula across all disciplines, including anatomy education, are undergoing reform to ensure inclusive learning experiences are afforded to all individuals.

Anatomy is a critical component of healthcare curricula. Robust knowledge of anatomy ensures the safe and effective practice of healthcare professionals. Motivation and engagement have been found to play an integral role in successful student learning. However, there are reports of a lack of both motivation and engagement among some healthcare students studying anatomy. Hence there is need to incorporate a specific pedagogical framework in anatomy curricula to enhance motivation and engagement among healthcare students and in turn promote an inclusive learning experience.

The aim of this thesis was to determine whether Universal Design for Learning (UDL) would be an appropriate pedagogical framework in the design and delivery of anatomy curricula to enhance healthcare students' motivation and engagement.

Firstly, a scoping review, which is a method of mapping emerging literature, was carried out which established that UDL has not been utilised in anatomy curricula of third level healthcare programmes, specifically medicine, dentistry, occupational therapy or speech and language therapy (Chapter Two). While there are published studies incorporating teaching strategies which align with UDL, and have in turn reported benefits to student learning, none of these studies specifically mention the

UDL framework. Motivation levels of first year undergraduate healthcare students in University College Cork (UCC) at the start and end of their anatomy modules were established (Chapter 3) using the Motivated Strategies for Learning Questionnaire (MSLQ), and a change in motivation over the duration of the module was identified. First year healthcare students in UCC and anatomy educators based in the ROI and United Kingdom (UK) were surveyed (Chapter Four and Chapter Five, respectively). The first year healthcare students were informed about UDL as they neared the end of an anatomy module. After informed consent was obtained a paper questionnaire was distributed to potential participants. An online questionnaire was distributed to anatomy educators using the online platform Microsoft Forms and was available for 12 weeks. Both studies highlighted that very few anatomy students or educators were aware of UDL. However, the majority of the participants in both studies acknowledged the potential of the UDL framework to enhance the design and delivery of anatomy curricula.

The results of this thesis show that the incorporation of UDL into the design and delivery of third level anatomy curricula could potentially enhance student motivation, engagement and their overall educational experience. More specifically, the results from the scoping review (Chapter Two) indicated that teaching methods which align with UDL enhance anatomy students' academic performance, motivation and confidence. The results described in Chapter Three highlight the range in motivation levels among anatomy students enrolled in various healthcare programmes both at the start of their respective anatomy modules and at the end. The majority of first year anatomy healthcare students thought that UDL benefits student learning (99%, n=186) and that the implementation of UDL increases student engagement (97%, n=183) (Chapter Four). Finally, the results described in Chapter Five revealed that anatomy educators have a mixed opinion of UDL as some participants were concerned about the time commitment required to implement UDL in anatomy curricula design. Nevertheless, the potential benefit of the utilisation of ULD was acknowledged by the majority of the participants.

In summary, students vary in their levels of motivation to study anatomy and the manner in which they prefer to engage with learning material, activities and assessments. The utilisation of the UDL pedagogical framework in anatomy curricula can accommodate learner variability and in turn afford all students the opportunity to reach their individual potential while enhancing and promoting an inclusive third level educational experience.

Overarching Research Question	**Is Universal Design for Learning (UDL) an appropriate framework to enhance the design and delivery of third level anatomy curricula?**		
Context	Universal Design for Learning in Anatomy Education of Healthcare Students: A Scoping Review. **Published** in *Anatomical Sciences Education* **Chapter Two**		
Empirical Studies	Examining motivation of first-year undergraduate healthcare students through the lens of Universal Design for Learning (UDL): A single institution study.	First-year undergraduate healthcare students' awareness and perception of Universal Design for Learning in their anatomy curriculum: an institution-based study.	Awareness of Universal Design for Learning among anatomy educators in higher level institutions in the Republic of Ireland and United Kingdom.
	In preparation	**Submitted**	**Published** in *Clinical Anatomy*
	Chapter Three	**Chapter Four**	**Chapter Five**

Figure 1.1 Overview of thesis

Chapter One

General Introduction

1.1 Higher Education Policy Context

Inclusion of all individuals in one learning environments is a priority for the European Union (EU) in education and training (European Commission, 2017). This priority aligns with the goals outlined in a policy document published in 2022 by the Department of Further and Higher Education in the ROI, the '*National Access Plan: A Strategic Action Plan for Equity of Access, Participation and Success in Higher Education 2022 – 2028'*. This strategic plan identifies five student-centred goals, namely "Inclusivity", "Flexibility", "Clarity", "Coherence" and "Sustainability" (HEA, 2022a). The Royal Irish Academy recently published the discussion paper '*Equity, Diversity and Inclusion in Higher Education in Ireland and Northern Ireland*' (Royal Irish Academy, 2021). This document states that curricular reform can facilitate enhanced inclusivity and furthermore affirms that the pedagogical framework known as Universal Design for Learning (UDL) promotes equity and inclusion in higher education (Royal Irish Academy, 2021). Additionally, the National Forum for the Enhancement of Teaching and Learning in Higher Education, which is the national body responsible for leading and advising on the enhancement of teaching and learning in Irish higher education, also recommends the utilisation of UDL in the design and delivery of curricula (National Forum, 2021). Indeed, there are a number of third level institutions in the ROI now promoting the uptake of postgraduate teaching and learning certificates by academic staff so that they may learn how to incorporate UDL and more inclusive and flexible teaching strategies in the design and delivery of their curricula (UCC, 2022b; UCD, 2022; UL, 2022). Thus, driven by policy mandates, curricula across all disciplines, including anatomy education, are undergoing curricular reform to ensure inclusive learning experiences are afforded to all individuals.

1.2 Anatomy Education

Anatomy education is a crucial element of allied health, dental and medical curricula and is considered the foundation of good and safe healthcare practice (Davis *et al.*, 2014; Merati *et al.*, 2021). However, some healthcare students find anatomy difficult and as a result struggle to remain engaged in the learning process (Hall *et al.*, 2018; Javaid *et al.*, 2018; Lieu, Gutierrez and Shaffer, 2018). Lack of engagement among anatomy students may be due to students having difficulty identifying the relevance of the learning material to their chosen healthcare careers (Finn *et al.*, 2019; Grosser *et al.*, 2019). This issue becomes worrisome as many of the clinical subjects which comprise healthcare education stem from knowledge of human anatomy (Teshome *et al.*, 2021). In fact, healthcare professionals are concerned about the poor anatomical knowledge possessed by recent healthcare graduates (O'Keeffe, Davy and Barry, 2019; Kumar and Singh, 2020). This concern has heightened the focus of university educators on the anatomy education of healthcare students in order to ensure dependable and effective clinical practice (Chia and Oyeniran, 2020; Shead *et al.*, 2020).

1.3 Anatomy Education and the Covid-19 Pandemic

Due to the Covid-19 pandemic, higher level institutions were forced to rapidly adapt to the unprecedented situation and alter their teaching and assessment methods to include online teaching sessions (Pacheco, Noll and Mendonça, 2020). This rapid move to remote teaching resulted in students having restricted or no access to resources such as prosections, models, bones and microscopes (Singal *et al.*, 2021). Thus, educators had to be creative in how they redesigned their anatomy curricula to sustain student motivation, engagement and academic performance while also acknowledging the challenges students faced while studying from home (Byrnes *et al.*, 2021; Poma *et al.*, 2022). The transition to remote teaching and learning was not easy for either students or educators (Singal *et al.*, 2021). Although, the pandemic highlighted the utility and benefit of technology in teaching anatomy, it also emphasized the need to utilise multiple forms of educational resources in conjunction with technology as students stressed the need for multiple forms of representation, such as textbooks and models, while they were learning remotely (Khasawneh, 2021; Singal *et al.*, 2021). The provision of multiple resources promotes an inclusive educational experience as it offers students the opportunity to choose which format is optimal to fulfil their learning needs (Black, Weinberg and Brodwin, 2015).

1.4 Profile of Current Healthcare Students

Generational and learner diversity are influential elements that propel change in curriculum design and delivery in healthcare programmes (Plochocki, 2019). The current generation of learners enrolling in third level healthcare programmes are called ”Generation Z” (born between the late 1990s and 2012) and as time progresses into the 2020s more of “Generation Z” will be enrolled in healthcare programmes (Eckleberry-Hunt, Lick and Hunt, 2018). This generation is considered more technologically advanced compared to previous generations (Boysen, Daste and

Northern, 2016), however this cannot be assumed for every learner in the generation (Das and Al Mushaiqri, 2021).

The social and cultural background of the student population is changing as students may travel cross country or abroad to receive their third level undergraduate healthcare education (Morgan, 2017; Attrill, Lincoln and McAllister, 2020; Traynor and O'Connell, 2022). In the Republic of Ireland (ROI), 18.4% of all third level graduates in 2019 were international students (CSO, 2019). More specifically, half the number of students enrolled in medical programmes in the ROI during the academic year 2017/2018 were international students (OECD, 2019).

Students enrolled in first year undergraduate programmes, are typically adolescents transitioning to third level education directly from second level education (Sawyer *et al.*, 2018). In general, second level education is a highly structured environment where students primarily engage in didactic teaching and rote learning (Higgins, Frankland and Rathner, 2021; Kearney and Tangney, 2021). However, when students enter third level education there is a requirement for them to develop executive functions and self-regulation skills (Valenzuela *et al.*, 2020; Higgins, Frankland and Rathner, 2021). The development of such skills varies among individuals, including healthcare students (Delany *et al.*, 2015; Bransen *et al.*, 2020). Students' varying abilities can be due to their varying ages and experiences as typically students in first year are between 18 and 19 years old but there is also usually an allocation of places on every programme for mature students who are 23 years and older. Educators need to understand this variability among their student cohort so to ensure they are providing opportunities for optimal learning for all individuals (Alt and Naamati-Schneider, 2021). Each of the above-mentioned factors influence healthcare students' motivation to study and engagement with learning material.

1.5 Motivation and Engagement

Academic motivation plays a critical role in supporting and stimulating student learning and performance (Sturges *et al.*, 2016). Research has identified both motivation and engagement as essential components of the learning process (Northey *et al.*, 2015; Du, Fan and Yang, 2020). Passive learning is not conducive to an engaging learning experience and in turn results in students losing motivation (Chutinan, Riedy and Park, 2018). The ability to efficiently identify the relevance of learning material has been highlighted as critical for encouraging and sustaining engagement and motivation among learners (Abdel Meguid, Smith and Meyer, 2020; Carroll, Tracy-Bee and McKenzie, 2021; Simons *et al.*, 2022). Thus, educators are continually challenged to develop novel ways of maintaining student engagement, interest and motivation in learning anatomy (Pickering and Swinnerton, 2019). This current generation of students expect more from their education, in particular with regard to the use of technology and accessibility of learning material (Miller and Mills, 2019). For example, it has become customary for learners to use online material as an alternative to reading textbooks in printed format (Mosca, Curtis and Savoth, 2019). Although these students are generally considered to be technologically shrewd, they still require assistance and guidance on how to use technology to their academic advantage and on how to ensure they are accessing accurate information (Das and Al Mushaiqri, 2021).

Anatomy is usually taught at the beginning of healthcare programmes prior to students embarking on their clinical placement. Studying anatomy at this stage provides students with a robust anatomical foundation which they will require as they progress through their professional degree programme and come into more frequent contact with patients (Allsop *et al.*, 2020). However, it appears that some medical and dental students struggle to engage with their anatomy content or to remain motivated to study the subject (Esther M Bergman *et al.*, 2013), particularly since the COVID-19 pandemic (Brassett *et al.*, 2020; Longhurst *et al.*, 2020).

Recently, Browne (2019) investigated the engagement rates of allied health students in an introductory anatomy and physiology module. Of all the courses surveyed, OT students had the least number of highly engaged students (38.5%, n = 117) and the third highest percentage of disengaged students (11.1%, n = 117) as measured by an e-learning quiz, which was circulated to students after each of their practical anatomy sessions (Browne, 2019). Additionally, perceived relevance is an essential component of student motivation and engagement and is instrumental in students developing deep learning approaches to their anatomy education, that is, studying with the aim of understanding rather than aiming to reproduce information for an examination (Weir, 2008; Wang *et al.*, 2013). However, there is little research on the perceived relevance of anatomy by OT and SLT students (Brumfitt, SM, Enderby, PM, and Hoben, K, 2005; Schofield, 2018; Fives, Lone and Nolan, 2022) in comparison to the number of studies carried out among medical and dental students regarding perceived relevance of anatomy (Malau-Aduli *et al.*, 2013; Abdel Meguid, Aly and Allen, 2017; Hassan *et al.*, 2018; Zhao *et al.*, 2020; Tan *et al.*, 2022).

Motivation and engagement play a vital role in successful student learning (Northey *et al.*, 2015; Sturges *et al.*, 2016; Du, Fan and Yang, 2020). Furthermore, research has identified a lack of motivation and engagement among anatomy students enrolled in some third level healthcare programmes (Esther M Bergman *et al.*, 2013; Browne, 2019; Pickering and Swinnerton, 2019; Brassett *et al.*, 2020). Perhaps if teaching strategies, such as providing students with timely feedback and emphasising the relevance of the learning material, which heighten student motivation and engagement (Griful-Freixenet *et al.*, 2017; Carroll, Tracy-Bee and McKenzie, 2021; Sewell, Kennett and Pugh, 2022) were incorporated into the design and delivery of anatomy curricula this would in turn enhance academic student performance, anatomy knowledge and students' overall educational experience.

1.6 Academic Motivational Theories

Academic motivation is crucial for successful learning (Wang *et al.*, 2013; Dagmar, 2019). There are numerous theories of motivation, including the Attribution Theory (Weiner, 1985), Social Cognitive Theory (SCT) (Bandura, 1986) and Self-Determination Theory (SDT) (Ryan and Deci, 2000).

Attribution Theory

Weiner (1985) posits that earlier theories of motivation have neglected to appreciate the connection between emotion and motivation. The attribution theory links event outcomes to emotions of either happiness or frustration, depending on whether the outcome was deemed a success or a failure. The theory postulates that an outcome is either expected or unexpected. An expected outcome will be received positively, but an unexpected outcome will be received negatively, and an explanation will be required. To achieve this explanation, the individual would reflect on past experiences, as past history performs a role in goal expectancy, and come to a conclusion of a perceived cause (i.e., causal attribution). The outcomes influence an individual's emotional reaction and consequently prompt future actions (Weiner, 1985). Numerous studies have built on Weiner's research and supported his theory. Maymon et al. (2018) found that causal attributions significantly influence student emotions. Further research has emphasized that students participate in causal thinking and as a result their motivation levels are determined by the way they attribute causes to the outcomes of certain events (Dong *et al.*, 2015; Fishman and Husman, 2017). The attribution theory may help educators to differentiate between student ideas which are adverse or helpful to their learning. Having such knowledge may also aid educators to interpret their own causal beliefs with regards to success and failures in the classroom and how these ideas influence student motivation, and in turn engagement (Alderman, 2013).

Social Cognitive Theory

The Social Cognitive Theory (SCT) initially began as the Social Learning Theory, developed by Albert Bandura in the 1960s. However, over time and with more research the theory transitioned into the SCT (Bandura, 1986). Bandura describes how human behaviour can be broken down into three components which are constantly interacting with each other; personal factors, environmental influences and behaviour itself. It is evident that people learn from their own experiences, however, Bandura theorises that people also learn and develop by noticing those around them, their actions and the consequences of those actions (Bandura, 1977).

The SCT supplies educators with a theory on how they may enhance their teaching strategies and in turn create an effective learning environment which heightens student academic motivation and nurtures the development of flexible motivational strategies among learners (Alderman, 2013).

Self-Determination Theory

The theory on the connection between personality, human motivation and optimal functioning is the Self-Determination Theory (SDT). The theory aids researchers and practitioners in understanding the concepts of motivation and characterises intrinsic and extrinsic sources of motivation (Center for Self-Determination Theory, 2022). The SDT also provides information on the specific function of intrinsic and extrinsic motivation in cognitive and social development. More specifically, SDT concentrates on the links found between the influence of extrinsic motivation on intrinsic forces (Abdel Meguid, Smith and Meyer, 2020). SDT centres on the way social and cultural factors help or threaten a learner's sense of autonomy and ambition. Additionally, there is a focus on the learner's well-being and the status of their performance (Ryan and Deci, 2000).

Cognitive Evaluation Theory (CET) was put forward by Deci and Ryan as a sub-theory of SDT (Deci and Ryan, 1985). CET concentrates on a learner's need for competence and autonomy. The theory suggests that receiving feedback or rewards after an action, which result in an emotional response of competence, can heighten intrinsic motivation for that particular action. However, emotions of competence will fail to heighten intrinsic motivation if a sense of autonomy is absent from the action (Ryan, 1982). Ryan and Deci presented a second sub-theory of SDT, which is called

Organismic Integration Theory (OIT). This theory was used to specify the various types of extrinsic motivation and the circumstantial factors that would promote or prevent internalisation and integration. Internalisation refers to the way in which external regulations are transformed into internal regulations, and integration refers to a learner's ability to integrate those regulations into their sense of self (Ryan and Deci, 2000). This theory highlights that autonomy, competence and relatedness are necessary for psychological growth (ten Cate, Kusurkar and Williams, 2011).

1.7 Current Design of Anatomy Curricula

Higher level institutions play a vital role in the development of society and in turn there is a requirement to satisfy the criteria of improvement, modernisation, and development (Rehman *et al.*, 2022). One of the main aims of third level education is to encourage students to become independent, autonomous and life-long learners (Pickering and Swinnerton, 2019). To accomplish this, pedagogies which stimulate and support student motivation and engagement in learning should be incorporated into curriculum design and delivery (Casey *et al.*, 2011). With regard to third level healthcare students' anatomy education, the design and delivery of anatomy curricula has been a topic of recent research (Evans and Pawlina, 2021; Roxburgh and Evans, 2021). This is, in part, due to a shortage of anatomy staff (Kramer *et al.*, 2020), the reduced number of teaching hours dedicated to anatomy (Wong *et al.*, 2020) and the COVID-10 pandemic (Harmon *et al.*, 2021). A core anatomy teaching syllabus for dental (Matthan *et al.*, 2020) and medical (Smith *et al.*, 2016) education has been recommended. These syllabi were developed in response to a perceived lack of resources guiding educators on curriculum content (C. F. Smith *et al.*, 2019).

However, these reports do not suggest teaching strategies for delivering the recommended anatomy content. While there has been a recent drive towards promoting inclusivity in the design and delivery of anatomy curricula in healthcare programmes (Baptiste, 2021; Border *et al.*, 2021; Mendonça *et al.*, 2021; Mishall *et al.*, 2022), no pedagogical frameworks have been recommended for anatomy educators.

The utilization of modern teaching strategies like interactive media, technology and new devices can create an improved learning experience (Das and Al Mushaiqri, 2021; Lone, Mohamed and Toulouse, 2021; da Silveira *et al.*, 2022). More specifically, there are recent studies investigating the inclusion of innovative teaching strategies such as anatomical body painting (Finn, 2018), 3-Dimensional (3D) computer programmes (Lone *et al.*, 2019) and augmented reality (Iwanaga, Terada, *et al.*, 2021) and have reported enhanced student academic performance. Additionally, neuroanatomy is typically considered a difficult subject for healthcare students to comprehend (Javaid *et al.*, 2018; Rezende *et al.*, 2020). The inclusion of stereoscopic 3D teaching has resulted in positive outcomes including improved knowledge and clinical competencies (Jacquesson *et al.*, 2020). Social media and web-based learning have both been reported as effective self-directed educational tools (Hennessy *et al.*, 2016; Nguyen, Lyden and Yoachim, 2021; Patra *et al.*, 2022), but guidance is required from educators to ensure that students are accessing reliable and accurate resources. It is evident that the design and delivery of anatomy curricula is changing both nationally and internationally (Trautman, McAndrew and Craig, 2019; Harmon *et al.*, 2021; Smith *et al.*, 2021). There are a range of factors propelling these changes including concerns regarding healthcare students anatomy knowledge (Hagan and Jaffe, 2018) and students requesting more engaging teaching methods (Davis *et al.*, 2014). However, it is not clear whether these changes are being incorporated in the most optimal manner so to enhance student learning and understanding of anatomy while simultaneously ensuring that all students have the opportunity to participate in an inclusive, accessible and flexible educational experience.

Anatomy Curricula in Healthcare Programmes in University College Cork

Undergraduate medical, dental, Occupational Therapy (OT) and Speech and Language Therapy (SLT) programmes in UCC include a compulsory human gross anatomy module in first year. The specific content of each module differs such that it is tailored to the needs of the professional programme. Regardless of the programme, all anatomy students attend lectures and practical sessions, which take place in the Facility for Learning Anatomy Morphology and Embryology (FLAME) laboratory. In the FLAME laboratory students have access to cadavers, anatomy atlases, 3D models, bones, plastinated specimen, anatomy computer programmes, microscopes and medical demonstrations. The practicals run in a 20 minute rotational system, allowing students to alternate between demonstrator led stations, student led stations and various other resources which represent the same learning material in multiple formats (Balta, Supple and O'Keeffe, 2021).

Medical Education

Medical doctors diagnose and treat numerous conditions as a part of their daily duties and adequate knowledge of anatomy is required to deliver safe and effective treatment to patients (Estai and Bunt, 2016; Jeyakumar, Dissanayake and

Dissabandara, 2020). The undergraduate medical programme in UCC is five years duration and is accredited by the Irish Medical Council. Medical students complete their anatomy modules during their first and second years (Table 1.1). In first year, students complete four modules which are each integrated with biochemistry, embryology, pathology and physiology teaching. Two modules are completed in semester one and two modules are completed in semester two of first year. Each module varies in credit weighting. However, in relation to their first anatomy module, they attend 23 hours of anatomy lectures and twelve 2-hour anatomy practicals.

Dental Education

A strong knowledge of anatomy, particularly of the head and neck, is essential for dental graduates as their daily work includes oral examinations, restorations, and surgical procedures (Rafai *et al.*, 2016; Lone *et al.*, 2019). The undergraduate direct-entry dentistry programme in UCC is five years duration and is accredited by the Dental Council of Ireland. Dental students complete their anatomy modules in year one and two (Table 1.1). In first year, the anatomy module is a ten-credit module, it is not semesterised and thus continues for the duration of the academic year. The students attend 36 hours of anatomy lectures and sixteen 2-hour practicals.

Occupational Therapy Education

Occupational therapists support individuals, groups and communities to achieve health, well-being, and participation in life through engagement in daily activities or occupations (American Occupational Therapy Association, 2020). Occupational therapists require a robust knowledge and understanding of body structures and functions to carry out their role effectively and safely (Schofield, 2018; American

Occupational Therapy Association, 2020; Dove *et al.*, 2022). The undergraduate OT programme in UCC is four years duration and is approved by CORU, Ireland's multi-profession health regulator and the Association of Occupational Therapists of Ireland, on behalf of the World Federation of Occupational Therapists. Students in UCC complete anatomy modules in first, second and third year (Table 1.1). Students attend 22 hours of anatomy lectures and six 2-hour practicals in first year.

Speech and Language Therapy Education

Speech and Language Therapists assess, diagnose and treat clients with speech, language, communication and swallowing difficulties. To accomplish these duties in a safe manner, knowledge of head, neck and respiratory anatomy is essential (Criado-Álvarez *et al.*, 2022). The undergraduate SLT programme in UCC is four years duration and is approved by CORU. The students complete anatomy modules in first, second and third year (Table 1.1). In first year, the students attend 22 hours of anatomy lectures and six 2–hour practicals.

Table 1.1 Breakdown of Anatomy Curricula in Healthcare Programmes in UCC

	Module Code	Credit Weighting	Number of lecture hours	Number of practical hours	Module Content
Anatomy modules completed by medical students					
First year	FM1010	15	23 x 1 hour	12 x 2 hours	Upper and Lower Limb
	FM1020	5	11 x 1 hour	4 x 2 hours	Cardiovascular
	FM1030	10	6 x 1 hour	6 x 2 hours	Respiratory
	FM1040	10	16 x 1 hour	10 x 2 hours	Gastrointestinal
Second year	FM2101	10	18 x 1 hour	6 x 2 hours	Neuroanatomy
	FM2102	10	9 x 1 hour	6 x 2 hours	Renal and reproductive
Anatomy modules completed by dental students					
First year	AN1006	10	36 x 1 hour	16 x 2 hours	Head and neck
Second year	AN2008	5	15 x 1 hour	10 x 1.5 hours	Tooth morphology
Anatomy modules completed by occupational therapy students					
First year	AN1060	5	22 x 1 hour	6 x 2 hours	Trunk, vertebral column, upper and lower limb
Second year	AN2060	5	20 x 1 hour	N/A	Embryology
Third year	AN3060	5	18 x 3 hours	4 x 3 hours	Neuroanatomy
Anatomy modules completed by speech and language therapy students					
First year	AN1061	5	22 x 1 hour	6 x 2 hours	Respiration, phonation, articulation, eye and ear
Second year	AN2061	5	20 x 1 hour	N/A	Embryology
Third year	AN3061	5	18 x 3 hours	4 x 3 hours	Neuroanatomy

1.8 Is a Change in the Design and Delivery of Anatomy Curricula Needed?

Emerging literature suggests that anatomy educators should utilize a multimodal approach in the design and delivery of third level anatomy curricula (Sotgiu *et al.*, 2020; Iwanaga, Loukas, *et al.*, 2021). Multimodal teaching strategies help to engage numerous types of students in the learning process (Shapiro *et al.*, 2020; Abu Bakar *et al.*, 2022). A review of anatomy teaching in the ROI and United Kingdom (UK) reported a transition from traditional teaching methods, such as lectures and the use of prosections, to more modern methods, such as technology-enhanced learning, 3-D printing and models, over the last 20 years (Smith *et al.*, 2021). A transition which was considered necessary due to the reduction in both anatomy teaching hours and anatomy staff and the increased cost of using prosections (Smith *et al.*, 2021). It is evident that changes are being made to the design and delivery of anatomy curricula. However, learner variability is present in every learning environment (Vasquez and Marino, 2021) and it is yet to be established whether these changes are aligning with the ROI educational policy regarding inclusiveness and accessibility (HEA, 2022a), and thus are taking into consideration learner variability. For example, Ruthberg et al. (2020) reported that including mixed reality in the design of their anatomy curricula improved the academic performance of some students whereas students with poor spatial abilities struggled with the teaching tool (Ruthberg *et al.*, 2020). Thus, there is a requirement for including options for how students engage in the learning environment, so to ensure inclusivity and a reduction of barriers to student learning. The delivery methods of anatomy curricula for students enrolled in healthcare programmes have changed and are likely to continue to change in light of the recent pandemic (Roxburgh and Evans, 2021). Consequently, ensuring effective teaching and learning is more vital than ever.

1.9 Universal Design for Learning

UDL is an educational framework designed with the aim of creating safe and inclusive learning environments for all types of learners. The UDL framework is built on the idea that a "typical" or "average" student does not exist, but rather that all students learn and understand material in different ways (CAST, 2021a). The UDL framework addresses learner variability, which is present in all learning environments (CAST, 2021a). For instance, some learners prefer visual aids whereas others prefer to receive information aurally (Lowrey *et al.*, 2017; Cullinane and Barry, 2022). Because learners possess different abilities and experiences, all learners benefit from a multimodal approach to learning (Hernandez *et al.*, 2020). Therefore, to educate at the optimum level of each student, there is a need to increase flexibility within learning environments (Rose and Gravel 2010). Through the incorporation of UDL, educators may provide equal opportunities for all learners (CAST, 2021a).

Theory of Universal Design for Learning

The UDL framework consists of principles, guidelines and checkpoints recommended for the development of curricula with minimal barriers to student learning (CAST, 2021a). The framework was created in the United States (US) by the Centre of Applied Special Technology (CAST). The idea of UDL stemmed from the field of architecture (King-Sears, 2009). The *Americans with Disabilities Act* (1990) requested universal access to premises for people with disabilities. This Act resulted in architects anticipating the needs of individuals with disabilities and thus, facilitating those needs in the original design plans (Hall *et al.*, 2003), as opposed to incorporating accessibility after construction was complete (Lieberman, 2017).

Building on the architectural idea, UDL is an approach to help remove barriers to student learning and to provide universal access to learning for all individuals (King-Sears, 2009). The framework integrates Universally Designed Instruction (UDI), Universally Designed Assessment (UDA) and Universally Designed Curriculum (UDC) (AHEAD, 2017). The UDL framework also derives from neurodiversity and research on how individuals learn (CAST, 2021a). Studies investigating how students learn and how they are motivated have established that students' differing abilities, experiences, preferences and backgrounds have an impact on the learning process (Menin et al., 2016; Mutlu and Yildirim, 2019; Arztmann et al., 2022). When a group of learners are all performing the same task, their brain activity is immensely different (Hollingshead, Lowrey and Howery, 2022) as the brain is made up of billions of neurons which interact with each other to create unique pathways (Tyukin *et al.*, 2019). The brain is extremely plastic and therefore is moulded by experiences and environmental factors (Yuliana, 2020; Chirokoff *et al.*, 2022). Educators' awareness of the brains' plasticity is invaluable as it enhances their understanding that learning is a process which is constantly growing and developing (Brault Foisy *et al.*, 2020). Thus, the incorporation of multiple teaching methods helps to optimally engage a variety of students, removes barriers to student learning and provides individuals with the opportunity to identify their own strengths and preferences, all within the one learning environment. Learning outcomes may remain the same, however, the manner in which that outcome is achieved may be adapted and optimised (Meyer, Rose and Gordon, 2014).

The UDL framework originally listed the principles as Multiple Means of Representation, Multiple Means of Action and Expression and Multiple Means of

Engagement and the guidelines and checkpoints were listed in numerical order. However, after additional research into the theory and practice of how students learn, adjustments were made to the order of the principles. It was determined that Multiple Means of Engagement needed to appear first on the list, as it was through the means of student engagement that the remaining principles could build upon the creation of inclusive teaching strategies and learning environment. Thus, the following description of UDL follows the revised version of the framework (Figure 1.2). The UDL pedagogical framework consists of three core principles which educators may use to help develop and design their curriculum. These principles include Multiple Means of Engagement, Multiple Means of Representation and Multiple Means of Action and Expression (CAST, 2021a). Each of the principles is broken down into guidelines. There are nine guidelines in total. Each guideline is further broken down into checkpoints, of which there are 31 in total (CAST, 2021a) (Figure 1.2).

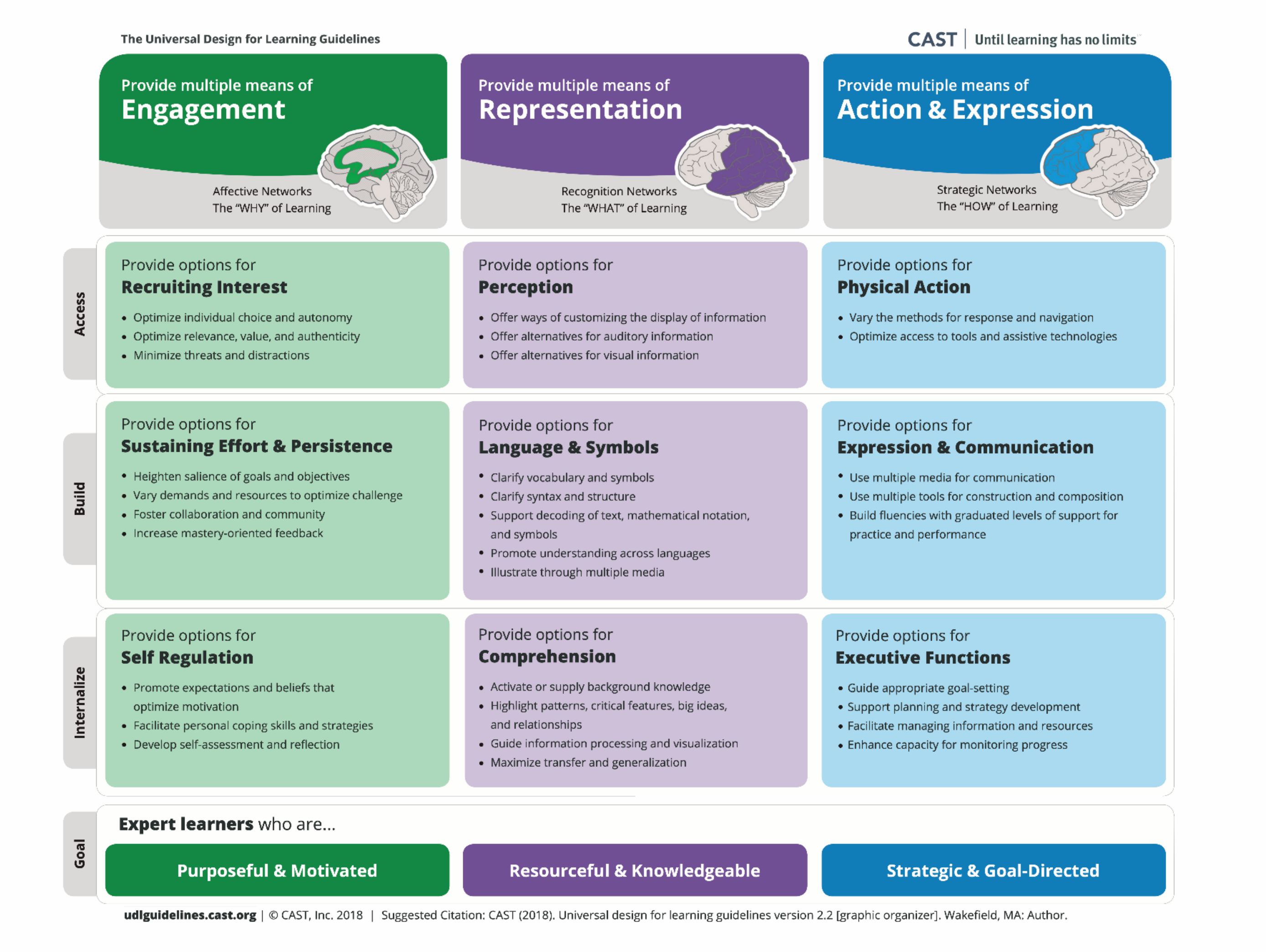

Figure 1.2 *A schematic outlining the three Universal Design for Learning principles and their respective guidelines and checkpoints* (CAST, 2021a). *Also in figure 2.1, 4.1 and 5.1.*

Multiple Means of Engagement

The Multiple Means of Engagement principle refers to the numerous ways in which educators can help students engage with learning material and remain motivated. Student engagement is necessary for successful learning as engagement assists in encouraging and enhancing the motivation of students while cultivating enthusiasm for learning (Hansen *et al.*, 2021). In order to enhance student learning and promote an inclusive learning experience, educators should promote motivation and self-regulation among students. However, the manner in which students are motivated or engaged is highly variable (Lowrey *et al.*, 2017). For example, some learners may be stimulated by spontaneity whereas others may withdraw from the learning process as a result. There is no single form of engagement that will suit all learners; hence, the inclusion of options and alternatives provides a more inclusive and successful learning experience (Amponsah, 2020).

UDL promotes the inclusion of multiple and flexible options for engagement by utilizing creative teaching strategies that also take into consideration the background and interests of a diverse student population (Lieberman, 2017; Balta, Supple and O'Keeffe, 2021). Multiple Means of Engagement may be applied successfully to curriculum design and delivery when educators identify learners' interests and acknowledge that not all learners are the same (Novak and Thibodeau, 2016). A single teaching strategy will struggle to optimise student engagement or interest (Ok *et al.*, 2017). When students' background and interests are taken into account, educators may then determine the most appropriate teaching strategy to heighten student engagement (CAST, 2021a).

Engagement is a critical aspect of student learning (Afflerbach and Harrison, 2017). There are three guidelines under the Multiple Means of Engagement principle, namely “Provide options for recruiting interest”, “Provide options for effort and persistence” and “Provide options for self-regulation”. Each of these guidelines is broken down into checkpoints, of which there are ten in total. Overall, this principle aims to nurture students to become purposeful and motivated. The framework proposes that these goals can be achieved by incorporating the UDL checkpoints (Table 1.2) into the design and delivery of curricula.

Literature supports the inclusion of the checkpoints in curriculum design. For instance, the importance of recruiting student interest is highlighted by Slot et al. (2020). The way in which learners engage may vary over time, depending on circumstances (Amponsah, 2020) and students’ interests may change in accordance to the environment in which they develop into self-determined adults (Ok *et al.*, 2017). Skinner et al. (2017) state that students are engaged by learning material and activities which are relevant to their learning goals and chosen careers, aligning with checkpoint 7.2 ‘Optimise relevance, value and authenticity’. Equally, educators need to be aware and conscious of variability among students as not all students will respond equally to a specific task or activity (Chandler, Zaloudek and Carlson, 2017), thus the inclusion of options and alternatives for students to engage, participate or study either in the lecture hall, tutorial room, laboratory or at home.

When students have choices, their self-determination is enhanced (Novak and Thibodeau, 2016) and the SDT highlights the connection between self-determination and student motivation (Deci and Ryan, 2000). Additionally, it is valuable for educators to create a safe and successful learning environment when designing curricula as this will help students to thrive and reach their personal best (Dobbs, Furnham and McClelland, 2011). Negative experiences could distract students and in turn compromise the learning process (Wass *et al.*, 2020); this aligns with checkpoint 7.3 'Minimise threats and distractions'.

Table 1.2 Multiple Means of Engagement Principle

Guideline 7[1]	*Provide options for Recruiting Interest*
Checkpoint 7.1	Optimise individual choice and autonomy
Checkpoint 7.2	Optimise relevance, value, and authenticity
Checkpoint 7.3	Minimise threats and distractions
Guideline 8	*Provide options for Sustaining Effort and Persistence*
Checkpoint 8.1	Heighten salience of goals and objectives
Checkpoint 8.2	Vary demands and resources to optimise challenge
Checkpoint 8.3	Foster collaboration and community
Checkpoint 8.4	Increase mastery-oriented feedback
Guideline 9	*Provide options for Self-Regulation*
Checkpoint 9.1	Promote expectations and beliefs that optimise motivation
Checkpoint 9.2	Facilitate personal coping skills and strategies
Checkpoint 9.3	Develop self-assessment and reflection

Motivated students are more likely to regulate their attention and maintain their focus and efforts which in turn benefits the learning process (Bovill, Bulley and Morss, 2011). Some students require guidance and support to remain focused on an activity

[1] The UDL guidelines are not presented in numerical order in the thesis and instead will follow the order of the revised version of the UDL framework (Figure 1.2).

as students may become distracted by various sources of intrigue within a learning environment (Rao, Ok and Bryant, 2014). The way in which students are challenged and motivated to reach their individual potential is highly variable. Although every student should be challenged, the level of challenge required will be different (Bedrossian, 2018). Varying the level of challenge and difficulty of an activity ensures all students remain engaged, if a task is too easy students will get bored and lose interest, similarly if a task is too difficult students will become disheartened by activity (Daschmann, Goetz and Stupnisky, 2011; Wang *et al.*, 2020). Thus, when designing tasks, educators should vary the intensities and demands required by the students (Amponsah, 2020). This aligns with checkpoint 8.2 'Vary demands and resources to optimise challenge'. Feedback is pivotal in helping students maintain their motivation and work rate, which is imperative for successful student learning (Griful-Freixenet *et al.*, 2017). When students receive feedback which is timely, constructive and relevant, it helps to sustain learner engagement (Sewell, Kennett and Pugh, 2022). Feedback also highlights the role of effort and practice as critical elements for influencing students towards rewarding habits and learning practices all of which aligns with the checkpoint 8.4 'Increase mastery-oriented feedback'.

Self-regulation refers to the ability of formulating motivating goals and sustaining effort to achieve those goals (Zimmerman, 2002). Successful student learning requires students to be able to engage in self-regulation and the management of their emotions (Sewell, Kennett and Pugh, 2022). However, learners' ability to self-regulate is highly variable and some learners may require guidance on how to develop this trait as they may not have any experience with self-regulation (Ainscough *et al.*, 2018). Thus, there is a need to provide students with supports and guidance on how they may enhance their ability to self-regulate their learning process (Ning and Downing, 2015). This is particularly pertinent to first year undergraduate students the majority of whom have transitioned directly from second level education to third level education and tend to require additional guidance and direction as they are unlikely to have prior experience of self-regulation (van der Meer, Jansen and Torenbeek, 2010; Räisänen *et al.*, 2020; Vosniadou, 2020). The process becomes even more integral because while these students are beginning their journey through third level education that are simultaneously encountering new experiences such as living away from home, managing finances and integrating with a new, and potentially more diverse, group of peers, this aligns with the UDL checkpoint 9.2 'Facilitate personal coping skills and strategies'. Moreover, supporting the development of coping skills encourages independence among students (Rao, Ok and Bryant, 2014). Furthermore, it is important to enhance students' intrinsic abilities so that they may be able to regulate and monitor their own motivations (Chandler, Zaloudek and Carlson, 2017). One of the primary reasons students lack motivation and interest is due to their inability to recognise or appreciate their personal progress (Lowrey *et al.*, 2017). Self-assessment and reflection have been proven to benefit student learning and motivation, aligning with checkpoint 9.3 'Develop self-assessment and reflection'.

Multiple Means of Representation

The Multiple Means of Representation principle takes into account the numerous ways in which information may be understood and grasped by learners (CAST, 2021a). This principle works on the recognition networks of the brain and how individual learners may gather facts and categorise what they see, hear and read (Meyer, Rose and Gordon, 2014).

Learning and understanding is enhanced when material is represented in numerous formats as this provides students with options for understanding and interacting with the learning material (Black, Weinberg and Brodwin, 2015). This can be accomplished by pairing verbal information with visual representation (Edyburn, 2021). Illustrations help with the understanding of long paragraphs of text as well as complex information. The UDL framework suggests that the incorporation of the guidelines "Provide options for perception", "Provide options for language and symbols" and "Provide options for comprehension" will help students to become resourceful and knowledgeable learners (CAST, 2021a). This principle is broken down into twelve checkpoints (Table 1.3). Studies have reported enhanced student learning and experiences as a result of incorporating teaching strategies which align with these checkpoints. Specifically, accompanying auditory information with visual diagrams, charts or written transcripts aids in the removal of barrier to student learning (Rao, Ok and Bryant, 2014; Murphy *et al.*, 2020) and enhances academic performance. Options and alternatives are necessary as vocabulary which clarifies a concept for one student, may confuse another in the same learning environment. Similarly, graphs may be illuminating for some students and puzzling for others (Sewell, Kennett and Pugh, 2022). Barriers to student learning arise when material is presented to students in a single format (Hromalik *et al.*, 2021). Hence, the inclusion of the UDL checkpoint 1.2 'Offer alternatives for auditory information' and checkpoint 1.3 'Offer alternatives for visual information' will remove barriers to student learning.

Table 1.3 Multiple Means of Representation Principle

Guideline 1	*Provide options for Perception*
Checkpoint 1.1	Offer ways of customising the display of information
Checkpoint 1.2	Offer alternatives for auditory information
Checkpoint 1.3	Offer alternatives for visual information
Guideline 2	*Provide options for Language and Symbols*
Checkpoint 2.1	Clarify vocabulary and symbols
Checkpoint 2.2	Clarify syntax and structure
Checkpoint 2.3	Support decoding of text, mathematical notation, and symbols
Checkpoint 2.4	Promote understanding across languages
Checkpoint 2.5	Illustrate through multiple media
Guideline 3	*Provide options for Comprehension*
Checkpoint 3.1	Activate or supply background knowledge
Checkpoint 3.2	Highlight patterns, critical features, big ideas, and relationships
Checkpoint 3.3	Guide information processing and visualisation
Checkpoint 3.4	Maximise transfer and generalisation

Words, icons or symbols may have different meanings to different learners depending on their background or native language (Hollingshead, Lowrey and Howery, 2022). The skill of decoding words, numbers or symbols requires practice. When a student struggles to decode certain symbols this heightens their cognitive load, and in turn decreases their efficiency with learning, in particular with information processing and understanding (Chacko *et al.*, 2013). Thus, by incorporating teaching strategies which align with checkpoint 2.1 "Clarify vocabulary and symbols" and checkpoint 2.2 "Clarify syntax and structure", will reduce the cognitive load on some learners which in turn will enhance their educational experience.

Learners’ ability to mould accessible material into useable knowledge is an active process and students’ skills to do so greatly differ (Diamond, 2013). Students need to be guided and supported on how to process prior knowledge to help understand new information. Murphy et al. (2020) report that students gain a better understanding of information when it is conveyed in a way that stimulates their background knowledge. However, inequities can arise when not all students have the same background knowledge that is necessary to comprehend the learning material. Similar inequities can occur when students possess the background knowledge but are oblivious to the relevance (Schwartz *et al.*, 2006). Students are not always efficient in identifying the learning material which is important and what is lower on the priority list (Katz and Sokal, 2016). Therefore, the utilisation of UDL checkpoint 3.1 ‘Activate or supply background knowledge’ aims to remove these inequities and instead create an inclusive learning experience with equal opportunities for all students, so for students to successfully transform learning material into useable knowledge, they may require guidance and support on how to process information optimally (Devolder, van Braak and Tondeur, 2012).

Information processing requires the selection and manipulation of information, a learning strategy which not all students possess (Holzworth, Stewart and Mumpower, 2018). A key skill in student learning is the ability to transfer and generalise information, especially when moving onto a new concept (Jacobson, 2008). Hence, the inclusion of teaching strategies which align with the UDL checkpoint 3.3 ‘Guide information processing and visualisation’ and checkpoint 3.4 ‘Maximise transfer and generalisation’ may enhance student understanding.

Multiple Means of Action and Expression

The Multiple Means of Action and Expression principle focuses on the enhancement of students' ability to plan and perform tasks (CAST, 2021a). It aims to remove barriers to curriculum design so that students can optimise their abilities to organise and expresses their ideas (Rao, Ok and Bryant, 2014). Various flexible and accessible methods of action and expression are essential, as students differ in their desire and ability to express their knowledge (Smith and Lowrey, 2017). For example, some students may prefer to communicate through speech rather than written text and vice versa. Action and expression require a combination of strategy, practice and organisation and not one method will suit all learners (Scanlon *et al.*, 2018). The UDL framework suggests that the incorporation of the guidelines "Provide options for physical action", "Provide options for expression and communication" and "Provide options for executive functions" will help students to become strategic and goal-orientated learners (CAST, 2021a). This principle is broken down into nine UDL checkpoints (Table 1.4), all of which aim to help in the creation of an inclusive learning experience for all individuals.

Table 1.4 Multiple Means of Action and Expression Principle

Guideline 4	*Provide options for Physical Action*
Checkpoint 4.1	Vary the methods for response and navigation
Checkpoint 4.2	Optimise access to tools and assistive technologies
Guideline 5	*Provide options for Expression and Communication*
Checkpoint 5.1	Use multiple media for communication
Checkpoint 5.2	Use multiple tools for construction and composition
Checkpoint 5.3	Build fluencies with graduated levels of support for practice and performance
Guideline 6	*Provide options for Executive Functions*
Checkpoint 6.1	Guide appropriate goal setting
Checkpoint 6.2	Support planning and strategy development
Checkpoint 6.3	Facilitate managing information and resources
Checkpoint 6.4	Enhance capacity for monitoring progress

All learners have a different level of spatial awareness and ability to negotiate their physical environment (Darrow and Adamek, 2018). To reduce learning barriers, it is imperative that students are provided with learning material which everyone can engage and interact with, whether a student has a physical impairment or difficulty carrying out certain executive functions. This aligns with checkpoint 4.1 'Vary the methods for response and navigation'. Generally, the provision of learning tools to students is not efficient, students need to be guided on how to appropriately and optimally utilise such tools, particularly if it is new and unfamiliar to them (Balta, Supple and O'Keeffe, 2021). It cannot be assumed that all students will be proficient immediately. This aligns with checkpoint 4.2 'Optimise access to tools and assistive technologies'. There is no single method of expression which will suit all learners equally (Hollingshead, Lowrey and Howery, 2022). Some students may excel relaying information through speech, and others through written text. Thus, when students have options for how they communicate and express themselves, they in turn can discover what method suits them best (Rao, Ok and Bryant, 2014). When learners have options for how they express themselves, it reduces the occurrence of media-specific obstacles (Hromalik *et al.*, 2021). Options simultaneously increase the likelihood of all learners establishing and developing a wider variety of expression in a world which has an abundance of different types of media (Meyer, Rose and Gordon, 2014). The provision of only one tool for the construction or composition of information does not allow learners to prepare sufficiently for the future (Edyburn, 2021), it limits their capacity for conveying their knowledge effectively (Biancarosa and Griffiths, 2012). Students should acquire a number of fluencies; aural, visual or reading for effective learning (Stevens, Walker and Vaughn, 2017). Fluency is developed by utilizing opportunities for practice so that learners may hone in on strategies which are optimal for their learning (Laurillard, 2012). This aligns with checkpoint 5.3 'Build fluencies with graduated levels of support for practice and performance'.

The development of executive functions helps students to control rash, short term responses to their learning environment and instead establish long term goals (García-Campos, Canabal and Alba-Pastor, 2020). However, many students require support and guidance to develop successful learning strategies for achieving their goals, to monitor their progress and in turn adjust strategies if necessary. Learners are variable in their knowledge, ability and desire to set individual suitable goals to steer their work, it is a skill which needs to be developed (Meyer, Rose and Gordon, 2014). The inclusion of teaching strategies which align with checkpoint 6.1 'Guide appropriate goal setting' have reported increased student engagement. Effective strategy development is an imperative skill to possess for successful learning and achieving learning goals (Novak and Thibodeau, 2016). Working memory, the part of the brain which is responsible for storing information, can limit a learner's executive functions (Vasquez and Marino, 2021). This area of the brain is quite limited for all learners but particularly so for students with learning and cognitive difficulties and can sometimes result in learners appearing disorganised, careless and forgetful (Oberauer *et al.*, 2016). Feedback is essential for efficient learning to occur, as feedback makes learners aware of the areas where they are making progress and in turn the areas where they are struggling (Beaumont, Moscrop and Canning, 2016). When assessments or feedback are not informative or received promptly, student learning will suffer as they do not know where or if changes should be made (Boud and Molloy, 2013). For this reason, students need to be made aware of their progress. Hence, the utilisation of UDL checkpoint 6.4 'Enhance capacity for monitoring progress'.

The UDL framework promotes the use of inclusive and engaging teaching strategies so that all learners can fulfil their potential (CAST, 2021a). There appears to be opportunities where UDL could be utilised to enhance the design and delivery of anatomy curricula in healthcare programmes (Balta, Supple and O'Keeffe, 2021). However, the formal inclusion of UDL in anatomy curricula has never been investigated or assessed.

1.10 Universal Design for Learning and Anatomy Education

Across the globe, higher level institutions acknowledge their role and responsibility in providing accessible and inclusive learning opportunities for all learners (Dalton *et al.*, 2019). UDL has been identified as an appropriate and pertinent framework to incorporate inclusiveness into curricula design and delivery (Hollingshead, Lowrey and Howery, 2022). There are limited published studies critiquing the incorporation of UDL in the design and delivery of third level education. In contrast, there are numerous publications promoting the implementation of UDL to enhance student learning and engagement. Specifically, Murphy et al. (2020) examined OT educators' awareness and utilisation of UDL in OT education. The study concluded that UDL holds the promise of enhancing student learning while simultaneously ensuring that educators are optimally meeting the needs of all learners (Murphy *et al.*, 2020). Gunderson and Cumming (2022) conducted a systematic review of studies reporting the use of UDL aligned audio podcasts to enhance student engagement in third level education. The review concluded that the incorporation of podcasting provided a novel way for both students and educators to engage in the learning process and should be considered as an assessment option for students to demonstrate their knowledge (Gunderson and Cumming, 2022).

Implementing teaching strategies which align with the UDL guidelines improves student engagement and in turn heightens intrinsic motivation, as outlined by a meta-analysis carried out by Patall and colleagues (2008). Similarly, Marais et al. (2019) found that choice and autonomy had an influence on student motivation and that learner engagement may be enhanced if varied opportunities for choice are incorporated into the curriculum design of undergraduate OT, SLT and medical programmes. Although the benefits of teaching strategies which align with UDL in anatomy curricula have been reported (Ben Awadh *et al.*, 2022; Yohannan *et al.*, 2022), no study has specifically utilised UDL to design anatomy curricula for medical, dental, OT or SLT programmes. Furthermore, there are no studies reporting the feasibility or benefit of UDL in the design and delivery of third level anatomy education. There are recent publications which aim to guide and support educators, of any discipline, with the incorporation of UDL into their curriculum. For example, Cotán et al. (2021) identified teaching strategies which educators from various disciplines used to create inclusive learning experiences. They also reported difficulties which educators encountered which hindered their abilities to implement inclusive teaching strategies such as, educators' lack of knowledge regarding active teaching strategies, their lack of teaching experience and a lack of educator training about inclusive education (Cotán *et al.*, 2021). Edyburn (2021) highlights examples of universal usability of technology by students. However, neither of these examples are specific to anatomy education.

The design and delivery of anatomy curricula is currently undergoing modification and development both nationally and internationally (Evans and Pawlina, 2021; Iwanaga, Loukas, *et al.*, 2021; Smith *et al.*, 2021; Lachman and Pawlina, 2022). A decrease in the time dedicated to teaching anatomy in healthcare programmes (Smith *et al.*, 2021), a shortage of anatomy educators (Wilson *et al.*, 2020) and more recently the Covid-19 pandemic (Evans *et al.*, 2020) are some of the reasons underpinning curricular modification. Additionally, the student population has evolved. The current generation of first year undergraduate students are typically accustomed to the utilisation of technology and active learning techniques in their learning environments (Boysen, Daste and Northern, 2016; Estai and Bunt, 2016; Hu, Wattchow and de Fontgalland, 2018), however, this cannot be presumed for all learners (Das and Al Mushaiqri, 2021). Furthermore, educators are becoming more aware of students' individual learning needs and preferences and educational changes are being made to promote accessibility of learning material and an overall inclusive educational experience for all students (Hu *et al.*, 2018; Lorenzo-Alvarez *et al.*, 2020; Seidlein *et al.*, 2020). Notwithstanding these developments, there is minimal research on specific pedagogical frameworks for the optimal design and delivery of anatomy curricula in healthcare education

1.11 Aim of the Thesis

This thesis has four aims:

1. To investigate the utilisation of UDL in anatomy healthcare education, specifically in medical, dental, OT and SLT programmes.
2. To establish first year undergraduate medical, dental, OT and SLT students' motivation to study anatomy at the start and end of their respective anatomy modules and identify any changes that may occur.
3. To determine whether first year undergraduate medical, dental, OT and SLT students studying anatomy are aware of the UDL framework.
4. To explore whether third level anatomy educators in the ROI and UK are aware of the UDL framework.

Chapter Two

Universal Design for Learning in Anatomy Education of Healthcare Students: A Scoping Review

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Abstract

There are concerns among healthcare practitioners about poor anatomical knowledge among recent healthcare graduates. Universal Design for Learning (UDL) is a framework developed to enhance students' experience of learning and help students to become motivated learners. This scoping review identified whether UDL has been utilized in third level healthcare education and if so, whether it had been used to enhance student motivation to study anatomy. Seven online databases were searched for studies reporting the use of UDL in the curricula of medical, dental, occupational therapy or speech and language therapy programs. Studies were screened for eligibility with set inclusion criteria. Data were extracted and analysed. Analysis revealed that UDL was not specifically mentioned in any of the studies thus there are no published studies on UDL being formally applied in healthcare education. However, the authors identified 33 publications that described teaching methods which aligned with UDL in anatomy curricula and a thematic analysis yielded four main themes relating to teaching strategies being employed. Universal Design for Learning was not mentioned specifically, indicating that educators may not be aware of the educational framework, although they appeared to be utilizing aspects of it in their teaching. The review revealed that there is a lack of research concerning the anatomy education of occupational therapy and speech and language therapy students. The role of UDL in enhancing motivation to learn anatomy in medical, dental, occupational therapy and speech and language therapy programs has yet to be explored.

Key words: universal design for learning; healthcare education; health professions education, gross anatomy education; occupational therapy education; speech and language therapy education; motivation; scoping review

Introduction

In recent years, the hours dedicated to teaching anatomy through dissection and didactic lectures to students of medicine and allied health professions, in the physical university environment, has reduced due to the advancement of technology and competition with teaching time from other disciplines (Papa and Vaccarezza, 2013; Wong *et al.*, 2020). Additionally, there are concerns among medical and dental practitioners about poor anatomical knowledge among recent healthcare graduates (Durham *et al.*, 2009; Fillmore *et al.*, 2016; Hagan and Jaffe, 2018). Moreover, there appears to be a paucity of published research concerning the anatomical knowledge of occupational therapy (OT) and speech and language therapy (SLT) graduates.

Anatomy is one of the fundamental subjects in healthcare curricula and is considered indispensable for safe and effective practice (Smith *et al.*, 2016). It is not only healthcare professionals that notice the inadequate anatomical knowledge among graduates, students themselves also recognize this. Students in the early stages of their medical degree have described anatomy as boring and relate it to learning off reams of factual information which demands self-discipline rather than understanding the material (Esther M Bergman *et al.*, 2013). A recent study has indicated that 53% (n = 87) of students, who had already completed their undergraduate degree in OT and were pursuing further OT training either by completing a Masters or a Doctorate, did not feel prepared or felt only somewhat prepared for the anatomy content of a mandatory module as they lacked confidence in their anatomical knowledge gained during their undergraduate OT program (Giles *et al.*, 2021). Schofield (2018) found that occupational therapists with more than three years' experience were of the opinion that newly graduated therapists did not possess adequate anatomy knowledge, although there is a lack of empirical data to affirm this opinion. These findings highlight the need to enhance healthcare students' anatomy learning. To maximise student motivation and enhance anatomical knowledge, it is suggested that changes be made regarding the educators' approach to teaching anatomy to healthcare students (Ghosh, 2016; Singh *et al.*, 2019). This has generated inquiries around ways in which educators can maximise learning for all their students and promote better understanding of anatomical knowledge. There are few studies investigating the inclusivity of teaching methods utilized in anatomy curricula. Meyer and Cui (2019) highlight how incorporating diversity and inclusivity to an anatomy and physiology module allowed students to flourish, make informed decisions and feel safe. Díaz-Navarro and Sánchez De La Parra-Pérez (2021) demonstrated how three-dimensional (3D) printed typhlological replicas could be used to teach the anatomy of the skull to visually impaired archaeology students and thus showed that it is possible to make anatomy curricula inclusive

Anatomy Curricula at Present

Anatomy is considered a classical science, it continues to demonstrate considerable relevance in the training of third level students in health professions, as the anatomical knowledge these students obtain will be used throughout their practical careers (Ruzycki *et al.*, 2019). However, the manner in which students' anatomy knowledge is being taught and assessed is changing. Rowland et al. (2011) reported that in 2005 there was a major shift in the method of anatomy assessments which health professional students undertook. Prior to 2005, students were typically assessed by way of practical and oral examinations as opposed to the methods used since then, namely written examinations such as multiple-choice questionnaires

(MCQs) and extended matching questions. Consequently, it was found that as assessment methods altered, so too did students' learning strategies. Students began to neglect the practical aspects of the anatomy content and instead focused on the theoretical information (Rowland *et al.*, 2011). As a result of students neglecting the practical anatomy content, opportunity to make connections between their theoretical and practical knowledge was reduced and their ability to use background information to further their understanding inhibited (Yong, 2012). Perhaps the introduction of teaching strategies which utilize elements of UDL like activating background knowledge and highlighting patterns, critical features and relationships may help to combat such disconnections between theory and practice among anatomy healthcare students (CAST, 2021a).

A recent study by Tayyem et al. (2019) reported that 46.6% (n = 313) of final year medical students felt that they had a poor grasp of anatomical knowledge. Furthermore, the authors highlighted the need to promote transfer of knowledge as only 111 (35.4%) students thought that the way anatomy was classically taught was adequate to understand radiological images, endoscopic views and laparoscopic views. Additionally, Tayyem et al. (2019) emphasized that although students thought that cadaveric teaching was the best method for teaching anatomy (79.6%), they were in fact being predominantly taught via lectures (92%). Similarly, the most common method of anatomical assessment among the students was MCQ examinations when only 36.7% of participating students actually chose this as their preferred method of assessment in anatomy (Tayyem *et al.*, 2019). The discrepancies between what students prefer and what occurs in practice suggest that perhaps if multiple means of engagement, representation, action and expression were available to the students they may find the learning material more accessible and inclusive of their needs.

Vitorino et al. (2020) compared the academic performance of anatomy students taught with passive and active teaching methodologies. Active methodologies refer to when students are the active subject in the teaching-learning process and the educator is acting as a facilitator, guiding the students through the learning process while allowing them to generate their own ideas and understanding (Lee and Hannafin, 2016). The purpose of UDL is similarly to nurture learners to become autonomous, independent and self-directed (CAST, 2021a). Although, this study found that students' academic performance was quantitatively better using passive rather than active methodologies (Vitorino, Fornaziero and Vignoto Fernandes, 2020), it should be highlighted that educational institutions typically utilize the traditional, passive, methods in their curricular design, whether in primary school or third level institutions (Lee and Hannafin, 2016). Thus, third level students may find it difficult to comprehend new teaching methods. It has been suggested that active methodologies should be gradually introduced to students at the beginning of their third level educational journey before they are effectively applied (Davis *et al.*, 2014). Furthermore, Lee and Hannafin (2016) suggest that students may prefer passive methods because they struggle to identify the key concepts within the learning material. This indicates that the use of passive teaching methods in isolation may deny students the opportunity to develop academic and life skills like critical thinking and the ability to recognize important information and critical concepts; all of which are skills which UDL aims to develop among students (CAST, 2021a).

Literature from the field of pedagogy does not identify any one teaching method as optimal, but instead suggests that the most appropriate method depends on the discipline, the student population and the learning material (Estai and Bunt, 2016). Universal Design for Learning, which provides students with multiple means of engagement, multiple means of representation and multiple means of action and expression (CAST, 2021a) enables such flexibility. This allows learners to develop the skills to identify methods which are most suitable, inclusive, accessible and applicable to their individual needs. Learners of varying abilities are afforded the opportunity to thrive in the same environment as their peers, they do not have to be singled out nor do specific accommodations need to be made for them (CAST, 2021a).

Universal Design for Learning

Universal Design for Learning (UDL) was developed by the Center of Applied Special Technology (CAST) in the United States in the early 1990s as a method to enhance student experience, remove barriers to learning and ensure that education is inclusive for all learners (CAST, 2021a). It posits that a “typical” or “average” student does not exist, but instead that all students learn differently (CAST, 2021a). Thus, UDL was constructed to incorporate more flexible approaches to teaching and assessment so that students of differing abilities are catered for (Gronneberg and Johnston, 2015). It is suggested that teachers should adhere to three UDL principles when designing learning, namely multiple means of engagement, multiple means of representation and multiple means of action and expression.

The principle of multiple means of engagement relates to ways in which students may become motivated learners by enhancing their opportunity to be autonomous, persistent and self-regulated (Meyer, Rose and Gordon, 2014).

Multiple means of representation focuses on methods which encourage students to become resourceful and knowledgeable (Meyer, Rose and Gordon, 2014), while multiple means of action and expression highlight methods to help students to become more strategic and goal-directed (CAST, 2021a). These three principles are divided into nine guidelines which are further broken-down into 31 checkpoints, which educators may use to enhance program design (Figure 2.1). The checkpoints allow for greater ease of understanding and use of the UDL framework by educators (CAST, 2021a). Universal Design for Learning allows flexible assessment opportunities whereby the students can express their learning in the manner which is most appropriate for them (Rose and Gravel, 2010). Research indicates that first year undergraduate students utilize memorization and rote learning as a learning strategy; whereas it has been shown that rote learning is not an optimal approach in third level education (Ahmed and Ahmed, 2017; Roces Montero and Sierra Y Arizmendiarrieta, 2017; Ishartono, Nurcahyo and Setyono, 2019). Thus, the incorporation of UDL may help students develop new strategies to help them succeed in their journey through third level education.

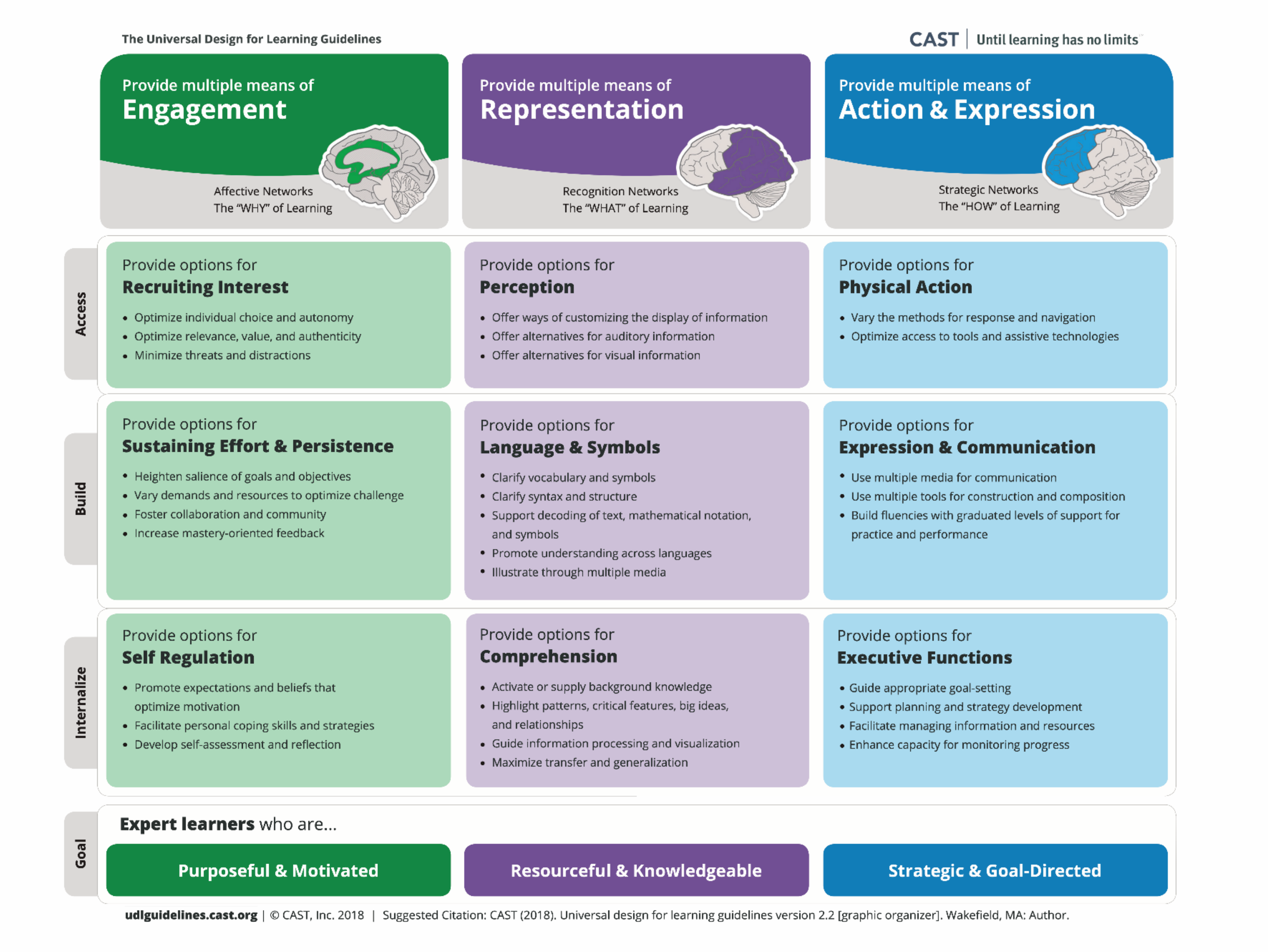

***Figure 2.1** A schematic outlining the three Universal Design for Learning principles and their respective guidelines and checkpoints* (CAST, 2021a)

A number of motivational theories overlap with the UDL principles including attribution theory (Weiner, 1985), social cognitive theory (Bandura, 1977), self-determination theory (Ryan and Deci, 2000) and goal orientated theories (Dweck and Leggett, 1988). A motivational theory which aligns with the first principle of UDL, namely multiple means of engagement and is relevant to the topic of this review is that proposed by Ryan and Deci (2000), namely self-determination theory. Self-determination theory suggests that learners are more inclined to develop intrinsic goals when they are provided with varying challenges and relevant feedback (Ryan and Deci, 2000). This aligns with the UDL checkpoints “vary demands and resources to optimise challenge” and “increase mastery-oriented feedback” (Figure 2.1). Furthermore, the study by Mattick and Knight, (2007) suggests that designing a curriculum which activates and emphasizes prior knowledge to enhance the integration of information is a factor in promoting motivation among second year medical students. This approach aligns with the UDL checkpoints “activate or supply background knowledge” and “maximise transfer and generalisation”. Therefore, instead of drawing from numerous learning theories, it may be more efficient to examine anatomy education through the singular lens of UDL.

Regarding the globalization of UDL, there appears to be an imbalance as studies exploring the benefits and use of UDL are predominantly based in first world countries (S. J. Smith *et al.*, 2019; Nieminen and Pesonen, 2020; Tomas *et al.*, 2021). In contrast, limited research has been conducted in lower and middle income countries (LMICs) (Chiwandire, 2019; Dalton *et al.*, 2019; McKenzie and Dalton, 2020). This highlights a future need to explore the implementation of UDL, specifically in healthcare education contexts in third world countries, to ensure that the global status is captured.

Universal Design for Learning in Third Level Anatomy Education

The UDL framework has been successfully incorporated into the curricula of various university programs (Al-Azawei, Parslow and Lundqvist, 2017; Dean, Lee-Post and Hapke, 2017; Nelson and Brennan, 2019). Studies have shown that UDL has positive effects on students' learning and their educational experience (Scanlon *et al.*, 2018; Dalton *et al.*, 2019). In 2019, Shikha and Mthombeni emphasized the need to incorporate UDL into the curriculum of family and consumer sciences to offer students access to education through varying learning experiences. Similarly, Snow, (2018) demonstrated how to vitalize student assessments by taking inspiration from UDL. It has been reported that UDL allowed students to explore various teaching and learning methods (Katz and Sokal, 2016), and therefore have the opportunity to learn to work in an optimal manner (Hashey, Miller and Foxworth, 2020). Implementing UDL in a third level public health program demonstrated an increase in learning, student engagement, improved personal development and student experience (Shiely and McCarthy, 2019). Evidently there are published studies reporting the use of UDL in third level education, however, the extent of utilization of UDL in healthcare curricula generally and in anatomy education specifically remains largely unknown. Therefore, an examination of its implementation in third level anatomy education is timely. Furthermore, UDL takes into account the developmental stage of learners and allows students of different abilities to reach their individual potential (Schreffler *et al.*, 2019). This is particularly important as most of the anatomy curriculum is typically covered in the first year of healthcare programs, when most students are adolescents (Sawyer *et al.*, 2018).

A recent publication from University College Cork, Ireland (UCC) described the utilization of the UDL framework in the delivery of practical anatomy teaching to first year medical students (Balta, Supple and O'Keeffe, 2021). Balta et al. (2021) concluded that UDL is sufficiently flexible to be included into an established practical anatomy course as a part of a medical program and that the ease of implementing UDL provides educators with the educational rationale for doing so. The role of UDL in enhancing motivation to learn anatomy in medical, dental, OT or SLT programs has yet to be explored.

Universal Design for Learning and Student Motivation

In the educational field, motivation is described as an individual's ambition and aspiration to participate in a learning environment (Wei *et al.*, 2015). Motivation is required for students to endeavour towards successful learning and enhance academic performance, and is crucial for learning (Budiman, 2016; Abdel Meguid, Smith and Meyer, 2020). Universal Design for Learning has been shown to allow students autonomy over their actions and how they express themselves (CAST, 2021a), as well as freedom and independence which promotes student participation and motivation (Cheon, Reeve and Vansteenkiste, 2020). Specifically, the UDL principle, multiple means of engagement, focuses on the way in which learners become engaged and remain motivated (Al-Azawei, Parslow and Lundqvist, 2017). Therefore, it has been proposed that having numerous methods of engagement will help to enhance and sustain motivation (Lowrey *et al.*, 2017). Furthermore, motivation appears to be one of the key ingredients for successful learning (Chai, Wong and King, 2016; Raza, Qazi and Umer, 2019). However, there remains a paucity of information on how educators may promote and sustain motivation among students studying to become healthcare professionals. The aim of this scoping review was to identify whether UDL has been utilized in the anatomy curricula of third level healthcare programs, specifically in medical, dental, SLT or OT education and if so, to identify what elements of UDL have been utilized and whether UDL enhances motivation of undergraduate healthcare students in learning anatomy.

Methods and Materials

Scoping reviews are used to investigate and highlight evidence in a particular area of interest (Rumrill, Fitzgerald and Merchant, 2010) and to define the gaps for future research (Arksey and O'Malley, 2005). Thus, scoping reviews are a useful tool to assess current knowledge in an area of study that is still emerging (Levac, Colquhoun and O'Brien, 2010), which is the case for UDL in anatomy curricula in healthcare education. The process of selecting studies on the use of UDL in the anatomy curricula of selected third level healthcare programs aligned with the recommendations in the Preferred Reporting Items for systematic reviews and meta-analyses extension for scoping reviews (PRISMA-ScR) checklist (Tricco *et al.*, 2018) and followed the framework developed by Arksey and O' Malley, (2005). The protocol for this scoping review was registered with the Open Science Framework (OSF).

Identification of the Research Questions

A preliminary search of the Cochrane Library (John Wiley & Sons, Ltd., Chichester, West Sussex, UK) and JBI Database of Systematic Reviews (JBI, Adelaide, Australia) were carried out to identify whether a scoping review on UDL in healthcare anatomy curricula had already been conducted. No such study was found. To explore relevant evidence in the literature, this review used an initial research question: "Has UDL been utilized in the curricula of third level healthcare students?". The search was then narrowed to answer the following questions:

1. "What are the elements of UDL which have been utilized in the anatomy education of third level healthcare students?"

2. “Does UDL enhance motivation of undergraduate third level healthcare students in learning anatomy?”

Identification of Relevant Studies

Searches were carried out using the following electronic databases: PubMed (US National Library of Medicine, National Institutes of Health, Bethesda, MD), Scopus (Elsevier B.V., Amsterdam, Netherlands), CINAHL (EBSCO Information Services, Ipswich, MA), PsycINFO (American Psychological Association, Washington, DC), Web of Science (Clarivate Analytics, Philadelphia, PA), ERIC (ProQuest, Ann Arbor, MI) and Science Direct (Elsevier B.V., Amsterdam, Netherlands). Studies published between January 1990 and August 2021 were included. Techniques for searching included the use of search tools such as Boolean operators and free text terms, where appropriate. The descriptive key search terms that were developed to guide the search and the number of studies identified are outlined: ((“universal design for learning” AND “healthcare education”) OR (“universal design for learning” AND “anatomy education”) OR (“universal design for learning” AND “undergraduate” AND “medical”) OR (“universal design for learning” AND “education” AND “health”) OR (“universal design for learning” AND “occupational therap*” AND “education”) OR (“universal design for learning” AND “medic*” AND “education”) OR (“universal design for learning” AND “speech – language therap*” AND “education”) OR (“universal design for learning” AND “dent*” AND “education”) OR (“accessib*” AND “healthcare education” AND “anatomy”) OR (“inclusi*” AND “intervention” AND “education” OR training” AND “allied health”) OR (“collab*” AND “allied health” AND “education”) OR (“inclusi*” AND “college student*” AND “healthcare education”) OR ((“accessib*” OR “inclusi*”) AND (“healthcare education” OR “allied health”) AND "education") OR ("universal design for learning" AND "speech-language patholog*" AND "education") OR (("inclusi*" OR "collab*") AND "motivation" AND "healthcare education") OR (("inclusi*" OR "collab*") AND "motivation" AND "anatomy education")). Please see the supplementary information for details of the search strategy. A hand search was carried out on the reference list of each of the included studies, grey literature and unpublished literature, such as theses, dissertations and abstracts of conference proceedings. The search was limited to original studies which were written in English.

Study Selection

The screening process was carried out in three stages; title screening, abstract screening, and full-text screening. Duplicates were identified and removed by the first author (A.M.K.D.) during the first stage of the review process. The first author (A.M.K.D.) carried out the initiation screen and presented her findings to the other authors (M.L., Y.M.N., E.H.). Publications were selected based on the inclusion (Table 2.1) and exclusion (Table 2.2) criteria for title selection and the abstracts were collected. The abstracts were then screened according to the inclusion (Table 2.1) and exclusion (Table 2.2) criteria for abstract selection, namely whether the abstract provided evidence of UDL in the curricula of specific healthcare programs or the inclusion of teaching strategies which aligned with UDL in the curricula of specific healthcare programs. The full texts associated with these abstracts were screened according to the inclusion criteria for full-text selection (Table 2.1) (A.M.K.D., M.L., Y.M.N., E.H.). To help identify whether a study utilized a UDL strategy, the authors composed a number of questions which aligned with each UDL principle. For instance, "Did students engage with the activity?", "Were the students provided with an opportunity to interact with their peers?", "Was the module content expressed in numerous formats?", "Was the module content accessible to all students?", "Did the students demonstrate their understanding?" or "Did the students have the opportunity to express themselves?". Search results were exported to the bibliographic software programs EndNote, version 9, (Clarivate Analytics, Philadelphia, PA) and Microsoft Excel spreadsheet (Microsoft Corp., Redmond, WA). The final analysis included 33 publications for data extraction and charting. All authors discussed and concurred on the selection of titles, abstracts and full articles selected for inclusion in the scoping review. There were no disputes.

Table 2.1 Inclusion Criteria for Study Selection

Inclusion Criteria	**Criteria**
Inclusion criteria for title selection	Published between 1990 and 2022
	Published in English in peer-reviewed journals
Inclusion criteria for abstract selection	Abstract reflects that the study is an original article
	Abstract shows evidence of UDL being implemented
	Abstract shows evidence of a teaching method aligning with UDL being implemented
	Abstract reflects that the study was carried out among third level healthcare students
Inclusion criteria for full text selection	Full text indicates that the study was carried out among medical, dental, OT or SLT students
	Full text describes the utilization of UDL in anatomy education of healthcare students
	Full text includes a description of a teaching method which aligns with at least one UDL checkpoint
	Full text shows evidence of evaluation of the teaching method implemented
	Full text provides clear methodology on the measurement of the outcome(s)

Table 2.2 Exclusion Criteria for Study Selection

Exclusion Criteria	Criteria
Exclusion criteria for title selection	Published prior to 1990
	Not published in peer-reviewed journals
	Not based on educational research
	Not published in English in peer-reviewed journals
Exclusion criteria for abstract selection	Abstract reflects that the study is not an original article
	Abstract does not show evidence of UDL being implemented
	Abstract does not show evidence of a teaching method aligning with UDL being implemented
	Abstract does not reflect that the study was carried out among third level healthcare students
Exclusion criteria for full text selection	Full text indicates that the study was not carried out among medical, dental, OT or SLT students
	Full text does not describe the utilization of UDL in anatomy education of healthcare students
	Full text does not include a description of a teaching method which aligns with at least one UDL checkpoint
	Full text does not show evidence of evaluation of the teaching method implemented
	Full text does not provide clear methodology on the measurement of the outcome(s)

Charting the Data

A table was developed to collate the relevant information from the selected publications as follows: author(s), year of publication, title of study, geographical location, study population, sample size, study design, study objectives, data collection method, UDL checkpoint utilized and reported outcomes. Confirmability of the extracted data was supported by frequent debriefing sessions and collaboration between the first author and supervisor team.

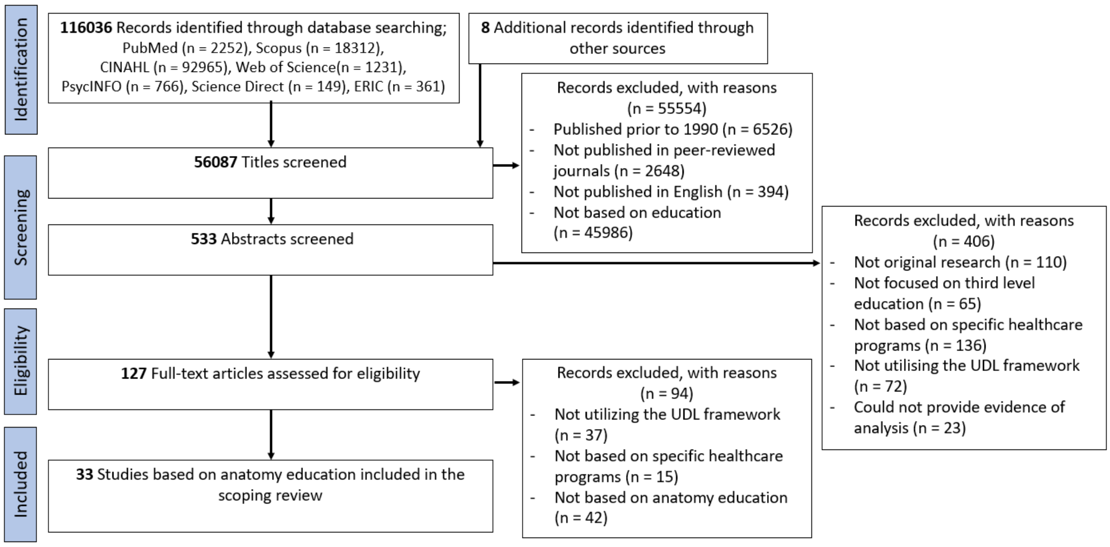

Figure 2.2 *A preferred reporting items for systematic reviews and meta-analyses extension for scoping reviews (PRISMA-ScR) flow diagram of the literature selection. Adapted from Tricco et al. (2018).*

Collating, Summarizing, and Reporting the Results

Descriptive statistics, specifically the measure of frequency, was used to report the UDL checkpoints utilized in the selected studies. It was noted when a teaching strategy described in each study was deemed to align with a specific UDL checkpoint. A thematic analysis (Braun and Clarke, 2006) was performed to identify the recurring elements of UDL which had been utilized in the anatomy education of third level healthcare students. Teaching methods which shared similar characteristics were organized thematically to provide a statement of the evidence.

Results

Literature Search

The searches resulted in a total of 116,044 publications identified through database searching (n = 116,036) and through other sources (n = 8) (Figure 2.2). Duplicates (n = 59,957) were removed. The titles of the remaining publications were screened according to the inclusion criteria (Table 2.1) and 55,554 publications were removed. The abstracts of the remaining 533 publications were screened according to the inclusion criteria. As a result, 406 publications were excluded as the abstracts revealed that the studies were not original research [book (n = 22), book chapter (n = 12), review article (n = 71), or opinion (n = 5)], they were not focused on third level education, they were not focused on the specific healthcare programs: medicine, dentistry, OT or SLT, they did not indicate the utilization of UDL or a strategy which aligned with the UDL framework or they could not provide evidence of quantitative or qualitative analysis. The full text for the remaining 127 publications were retrieved and screened according to the inclusion (Table 2.1) and exclusion (Table 2.2) criteria. The full text of the remaining 33 publications which fulfilled all the inclusion criteria were analyzed. The majority of the selected publications were based on studies conducted on medical students, although two involved dental students, one was conducted among OT students, and three included a mixture of medical and dental students. The process of data selection is illustrated (Figure 2.2).

Characteristics of the Selected Studies

The 33 selected studies were published between 2012 and 2022. The study characteristics are summarized (Table 2.3).

Table 2.3 Study characteristic of selected anatomy-based studies

Author	Year of Publication	Title of Study	Geographical Location	Study Population	Data Collection Method[2]	Study Design[3]
Yohannan et al.	2022	"Air anatomy" - teaching complex spatial anatomy using simple hand gestures.	India	Medicine	A	L
Rao Bhagavathula et al.	2021	The integration of pre-laboratory assignments within neuroanatomy augment academic performance, increase engagement and enhance intrinsic motivation in students.	USA	Occupational Therapy	A, B, H	L
Dua et al.	2021	Development of a novel peer-sharing application to supplement learning from cadaveric dissection.	USA	Medicine	A, B	J
Abdullah et al.	2020	Student-centred learning in the anatomy laboratory: Medical students' perspective.	Ireland	Medicine	A, B	J

[2]A, Questionnaire on student perception; B, Open-ended questions; C, Questionnaire on educator perception; D, Pre- and post-knowledge test; E, Focus group discussion; F, Pre – and post-skills test; G, Semi-structured interview; H, Post knowledge test.

[3] I, Cross-sectional study; J, Quasi-experimental study; K, Retrospective study; L, Randomized controlled trial.

Ben Awadh et al.	2020	Multimodal three-dimensional visualisation enhances novice learner interpretation of basic cross-sectional anatomy.	UK	Medicine	A, D	I
Gnanasegaram et al.	2020	Evaluating the effectiveness of learning ear anatomy using holographic models.	Canada	Medicine	A, B, D	L
Golenhofen et al.	2020	The use of a mobile learning tool by medical students in undergraduate anatomy and its effects on assessment outcomes.	Germany	Medicine	A, D	I
Lee et al.	2020	A web-based virtual microscopy platform for improving academic performance in histology and pathology laboratory courses: A pilot study.	Taiwan	Medicine	A	K
Lorenzo-Alvarez et al.	2020	Game-based learning in virtual worlds: A multiuser online game for medical undergraduate radiology education within second life.	Spain	Medicine	A, B, D	L
Mogali et al.	2020	Summative and formative style anatomy practical examinations: Do they have impact on students' performance and drive for learning?	Singapore	Medicine	A, B, D	K

Rezende et al.	2020	Comparison of team-based learning versus traditional lectures in neuroanatomy: Medical student knowledge and satisfaction.	Brazil	Medicine	A, D	J
Felszeghy et al.	2019	Using online game-based platforms to improve student performance and engagement in histology teaching.	Finland	Medicine & Dentistry	A, B	L
Guimaraes et al.	2019	The role of anatomy computer-assisted learning on spatial abilities of medical students.	Portugal	Medicine	F	I
Hoffmann et al.	2019	Massage and Medicine: An interprofessional approach to learning musculoskeletal anatomy and enhancing personal wellness	USA	Medicine	A, B, D, E	L
Mogali et al.	2019	Scan and Learn: Quick response code enabled museum for mobile learning of anatomy and pathology	Singapore	Medicine	A, B	I
Pillay et al.	2019	Exploring opportunities for embedding graduate attributes in a first-year undergraduate anatomy course for allied health students	South Africa	Medicine	E, H	I
Nathaniel et al.	2018	Impact and educational outcomes of a small group self-directed teaching strategy in a clinical neuroscience curriculum	USA	Medicine	A, B	L

Oakes et al.	2018	Using the jigsaw method to teach abdominal anatomy	Australia	Medicine	A, B	L
Kranz et al.	2017	Implementation of clinical references for undergraduates in anatomy	Germany	Medicine	A	L
Hu et al.	2016	Motivation in computer-assisted instruction	USA	Medicine	A, B, H	L
Ma et al.	2016	Personalised augmented reality for anatomy education	Germany	Medicine	A, C	I
Manyama et al.	2016	Improving gross anatomy learning using reciprocal peer teaching	Tanzania	Medicine	A, C, D	I
McBride and Drake	2015	Student perceptions of an interprofessional educational experience: The importance of goal articulation	USA	Medicine	A	I
McCluskey et al.	2015	Developing an e-tutorial of heart anatomy with real-time 3D cadaveric prosections and cardiac imaging techniques	UK	Medicine	A	J
Ocak and Topal	2015	Blended learning in anatomy education: a study investigating medical students' perceptions	Turkey	Medicine	B, G	J
Park and Howell	2015	Implementation of a flipped classroom educational model in a predoctoral dental course	USA	Dentistry	A, D	I

Murphy et al.	2014	Medical student knowledge regarding radiology before and after a radiological anatomy module: Implications for vertical integration and self-directed learning	Ireland	Medicine	A, D	I
Pratten et al.	2014	Group in-course assessment promotes cooperative learning and increases performance	UK	Medicine	D	I
Anyanwu	2013	Anatomy adventure: A board game for enhancing understanding of anatomy	Nigeria	Medicine & Dentistry	A	L
Bacro et al.	2013	Lecture recording system in anatomy: Possible benefit to auditory learners	USA	Dentistry	A	L
Bergman et al. b	2013	Constructive, collaborative, contextual and self-directed learning in surface anatomy education	The Netherlands	Medicine	A, B	I
Inuwa et al.	2012	Implementing a modified team-based learning strategy in the first phase of an outcome-based curriculum - Challenges and prospects	Oman	Medicine	A, B	I
Jaffar	2012	YouTube: An emerging tool in anatomy education	United Arab Emirates	Medicine	A, B, E	I

The utilization of Universal Design for Learning in Third Level Healthcare Education

The scoping review identified that no published studies formally reported the utilization of UDL in the curricula of third level medical, dental, OT and SLT programs as none of the studies identified in the review mentioned the term UDL. However, 33 publications met the inclusion criteria as they presented enough evidence that the teaching methods described in the study aligned with the UDL principles.

The utilization of Universal Design for Learning in Third Level Anatomy Education

None of the studies based on anatomy education in healthcare programs mentioned the term UDL. Of the identified 33 studies, only eight assessed student motivation. The remaining 25 studies investigated factors including: student attendance, student performance, teaching strategies and the learning environment. Although none of the selected studies specifically mentioned the term UDL, they met the scoping review inclusion criteria as they implemented at least one UDL checkpoint (Table 2.1). The most frequent checkpoint from the “engagement” principle was “develop self-assessment and reflection”, appearing in 23 (69.7%) of the studies. “Support decoding of text, mathematical notation and symbols” was the only checkpoint that was not used, from the “representation” principle, in any of the 33 selected studies (Table 2.4). The checkpoints which fall under the engagement principle appeared most frequently: “foster collaboration and community” (54.5%), “optimise individual choice and autonomy” (42.4%), “optimise relevance, value and authenticity” (45.5%), “heighten salience of goals and objectives” (45.5%) and “increase mastery-oriented feedback” (45.5%) (Table 2.4). The most frequent occurring checkpoint from the “representation” principle was “maximise transfer and generalisation” (51.5%) and the most frequent checkpoint from the “action and expression” principle was “enhance capacity for monitoring progress” (51.5%) (Table 2.4).

Table 2.4 UDL checkpoint utilised in the selected anatomy-based studies

Universal Design for Learning Checkpoint (*n* =33)		**Count *n* (%)**
Multiple Means of Engagement	Optimise individual choice and autonomy	14 (42.4)
	Optimise relevance, value, and authenticity	15 (45.5)
	Minimise threats and distractions	4 (12.1)
	Heighten salience of goals and objectives	15 (45.5)
	Vary demands and resources to optimise challenge	12 (36.4)
	Foster collaboration and community	18 (54.5)
	Increase mastery-oriented feedback	15 (45.5)
	Promote expectations and beliefs that optimise motivation	11 (33.3)
	Facilitate personal coping skills and strategies	6 (18.2)
	Develop self-assessment and reflection	23 (69.7)
Multiple Means of Representation	Offer ways of customising the display of information	11 (33.3)
	Offer alternatives for auditory information	8 (24.2)
	Offer alternatives for visual information	3 (9.1)
	Clarify vocabulary and symbols	2 (6.1)
	Clarify syntax and structure	1 (3)
	Support decoding of text, mathematical notation, and symbols	0 (0)
	Promote understanding across languages	1 (3)
	Illustrate through multiple media	5 (15.2)
	Activate or supply background knowledge	7 (21.2)
	Highlight patterns, critical features, big ideas and relationships	10 (30.3)
	Guide information processing and visualisation	15 (45.5)
	Maximise transfer and generalisation	17 (51.5)
Multiple Means of Action and Expression	Vary the methods for response and navigation	13 (39.4)
	Optimise access to tools and assistive technologies	5 (15.2)
	Use multiple media for communication	4 (12.1)
	Use multiple tools for construction and composition	3 (9.1)
	Build Fluencies with graduated levels of support for practice and performance	3 (9.1)
	Guide appropriate goal setting	2 (6.1)
	Support planning and strategy development	5 (15.2)
	Facilitate managing information and resources	13 (39.4)
	Enhance capacity for monitoring progress	17 (51.5)

Universal Design for Learning to Enhance Motivation to Study Anatomy

The review also sought to identify whether UDL enhanced motivation of undergraduate healthcare students in learning anatomy, specifically students enrolled in medical, dental, OT and SLT programs. Although the 33 anatomy-based studies implemented strategies which are categorized under the UDL framework, only eight investigated the effect of UDL on student motivation to study anatomy (Anyanwu, 2014; Hu *et al.*, 2016; Felszeghy *et al.*, 2019; Mogali *et al.*, 2019, 2020; Gnanasegaram, Leung and Beyea, 2020; Rezende *et al.*, 2020; Rao Bhagavathula *et al.*, 2022). Seven of the selected articles reported an increase in self-reported motivation and engagement among medical, dental and OT students. However, only two of the studies used a validated instrument to measure student motivation. These were the Intrinsic Motivation Inventory (IMI) (Rao Bhagavathula *et al.*, 2022) and the Instructional Materials Motivation Survey (IMMS) (Hu *et al.*, 2016).

Results of Thematic Analysis

The thematic analysis yielded four main themes relating to teaching strategies which aligned with UDL: technology – enhanced teaching, contextualization, the learning environment, and active learning. Various technological tools, for example, e-learning programs, radiological images, video recordings, simulations and quick response (QR) codes, have been used to enhance the teaching of anatomy (Jaffar, 2012; Bacro, Gebregziabher and Ariail, 2013; McCluskey *et al.*, 2015; Guimarães *et al.*, 2019; Mogali *et al.*, 2019; Golenhofen *et al.*, 2020; Lee *et al.*, 2020; Ben Awadh *et al.*, 2022; Yohannan *et al.*, 2022). Specifically, technology-enhanced teaching was utilized in 17 (52%) of the selected anatomy-based studies. This teaching method aligns with numerous UDL checkpoints, like “vary demands and resources to optimise challenge” from the "engagement” principle, “offer ways of customising the display of information” from the “representation” principle and “vary the methods for response and navigation” from the “action and expression” principle. Contextualization of anatomy is essential to sustain student engagement (Nicholson, Reed and Chan, 2016). In this regard, eight of the selected studies highlighted the relevance of anatomy to medical students’ future careers (Murphy *et al.*, 2014). This strategy of contextualization aligns with the UDL checkpoints “optimise relevance, value, and authenticity”, “heighten salience of goals and objectives” and “promote expectations and beliefs that optimise motivation”. Although only one study created a specific learning environment for undergraduate medical students to practice, assess and consolidate their anatomy knowledge (Ocak and Topal, 2015), the inclusion of certain teaching methods, namely providing numerous learning materials for students at a time which was most convenient for them, helped to nurture a safe and inclusive learning environment. This teaching method utilized by Ocak and Topal (2015), aligned with several UDL checkpoints: “minimise threats and distractions”, “vary demands and resources to optimise challenge”, “develop self-assessment and reflection” from the “engagement” principle, “optimise access to tools and assistive technologies” and “facilitate managing information and resources” from the “action and expression” principle. Furthermore, this specific learning environment ensured that all students had access to a safe and nurturing environment to study anatomy. Additionally, the gamification of anatomy learning material helped to create a relaxed learning environment for students (Anyanwu, 2014; Ma *et al.*, 2016; Felszeghy *et al.*, 2019).

The authors identified numerous examples of active learning from the selected anatomy-based studies. Specifically, 19 (58%) of the studies investigated the use of collaborative learning which aligned with the UDL checkpoint "foster collaboration and community". Collaborative learning was introduced via a variety of methods including small group learning, a flipped classroom or peer assessment (Inuwa *et al.*, 2012; Esther M. Bergman *et al.*, 2013; Pratten, Merrick and Burr, 2014; McBride and Drake, 2015; Park and Howell, 2015; Manyama *et al.*, 2016; Hoffmann, Dancing and Rosenbaum, 2019; Oakes *et al.*, 2019; Abdullah, Lone and Balta, 2020; Mogali *et al.*, 2020).

Analysis of the reported outcomes from the selected studies highlights the positive effect of teaching strategies which align with the UDL framework on promoting student learning. The selected studies revealed that providing students with multiple methods for engagement with the learning material, representing the material in multiple formats or allowing students to express their knowledge in multiple ways has, in turn, heightened student motivation, participation and performance. Specifically, 14 (42%) of the selected anatomy-based studies utilizing elements of UDL reported improved performance and understanding among the students. Seven (21%) studies reported an increase in motivation, and five (15%) reported an increase in confidence as a result of utilizing one or more UDL checkpoints. However, due to the lack of formal utilization and acknowledgement of UDL in the studies, such results cannot be attributed to UDL with absolute certainty. Thematic analysis is summarized (Table 2.5).

Table 2.5 Themes and subthemes of strategies aligning with UDL

Theme	Subtheme	Studies in which themes appear[4]
Technology-Enhanced Teaching	E-learning	C, D, F, G, H, I, J, L, N, P, Q, R, U, V, X, Z, AA, AB
	Mobile applications	F, G, H, I, N, R, V
	Quick Response (QR) codes	V
	Radiological images	O, Q, X, AD
	Recordings	C, K, L, N, AA, AC, AG
	Simulations	D, G, H, J, L, Q, R, U
Contextualization	Career relevance	D, E, L, O, Q, S, T, Y
	Clinical relevance	B, D, E, G, I, J, K, M, N, Q, U, Y, AD, AE, AF
Learning Environment	Gamification	B, G, R, Q, V
	Reflection	B, C, F, G, K, M, W, Y, AC, AD, AF
	Specific space	AA
Active Learning	Flipped classroom	A, F, K, T, Z, AB
	Peer-assessment	E, M, S, T, Z, AB, AD
	Team based activities	A, B, D, E, F, G, K, M, S, V, W, X, Y, Z, AA, AB, AC, AD, AF

[4] A, (Abdullah, Lone and Balta, 2020); B, (Anyanwu, 2014); C, (Bacro, Gebregziabher and Ariail, 2013); D, (Ben Awadh *et al.*, 2022); E, (Esther M. Bergman *et al.*, 2013); F, (Dua *et al.*, 2021); G, (Felszeghy *et al.*, 2019); H, (Gnanasegaram, Leung and Beyea, 2020); I, (Golenhofen *et al.*, 2020); J, (Guimarães *et al.*, 2019); K, (Hoffmann, Dancing and Rosenbaum, 2019); L, (Hu *et al.*, 2016); M, (Inuwa *et al.*, 2012); N, (Jaffar, 2012); O, (Kranz *et al.*, 2017); P, (Lee *et al.*, 2020); Q, (Lorenzo-Alvarez *et al.*, 2020); R, (Ma *et al.*, 2016); S, (Manyama *et al.*, 2016); T, (McBride and Drake, 2015); U, (McCluskey *et al.*, 2015); V, (Mogali *et al.*, 2019); W, (Mogali *et al.*, 2020); X, (Murphy *et al.*, 2014); Y, (Nathaniel *et al.*, 2018); Z, (Oakes *et al.*, 2019); AA, (Ocak and Topal, 2015); AB, (Park and Howell, 2015); AC, (Pillay, Ally and Govender, 2019); AD, (Pratten, Merrick and Burr, 2014); AE, (Rao Bhagavathula *et al.*, 2022); AF, (Rezende *et al.*, 2020); AG, (Yohannan *et al.*, 2022).

Discussion

This scoping review revealed that the term UDL has not been utilized in third level healthcare education generally, nor specifically in the anatomy curricula of medical, dental, SLT and OT programs. Furthermore, the review revealed that UDL has not been specifically used to enhance motivation of undergraduate third level healthcare students to learn anatomy. Although the term UDL was not mentioned in the selected studies, the teaching methods described in the studies align with the UDL framework. However, it should be noted that each of the selected studies aligned with no more than half of the UDL checkpoints and in turn the benefits identified in the reported outcomes cannot be attributed entirely to the incorporation of UDL strategies. Nevertheless, the review has identified a gap in the literature in regard to the utilization of the UDL educational framework in the anatomy curricula of third level healthcare students.

Universal Design for Learning in Third Level Healthcare Education

Universal Design for Learning has much to offer teaching and learning in programs from many fields like information technology (Al-Azawei, Parslow and Lundqvist, 2017), microbiology (Kumar and Wideman, 2014) and geology (Feig *et al.*, 2019). However, the advantage of UDL as a tool for teaching and learning in healthcare programs remains largely unexplored. Furthermore, none of the selected studies mentioned UDL, which suggests that the full potential of UDL has not been realized in the selected studies. It points to the likelihood that the authors of these studies were unaware of the framework and its potential benefits to student learning.

Universal Design for Learning in Third Level Anatomy Education

The studies identified in this review demonstrate that the teaching methods utilized, which aligned with the UDL framework, benefit the learning experience of medical, dental and OT students. These range from improved performance (Pratten, Merrick and Burr, 2014; Manyama *et al.*, 2016; Guimarães *et al.*, 2019; Oakes *et al.*, 2019; Lee *et al.*, 2020; Mogali *et al.*, 2020; Rao Bhagavathula *et al.*, 2022) and understanding (Jaffar, 2012; Esther M. Bergman *et al.*, 2013; Murphy *et al.*, 2014; Nathaniel *et al.*, 2018; Hoffmann, Dancing and Rosenbaum, 2019) to enhanced participation (Inuwa *et al.*, 2012; Pratten, Merrick and Burr, 2014; Park and Howell, 2015) and confidence (Anyanwu, 2014; Manyama *et al.*, 2016). The improvements and enhancements in teaching and learning reported in the selected studies can be attributed to the incorporation of technology, gamification, team-based activities, peer-assisted learning, an emphasis on the relevance of anatomy or the creation of a tailored anatomy learning environment. Moro et al. (2021), concluded from a review of the relevant literature that virtual and augmented reality are viable alternatives to traditional methods of teaching anatomy as they provide students with the opportunity to learn their anatomy material through various means, and thus concurs with the findings from this scoping review.

One of the aims of UDL is to promote accessibility and inclusivity among the student population. It cannot be stated for certain whether this was achieved in the selected studies as it was not investigated by the authors. It could be postulated though that the improved academic performance and understanding identified could be due to the learning material being more accessible to a larger variety of students. However, further research is required to confirm this. The scoping review also identified a paucity of studies that utilized the UDL framework in anatomy in allied health programs, specifically in OT and SLT programs as the majority of studies involved medical students only. This is surprising given the concerns among allied health professionals about the anatomy curricula of allied health programs which, in their opinion, requires attention and investigation during the preclinical years (Nayar, Gray and Blijlevens, 2013; Singh *et al.*, 2015; Wittich *et al.*, 2017).

Evidently, there is scant research on how students enrolled in allied health programs are taught anatomy. For example, clinical therapy programs are considered new and young (Paden, 1970; Quiroga, 1995; Donnelly *et al.*, 2013) when compared to the long-established professional medical and dental programs (Vieira and Caramelli, 2009; Schwartz, 2014). Therefore, allied health professions may not yet have the same established culture of research into curriculum development generally and of relevance here, anatomy education. This reiterates the need to research teaching methods which enhance, consolidate, and sustain students' motivation to learn anatomy in allied health professional programs. Unlike medical graduates, graduates of OT and SLT programs are not required to pursue further qualification once they have completed their undergraduate degree. Typically, students are taught the theoretical aspects of anatomy during their first year of study and must utilize this knowledge throughout their professional careers (Latman and Lanier, 2001; Janssen *et al.*, 2014). It is imperative therefore that OT and SLT students gain the most from their first-year anatomy education. However, during their first year of study, usually before any clinical placements, students do not often grasp the relevance of anatomy (Smith, Martinez-Álvarez and McHanwell, 2014), and therefore struggle to motivate themselves to participate and understand (Latman and Lanier, 2001; Smith, Martinez-Álvarez and McHanwell, 2014; Barros, Silva and Liquidato, 2017). Additionally, first year students are typically adolescents and are in the midst of their transition to third level education (Sawyer *et al.*, 2018).

Universal Design for Learning and Motivation among Undergraduate Anatomy Students

Eight of the selected studies assessed motivation among healthcare students, and five were carried out on undergraduate students, as opposed to graduate entry students. This is of importance as McKeown and Anderson (2016) highlighted how graduate entry and undergraduate students are motivated differently. They found that graduate entry business students were more motivated to study and participate when compared to an undergraduate cohort enrolled in a similar module (McKeown and Anderson, 2016). Furthermore, Wickramasinghe and Samarasekera, (2011) reported that undergraduate medical students preferred a passive approach in comparison to graduate entry students. They concluded that this may be because graduate entry programs are typically more self-directed compared to undergraduate programs in which curricula are primarily based on lectures and tutorials (Wickramasinghe and Samarasekera, 2011). Self-directed learning has been shown to promote academic motivation (Ryan and Deci, 2000). Dynan et al. (2008) proposed that not all undergraduate students are prepared for self-directed learning when compared to graduate entry students, emphasizing the need to robustly investigate whether the UDL framework would enhance motivation among undergraduate healthcare students studying anatomy in the same way it has enhanced learning for undergraduate students from other programs (Al-Azawei, Parslow and Lundqvist, 2017; Dean, Lee-Post and Hapke, 2017; Nelson and Brennan, 2019).

Overall, this scoping review provides the rationale for further investigation into the utilization of UDL within the anatomy curricula of third level healthcare students. The results highlight the benefits of incorporating multiple means of engagement, multiple means of representation and multiple means of action and expression within the anatomy curriculum in order to promote participation, motivation, academic success and knowledge retention among healthcare students.

Limitations of the study

This review aimed to identify the utilization of UDL in the anatomy curriculum of healthcare programs. However, CAST developed the term UDL in the 1990s, therefore the review period was from January 1990 to August 2021 and literature prior to this were not included. Additionally, the review only included studies conducted with students enrolled in medical, dental, OT or SLT programs. Determining whether a study met the inclusion criteria was reliant on the authors' opinion, specifically in relation to its utilization of the UDL framework.

Conclusion

In this scoping review, the extent and nature of the use of the UDL framework in the anatomy curricula of healthcare programs was examined. Analysis indicated that although elements of UDL have been utilized in third level anatomy education, educators may not be aware of the framework as they did not explicitly use of the language of UDL. This suggests that if educators were more aware of the breadth and depth of the UDL framework, its full potential could be leveraged to enhance student learning. The results identified a lack of research concerning the anatomy education of OT and SLT students. Thus, whether or not the anatomy curriculum of these programs requires adjustments is yet to be determined. The role of UDL in enhancing motivation of third level healthcare students to learn anatomy in medical, dental, OT and SLT programs has also yet to be explored. Analysis of the selected studies from this scoping review suggest that providing students with multiple means of engagement is of crucial importance in healthcare education. This is in line with the UDL framework which was designed with the intention of moulding and guiding students to become motivated and resourceful learners (CAST, 2021a). The authors propose that the UDL framework is a pertinent framework to enhance student motivation to study anatomy through its utilization in healthcare programs.

Chapter Three

Examining Motivation of First-Year Undergraduate Healthcare students through the lens of Universal Design for Learning (UDL): a single institution study

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Abstract:

Motivation is critical for meaningful learning among healthcare students studying anatomy. Learners are highly variable, and it is important to ensure learners are equally supported in the diverse aspects of an anatomy curriculum. Implementation of the educational framework, Universal Design for Learning (UDL) in anatomy curricula could potentially enhance student motivation. The multiple means of engagement principle of UDL refers to the enhancement of motivation among students. This study aimed to identify healthcare students' motivation levels at the start and end of their anatomy module, and whether there was any change in motivation. The Motivated Strategies for Learning Questionnaire (MSLQ) was distributed to gather the self-reported motivation levels of first-year undergraduate medical, dental, occupational therapy (OT) and speech and language therapy (SLT) students studying anatomy at the start of their respective anatomy modules and again at the end of the module. The overall response rate was 74% and 69%, at the start and end of the study, respectively. Responses were analysed by the respective programme of study. Motivation to study anatomy among medical, dental, OT and SLT students ranged from medium to high on the MSLQ at the start of their respective anatomy modules. By the end of the anatomy modules, dental students reported high levels of motivation to study anatomy whereas motivation among medical, OT and SLT students ranged from medium to high. A change in the students' self-reported motivation levels while studying anatomy was identified. The study emphasises the benefits of UDL and its flexible nature to enhance motivation.

Keywords: Anatomy education; engagement; healthcare education; motivation; universal design for learning

Introduction

Motivation is an essential part of students' academic performance and meaningful learning (Abdel Meguid and Khalil, 2017). It is also an integral element of their career development (Owolabi, Tijani and Shallie, 2013). There are two types of motivation, intrinsic and extrinsic, and both are known to affect student learning (Ryan and Deci, 2020). Intrinsic motivation is characterised as a fundamental satisfaction of completing a task and carrying out the activity for enjoyment and gratification (Drysdale and McBeath, 2018), while extrinsic motivation is concerned with external values and accolades, for example the achievement of high grades (Delaney and Royal, 2017). In anatomy education, the absence of either intrinsic or extrinsic motivation has been linked with poor academic performances (Khalil, Williams and Gregory Hawkins, 2018; Mogali *et al.*, 2020). The pivotal role of intrinsic motivation in the education and training of healthcare students towards becoming skilled and effective healthcare professionals, through the creation of a positive learning experience, is becoming increasingly recognised (Kusurkar, 2019; Tumlinson *et al.*, 2019; Chaudhuri, 2020; Kotera *et al.*, 2021).

Anatomy education has been described as critical for good clinical practice among medical, dental and allied health professionals (Davis *et al.*, 2014). However, the study of anatomy requires the understanding and retention of large volumes of information (Zilundu, Chibhabha, Chengetanai, *et al.*, 2022). In recent years, there has been a reduction in the amount of time dedicated to teaching anatomy in many healthcare programmes (Rockarts *et al.*, 2020; Smith *et al.*, 2021; Zibis *et al.*, 2021), resulting in a focus on students to engage in self-directed learning (Henssen *et al.*, 2020; Diaz and Woolley, 2021). Studies have identified an improvement in academic performance among anatomy students as a result of incorporating self-directed learning strategies into curriculum design and delivery (Bork *et al.*, 2019; Tanner *et al.*, 2020). However, motivation plays a crucial role in successful self-directed learning (Golenhofen *et al.*, 2020). Thus, understanding student motivation to study anatomy is important for student success.

Many healthcare students struggle with the study of anatomy (Robertson, Thompson and Notebaert, 2020; Joseph *et al.*, 2021). Some students find it difficult to remain motivated to study, while others grapple with the relevance of anatomy to their chosen careers (Eleazer and Scopa Kelso, 2018), and many do not perceive the value of anatomy until they engage in clinical placement (Rafai *et al.*, 2016; Grosser *et al.*, 2019; Robertson, Thompson and Notebaert, 2020), typically later in their programme. After exposure to the workplace, many healthcare students develop a newfound appreciation of anatomy (O'Leary and Cantillon, 2020) but anatomy lectures and practicals are often finished at this stage, and the opportunities to engage with the resources available are missed. Therefore, there is a need to motivate students from the very start of their third level education and highlight the relevance and value of having a robust knowledge of anatomy. In turn, students require encouragement and guidance on how to become lifelong confident learners who are capable of optimising their learning and becoming efficient learners and healthcare practitioners (Mamede *et al.*, 2019; Hansen *et al.*, 2021). All learners have different strengths, and it is important to ensure that they are equally supported and included in the diverse aspects of an anatomy curriculum (Drysdale and McBeath, 2018).

Implementation of Universal Design for Learning

Implementation of the educational framework Universal Design for Learning (UDL) in anatomy curricula could potentially enhance student motivation and engagement among healthcare students studying anatomy. UDL is a framework which guides educators with curriculum design to ensure all learners are accounted for in the one environment (CAST, 2021a). This may be accomplished by merging flexible methods of assessment and teaching for students attending the same tutorial room, lecture hall or laboratory (Meyer, Rose and Gordon, 2014). The three guiding principles of the UDL framework are multiple means of engagement, multiple means of representation and multiple means of action and expression, which are broken down into 31 checkpoints (CAST, 2021a). The framework is already in use in a variety of disciplines including marketing, family and consumer sciences and ecology, and in numerous countries such as the United States, South Africa and Canada (Dean, Lee-Post and Hapke, 2017; Trivedi, 2019; Super *et al.*, 2021). However, the formal utilisation of UDL in anatomy curricula has yet to be published (Dempsey *et al.*, 2022). Moreover, the use of UDL in anatomy education specifically to enhance motivation has not been identified, discussed nor researched.

The multiple means of engagement principle of the UDL framework refers to the encouragement and enhancement of motivation among students while cultivating enthusiasm for learning (Hashey, Miller and Foxworth, 2020). There are numerous theories of motivation including attribution theory (Weiner, 1985), social-cognitive theory (Bandura, 2001), and self-determination theory (Ryan and Deci, 2000). These motivational theories are the foundation of student motivation questionnaires such as the Motivated Strategies for Learning Questionnaire (MSLQ) (Pintrich *et al.*, 1991) to assess the self-reported academic motivation of students, including students in higher education (Roth, Ogrin and Schmitz, 2016).

The aim of this study was to investigate self-reported motivation among first year undergraduate healthcare students, in a single institution, to study anatomy, and whether there was a change in motivation among the students from the start of their respective anatomy modules to the end of the modules. The study used the MSLQ to address a number of research questions:

1. How motivated are first-year undergraduate medical, dental, OT and SLT students to study anatomy at the start of their third level education?
2. How motivated are first-year undergraduate medical, dental, OT and SLT to study anatomy at the end of their anatomy module?
3. Is there a change in motivation from the start of the anatomy module to the end among specific healthcare programmes?

Methods and Materials

Educational context and participants

This study was carried out in University College Cork (UCC), Ireland with first year undergraduate students enrolled in either BSc Occupational Therapy, BSc Speech and Language Therapy, MB, BCh, BAO Medicine or BDS Dentistry. Each of these undergraduate healthcare programmes has a compulsory gross anatomy module as a part of the first-year curriculum. The specific content and detail of the respective gross anatomy modules varies between programmes. Each module has a practical element which takes place in the Facility for Learning Anatomy, Morphology and Embryology (FLAME) laboratory where student learning is supported by the inclusion of a number of different methods and materials, including prosections, anatomical models, computer programmes and demonstrations, to consolidate their learning. Students enrolled in each of the healthcare programmes attend both lectures and anatomy practical sessions. The range falls between 22 and 36 hours of lectures and six and sixteen two-hour practicals with an average of 25 hours of lectures and ten two-hour practicals per anatomy module. The anatomy modules are supported by the host university's Learning Management System (LMS), which provides students' access to the learning material for their respective lectures and practical sessions.

Research Instrument

The MSLQ (Pintrich *et al.*, 1991) was used to assess self-reported academic motivation of students. This previously validated and widely used questionnaire was created to measure a number of motivational and self-regulated learning constructs and thus is divided into a motivation section and a learning strategies section. There are 31 items in the academic motivation section of the MSLQ which are grouped into six motivation subscales. The six motivation subscales of the MSLQ (with their MSLQ Scoring Manual Reference Cronbach's α listed) are: "Intrinsic Goal Orientation" (n = 4; α = 0.74); "Extrinsic Goal Orientation" (n = 4; α = 0.62); "Task Value" (n = 6; α = 0.90); "Control of Learning Beliefs" (n = 4; α = 0.68); "Self-efficacy for Learning and Performance" (n= 8; α = 0.93) and "Test Anxiety" (n = 5; α = 0.80). The questionnaire is scored on a 7-point Likert scale ranging from 1 is "not at all true of me" to 7 is "very true of me". Demographic data including the participant's gender, age and programme of study were collected.

Data Collection

An information sheet about the study was distributed among potential participants, followed by a consent form. A physical copy of the MSLQ was distributed by the first author (A.M.K.D) to first-year undergraduate healthcare students studying anatomy during the first week of semester one of the academic year 2019/2020 during an anatomy practical. The same questionnaire was distributed to the same cohorts during their final anatomy practical session at the end of their respective anatomy modules. Informed consent was obtained. Participation by students was entirely voluntary and remained anonymous throughout the process. Ethical approval was obtained from the institutional Social Research Ethics Committee [Log 2019-127]. Students under the age of 18 years were excluded as parental consent is required. Only aggregate level data are presented as ethical approval did not allow for identifying and matching students' responses at the start and end of the anatomy module.

Statistical analysis

Data from the MSLQ were analysed using Statistical Package for Social Scientists (SPSS), version 28 (IBM Corp., Armonk, NY). Frequencies and percentages were used to summarise the data. Parametric analyses were used to ensure that this study was comparable to similar studies utilising the MSLQ (Chitkara *et al.*, 2016; Abdel Meguid, Smith and Meyer, 2020). Data were analysed using Independent t-tests to assess changes in the mean responses of the motivation subscales from the start to the end of the anatomy module. Data are reported as mean ± Standard Deviation (SD). Differences with a p value less than 0.05 were considered statistically significant. * denotes statistically significant differences at 0.05. ** denotes statistically significant differences at 0.01. Reliability analysis of each motivation subscale was conducted for the present study and reported as Cronbach's alpha (α).

Results

Demographic Characteristics

The questionnaire was distributed to 221 potential participants both at the start and the end of the study. The overall response rate at the start of the study (and respective anatomy modules) was 74%, and 69% at the end of the study. The majority of the participants in this study were female (77%) and aged 18 and 19 years (77% and 74% at the start and at the end of the study, respectively). About 20% of participants at the start of the study and at the end were over the age of 20 years. This corresponds to the typical allotment of places for mature students in undergraduate programmes. Demographic information from the participating students at the start of the study and again at the end of the study is summarised in Table 3.1.

Table 3.1 Distribution of participants at the start and end of the study.

	Start	**End**
Number of Participants	164 (74%)	153 (69%)
Gender		
Male	37 (23%)	48 (31%)
Female	127 (77%)	105 (69%)
Healthcare Programme		
Medicine	80 (49%)	97 (63%)
Dentistry	26 (16%)	17 (11%)
Occupational Therapy	30 (18%)	18 (12%)
Speech and Language Therapy	28 (17%)	21 (14%)
Age (years)		
18 – 19	126 (77%)	113 (74%)
≥20	38 (23%)	40 (26%)

Reliability analysis

The reliability and internal consistency for each of the subscales for this study is reported alongside the recommended Cronbach's α value from the MSLQ Scoring Manual (Pintrich *et al.*, 1991) (Table 3.2).

Table 3.2 Reliability analysis of each motivation subscale at the start and end of the anatomy module reported as Cronbach's α

Motivation Subscale	Cronbach's α **Start**	Cronbach's α **End**	Cronbach's α (Pintrich *et al.*, 1991)
Intrinsic Goal Orientation	0.7	0.74	0.74
Extrinsic Goal Orientation	0.55	0.63	0.62
Task Value	0.86	0.86	0.90
Control of learning beliefs	0.62	0.7	0.68
Self-efficacy for learning and performance	0.92	0.91	0.93
Test anxiety	0.73	0.73	0.8

The responses from the participants were analysed by the programme of their study to obtain a measure of motivation among each cohort during the first week of enrolment on the anatomy module and again during the final week of enrolment. The breakdown of the self-reported mean scores from the motivation subscales of the MSLQ at the start and end of the module from each cohort is reported in Table 3.3. Using the method of Cho et al. (2017), the subscale scores were categorised as low (1 to <2.5), medium (>2.5 to <5) and high scores (>5 to 7) on the Likert scale.

Motivation at the start of the anatomy module

Dental students' motivation at the start of their anatomy module ranged from medium to high. The lowest reported mean value on the Likert Scale was 4.67. This was for the subscale, “Test Anxiety”. The highest value was 6.17 for the motivational subscale “Task Value”. Medical students’ motivation at the start of their anatomy module ranged from medium to high. The lowest reported mean value on the Likert Scale was 4.03. This was for the subscale, “Test Anxiety”. The highest value was 6.28 and was for the motivational subscale “Task Value”. The motivation to study anatomy among OT students at the start of their anatomy module also ranged from medium to high. The lowest reported mean value on the Likert Scale was 4.08 for the subscale, “Self-efficacy for Learning and Performance”. The highest value was 5.68 and was for the motivational subscale “Task Value”. Similarly, self-reported motivation among SLT students at the start of their anatomy module ranged from medium to high. The lowest reported mean value on the Likert Scale was 4.38 for the subscale, “Self-efficacy for Learning and Performance”. The highest value was 5.55 and was for the motivational subscale “Control of Learning Beliefs”.

Motivation at the end of the anatomy module

Dental students self-report motivation was high across all six subscales at the end of their anatomy module. The lowest value was 5.05 for “Intrinsic Goal Orientation”. The “Task Value” subscale remained the highest value on the Likert Scale with a score of 6.13. Medical students self-reported motivation was between medium and high at the end of their anatomy module. The lowest value was 4.57 for “Test Anxiety”. The “Task Value” subscale remained the highest value on the Likert Scale with a score of 5.91. The mean value of OT students self-report motivation remained between medium and high at the end of their anatomy module. The lowest value was 4.15 for “Self-efficacy for Learning and Performance”. The “Task Value” subscale remained the highest mean value on the Likert Scale with a score of 5.67. The mean value of SLT students' motivation also remained between medium and high at the end of their anatomy module. The lowest value was 4.50 for "Intrinsic Goal Orientation". The "Control of Learning Beliefs" subscale remained the highest mean value on the Likert Scale with a score of 5.94.

Change in motivation over the course of the anatomy module

There were no significant differences in mean motivation scores obtained from the dental or OT students between the start and the end of their respective anatomy modules. There was a significant decrease in "Intrinsic Goal Orientation" (p=0.001) and "Task Value" (p=0.002) in the cohort of first year medical students between the start and end of their anatomy module. "Test Anxiety" in these medical students between the start and end of the module was significantly increased (p=0.003). The only MSLQ subscale where mean motivation scores were significantly different between the start and the end of the study in SLT students was "Control of Learning Beliefs". The SLT students reported a significant increase (p=0.038) in "Control of Learning Beliefs" at the end of the anatomy module compared to the start (Table 3.3).

Table 3.3 MSLQ mean motivation subscale scores of dental, medical OT and SLT students at the start and end of studying an anatomy module.

Dentistry				
	Start	**End**	p value	Change in Motivation
Motivation Subscale	(n = 26) Score (±SD)	(n = 17) Score (±SD)		
Intrinsic Goal Orientation	5.36 (±0.79)	5.05 (±0.97)	0.278	-
Extrinsic Goal Orientation	5.5 (±0.88)	5.53 (±0.96)	0.919	-
Task Value	6.17 (±0.72)	6.13 (±0.78)	0.869	-
Control of learning beliefs	6.08 (±0.54)	6.12 (±0.52)	0.807	-
Self-efficacy for learning and performance	5.13 (±0.77)	5.52 (±0.88)	0.143	-
Test anxiety	4.67 (±1.1)	5.06 (±1.1)	0.263	-
Medicine				
	Start	**End**	p value	Change in Motivation
Motivation Subscale	(n = 80) Score (±SD)	(n = 97) Score (±SD)		
Intrinsic Goal Orientation	**5.38 (±0.83)**	**4.92 (±1.07)**	**0.001****	↓
Extrinsic Goal Orientation	5.36 (±0.94)	5.17 (±1.06)	0.206	-
Task Value	**6.28 (±0.71)**	**5.91 (±0.86)**	**0.002****	↓
Control of learning beliefs	5.71 (±0.89)	5.75 (±0.9)	0.779	-
Self-efficacy for learning and performance	5.08 (±1.0)	4.99 (±1.0)	0.549	-
Test anxiety	**4.03 (±1.19)**	**4.57 (±1.22)**	**0.003****	↑
Occupational Therapy (OT)				
	Start	**End**	p value	Change in Motivation
Motivation Subscale	(n = 30) Score (±SD)	(n = 18) Score (±SD)		
Intrinsic Goal Orientation	4.36 (±1.11)	4.44 (±0.91)	0.771	-
Extrinsic Goal Orientation	5.07 (±1.03)	5.36 (±0.85)	0.289	-
Task Value	5.68 (±0.96)	5.67 (±0.88)	0.971	-
Control of learning beliefs	5.49 (±0.91)	5.32 (±1.22)	0.608	-
Self-efficacy for learning and performance	4.08 (±0.96)	4.15 (±1.04)	0.824	-
Test anxiety	5.01 (±1.31)	5.01 (±1.33)	0.991	-
Speech and Language Therapy (SLT)				
	Start	**End**	p value	Change in Motivation
Motivation Subscale	(n = 28) Score (±SD)	(n = 21) Score (±SD)		
Intrinsic Goal Orientation	4.49 (±0.77)	4.5 (±0.97)	0.972	-
Extrinsic Goal Orientation	5.23 (±0.89)	5.54 (±0.79)	0.214	-
Task Value	5.51 (±0.75)	5.33 (±0.86)	0.433	-
Control of learning beliefs	**5.55 (±0.77)**	**5.94 (±0.52)**	**0.038***	↑
Self-efficacy for learning and performance	4.38 (±0.81)	4.53 (±0.82)	0.528	-
Test anxiety	4.93 (±0.92)	5.26 (±0.7)	0.160	-

Motivation subscales scores ranged from 1 = “not at all true of me” and 7 = “very true of me* p<0.05; **p<0.001

Discussion

The task of stimulating students' motivation to learn is a fundamental challenge in education (Duan *et al.*, 2020). Understanding how healthcare students are motivated to study anatomy can potentially influence curriculum design to advance self-directed learning and academic performance (Zilundu, Chibhabha, Yu, *et al.*, 2022). The healthcare students in this study were first year undergraduates, who were predominately aged 18 and 19 years old. These students were in the process of transitioning from secondary to tertiary education. Research has shown that students beginning their journey through third level education require guidance and support to become motivated to study while simultaneously navigating their new routines and environments (Edgar *et al.*, 2019; Corpus, Robinson and Wormington, 2020).

This study identified that motivation levels among first year undergraduate healthcare students ranged from medium to high, as defined by Cho et al. (2017), on the MSLQ Likert scale at the start of their respective anatomy modules. At the end of the anatomy module, only dental students reported high motivation levels to study anatomy whereas at the same time point, motivation levels to study anatomy among medical, OT and SLT students ranged from medium to high on the Likert scale. This could perhaps be due to the anatomy module for dental students spanning two semesters, while the anatomy modules for the other cohorts all occurred in semester one. To elaborate further, medical students are taught anatomy in both semester one and semester two. However, these are separate modules which occur in each semester (medical students take four integrated modules in total, two in each semester). In this study, the questionnaire was distributed among the medical students at the start and the end of their first anatomy module, thus during semester one only. The dental students take one anatomy module during first year, which is not semesterised and thus the questionnaire was distributed among the dental students at the start and end of their anatomy module which spanned two semesters.

There is little research regarding the impact of semesterisation on academic performance or motivation (Turner, Webb and Cotton, 2021). Detailed analysis of the results identified a change in motivation between the start and end of studying an anatomy module among each of the four cohorts. Changes in self-reported motivation may be a cause for revaluation of the design and delivery of anatomy curricula and more specifically, a focus on how students are, or could be, motivated and engaged in the process of learning.

Intrinsic and extrinsic motivation have been reported to play a role in student learning (Duan *et al.*, 2020). In this study "Extrinsic Goal Orientation" was high on the Likert scale across all four cohorts at the start of their anatomy module and remained high at the end of the module. Similarly, Zilundu, Chibhabha, Yu, et al. (2022) reported high "Extrinsic Goal Orientation" scores among medical students studying anatomy, at the end of their module. In the current study, there was no significant change in either intrinsic or extrinsic motivation for dental, OT or SLT students. "Intrinsic Goal Orientation" ranged from medium to high, on the MSLQ Likert scale, across all four cohorts at the start of the anatomy module. However, at the end of the anatomy module only dental students reported high "Intrinsic Goal Orientation".

Although the mean score for this motivational subscale remained high among dental students, their motivational levels did decrease over the course of the module. The motivational levels for medical, OT and SLT students were medium on the Likert scale at the end of the anatomy module. These results are similar to those reported by Abdel Meguid et al. (2020) who distributed the MSLQ to first year chiropractic and dental students, studying anatomy, at the end of their module. The current study reported a decrease in “Intrinsic Goal Orientation” among medical students, which suggests that they may have lost interest in anatomy as the module progressed. This becomes worrisome when the integral role of anatomy in their chosen careers is considered (Zhang *et al.*, 2020). The relevance of anatomy may need to be repeatedly emphasised to students enrolled in all four healthcare programmes during their learning to help sustain interest, although there was a marginal increase in “Intrinsic Goal Orientation” among OT and SLT students. McNamara and Nolan (2022) reported that incorporating specific applied anatomy activities to the curriculum to emphasise anatomy as clinically important, made learning more interesting and engaging for medical students. This is in line with the checkpoint 7.2 “Optimise relevance, value, and authenticity” of the UDL pedagogical framework (CAST, 2021a).

Task value refers to an individual’s opinion of the importance of an activity (Vanslambrouck *et al.*, 2018). The mean score for the “Task Value” subscale was reported as high across all four cohorts both at the start of the anatomy module and also at the end. These results are on par with those reported by first year students enrolled in a medical programme in 2017 and 2019 (Zilundu, Chibhabha, Yu, *et al.*, 2022). However, the results for “Task Value” in the current study are higher than the scores reported by first year chiropractic and dental students in a previous study

(Abdel Meguid, Smith and Meyer, 2020). A recent study carried out by Zilundu, Chibhabha, Yu, et al. (2022) found that a driving factor of medical students' motivation to study anatomy was the importance and value of the subject matter. The self-reported "Task Value" among medical students in the current study decreased significantly between the start and end of studying the anatomy module. This suggests that the medical students did not value the study of anatomy by the end of their module. It could be argued that students should have a heightened opinion of the importance of anatomy at this stage. Perhaps the incorporation of teaching strategies which align with the UDL checkpoint 7.2 "Optimise relevance, value and authenticity" (CAST, 2021a) would enhance students' understanding of why anatomy is important to study. For example, emphasising the clinical significance of certain structures or describing scenarios when they would have to recall certain anatomical information, could optimise "Task Value" among learners. Similarly, educators could introduce gamification, to highlight the relevance and value of anatomy, as Dugnol-Menéndez et al. (2021) described an increase in learning motivation among OT students when they introduced gamification to the design of their anatomy curriculum.

Students' learning belief plays a major role in academic motivation and performance (Abdel Meguid, Smith and Meyer, 2020; Lobos *et al.*, 2021). It has been suggested that if students believe their endeavours to study have a positive impact on their learning, they may in turn study in a more strategic and effective manner (Schunk and DiBenedetto, 2020). Students need to believe that they can accomplish a task as a result of their own efforts and that positive outcomes are not contingent on external factors like their educator (Eccles and Wigfield, 2020).

At the start of the anatomy module the mean score for the MSLQ subscale "Control of Learning Beliefs" was high for all four cohorts and the mean score remained high at the end of the anatomy module. Dental students had a higher mean Likert score for the subscale "Control of Learning Beliefs" at the end of their module compared to other dental students studying anatomy in first year (Abdel Meguid, Smith and Meyer, 2020), and the medical students were on par with other medical students' self-reported "Control of Learning Beliefs" at the end of the module (Zilundu, Chibhabha, Yu, *et al.*, 2022). The mean score for the motivation subscale "Control of Learning Beliefs" significantly increased in SLT students between the start and end of the study suggesting that SLT students believed that if they were to study in appropriate ways then they would be able to master the learning material. It also implies that as SLT students progressed through the anatomy module they became significantly more aware of their capabilities. It could be speculated that this was a result of educators incorporating teaching strategies which encouraged the students to monitor their progress, have confidence in their abilities and engage in self-reflection, all of which align with the UDL checkpoint 6.4 "Enhance capacity for monitoring progress", checkpoint 9.2 "Promote expectations and beliefs that optimise motivation" and checkpoint 9.3 "Develop self-assessment and reflection". In contrast, there was a decrease in "Control of Learning Beliefs" among OT students from the start of their module to the end. This suggests that OT students were unable to sustain the belief in their own learning abilities which they possessed at the beginning of their journey into third level education. There are a number of reasons why this may have occurred, including situational factors such as the impending summative examinations or feelings of being overwhelmed by the amount of learning material which they must study. The UDL checkpoints 7.1 “Optimise individual choice and autonomy”, 8.2 “Vary demands and resources to optimise challenge” and checkpoint 9.2 “Facilitate personal coping skills and strategies” are reported to promote self-belief among students by recruiting interest and sustaining effort, respectively (CAST, 2021a).

Self-efficacy refers to a learner’s assessment of their own abilities to set out a number of actions which require completion in order to succeed at achieving a certain goal (Bandura, 2001). In turn, learner’s self-efficacy beliefs drive their level of motivation (Bandura, 2001). Outcome expectations are decisive as learners think ahead about the possible end result of various tasks and respond in a manner which they believe will assist in accomplishing their desired result (Abdel Meguid, Smith and Meyer, 2020). Tembo and Ngwira (2016) concluded that self-regulation was closely related to self-efficacy beliefs in anatomy education. They suggest that the more medical students believe they can accomplish a particular task, the more inclined they are to engage in a wider range of learning strategies. Thus, there is a requirement for educators to create a learning environment in which students can enhance their self-efficacy beliefs of studying anatomy (Tembo and Ngwira, 2016). In the present study, students “Self-efficacy for Learning and Performance” ranged from medium to high on the Likert scale at the start of their anatomy module for all cohorts. The range of scores remained between medium and high on the Likert scale at the end of the anatomy module. These results are lower than self-reported self-efficacy among medical students studying anatomy in 2017 and 2019 (Zilundu, Chibhabha, Yu, *et al.*, 2022). There was no significant change in the mean score for self-efficacy for learning and performance in any cohort between the start and the end of the anatomy module.

Test anxiety has been found to be negatively related to academic performance (Pizzimenti and Axelson, 2015; Tang *et al.*, 2019). In this study, “Test Anxiety” was reported as high, as defined by Cho et al. (2017), by dental, OT and SLT students at the end of their anatomy module. There was no statistically significant change in “Test Anxiety” among these three cohorts. Medical students self-reported “Test Anxiety” at the end of their anatomy module was also high when compared to similar studies (Pizzimenti and Axelson, 2015; Zilundu, Chibhabha, Yu, *et al.*, 2022). Self-reported “Test Anxiety” was significantly increased in medical students at the end of the module, compared to the start of the module, which coincided with the approach of the examination period. Test anxiety is made up of two elements, worry and emotionality (Liebert and Morris, 1967; Lotz and Sparfeldt, 2017). Warnecke et al. (2019) reported that guiding students on the use of effective learning strategies or self-regulatory skills reduced test anxiety among third level students. Hence, educators could consider the implementation of UDL in the design and delivery of their anatomy curriculum to introduce learners to multiple learning strategies so that students may be able to choose their optimal and preferred method of studying (CAST, 2021a). Zilundu, Chibhabha, Yu, et al. (2022) concluded that anatomy educators should be aware of their students’ motivations and learning strategies so that they may encourage self-regulated and lifelong learning traits. The UDL guideline 9, “Provide options for self-regulation” is broken down into the following checkpoints: checkpoint 9.1 “Promote expectations and beliefs that optimise motivation”, 9.2 “Facilitate personal coping skills and strategies” and 9.3 “Develop self-assessment and reflection" (CAST, 2021a). Similar to the current study, Bischofsberger et al. (2021) reported an increase in test anxiety in medical students at the end of an anatomy module compared to the start. Specifically, they found that the percentage of first year medical students reporting test anxiety increased from 15% to 25%. By incorporating teaching strategies which align with UDL in the design and delivery of curricula, anatomy educators would afford students the opportunities to increase their confidence and become more comfortable with learning the anatomy material. In particular, educators could incorporate teaching strategies such as the inclusion of self-assessment activities which allow students to monitor their progress, reflect on their understanding and gain immediate feedback. However, more research is required to understand precisely how the inclusion of UDL could alleviate test anxiety among students studying anatomy, particularly those enrolled in dental, OT or SLT programmes.

Limitations

The present study used the MSLQ which is a self-report questionnaire. Although this questionnaire has been validated, it can only measure motivation among the healthcare students as accurately as the students' own perceptions allow. Additionally, this study was conducted with first year undergraduate students in a single institution, thus limiting generalisability of the findings. Statistical changes were reported to a greater degree among the medical cohort when compared to the dental, OT and SLT cohorts. This may be due to the higher number of participants enrolled in the medical programme and thus the increased power for statistical analysis.

Conclusion

Motivation to study anatomy among medical and dental students was high on the MSLQ at the start of the module. Motivation among OT and SLT students ranged from medium to high, at the start of their anatomy module. By the end of the anatomy module dental students reported high levels of motivation to study anatomy and motivation among medical, OT and SLT students ranged from medium to high. However, this study identified a change in the students' self-reported motivation while studying anatomy. It is crucial that educators implement all the tools available to engage anatomy students and promote their learning. This study emphasises the benefits of UDL and its flexible nature to enhance motivation and promote learning. Furthermore, it identified areas where theories of motivation aligned with the UDL checkpoints.

Chapter Four

First-year undergraduate healthcare students’ awareness and perception of Universal Design for Learning (UDL) in their anatomy curriculum: an institution-based study.

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Abstract

Healthcare students perceive anatomy as a difficult subject to study, yet there is limited literature to explain why students think that anatomy is difficult to learn. Studies have assessed student opinion of anatomy teaching strategies, but there is no specific research regarding healthcare students' perception of pedagogical frameworks utilised in anatomy curricula. Considering the importance of student experience, the design of anatomy curricula should include the perspectives of students. Universal Design for Learning (UDL) is a framework which aims to optimise learning opportunities. There is no specific research on healthcare students' awareness or perception of UDL in anatomy curricula. A questionnaire was administered to first-year undergraduate medical, dental, occupational therapy (OT) and speech and language therapy (SLT) students studying anatomy. Demographic data and participants' perception of UDL were gathered. The response rate was 83%. The majority of participants were female (69%) and studied medicine (59%). Ninety-seven percent of participants had not heard of UDL. After a brief explanation of UDL, 91% thought that UDL had been implemented in anatomy laboratory sessions and 52% thought UDL had been implemented in anatomy lectures. Although the majority of participants were not aware of UDL, they identified aspects of UDL in their anatomy curriculum. UDL helps create an inclusive learning experience. The discussion about the design and delivery of anatomy curricula should include the opinions and perspectives of healthcare students.

Keywords: Anatomy; Curriculum Design; Healthcare Education; Universal Design for Learning

Introduction

The study of human anatomy is imperative for the safe teaching and training of healthcare students (Bartoletti-Stella *et al.*, 2021). It has been reported that students perceive anatomy as a difficult subject to study (Guimarães *et al.*, 2017; Javaid *et al.*, 2018; Vitali *et al.*, 2020; Cheung, Bridges and Tipoe, 2021; Rutenberg *et al.*, 2022) yet there is limited literature about why students think anatomy is difficult to learn. One study identified visualisation of structures, body of information and curriculum design as the main challenges for a cohort of medical students, junior medical doctors and anatomy educators (Cheung, Bridges and Tipoe, 2021). Similarly, Sturges and Mauner (2013) reported that the high volume of content in the module, the students' own approach to studying and educators' style of content delivery contributed to the perceived difficulty of the anatomy and physiology modules as identified by a cohort of undergraduate allied health students.

In order to improve anatomy students' engagement, academic performance and outcomes, educators must first understand and appreciate the barriers and challenges which students face during their journey through third level education that may contribute to the perceived difficulty of studying anatomy, as well as the academic activities which they enjoy and engage with (Vitali *et al.*, 2020). Curriculum design and delivery can hinder or promote an inclusive educational experience among learners (Bunbury, 2020; Baptiste, 2021). Studies have assessed student opinion of certain anatomy teaching methods, including the utilisation of cadaveric material, technology, anatomical models, anatomy demonstrations and peer learning (Davis *et al.*, 2014; Backhouse, Taylor and Armitage, 2019; Jeyakumar, Dissanayake and Dissabandara, 2020; Lopez *et al.*, 2022; Muraleedharan *et al.*, 2022), but there is no specific research concerning healthcare students' opinion or perception of pedagogical frameworks utilised in anatomy curricula.

While there is currently no pedagogical framework proposed for the delivery of anatomy to healthcare students, a review carried out by Dempsey et al. (2022) reports several publications describing teaching strategies implemented in anatomy education which aligned with the Universal Design for Learning (UDL) pedagogical framework. UDL was developed by the Center of Applied Special Technology (CAST) in the United States (US) in the 1990s and comprises three guiding principles namely multiple means of engagement, multiple means of representation and multiple means of action and expression. Each of these principles are subdivided into checkpoints. There are a total of 31 checkpoints to guide educators in their curriculum design (Figure 4.1). The aim of UDL is to transform the design and the delivery of curricula such that curricula will be inclusive of all types of learners within the one teaching environment (García-Campos, Canabal and Alba-Pastor, 2020) ; CAST 2022). Parallels exist between UDL and other educational theories and frameworks, such as Cognitive Flexibility Theory (CFT) (Spiro *et al.*, 1991), Generative Learning Theory (GLT) (Wittrock, 1974; Brod, 2021) and Self-Determination Theory (SDT) (Deci and Ryan, 2000; Hu and Zhang, 2017). UDL also encompasses the FAIR (Feedback, Activity, Individualisation and Relevance) principles postulated by Harden and Laidlaw (2016). These principles are designed to guide educators on feedback to students, engagement of students in active learning, individualisation of learning to the personals needs of students and the relevance of learning. However, there is no published literature on healthcare students' awareness or perception of UDL as a pedagogical framework for anatomy.

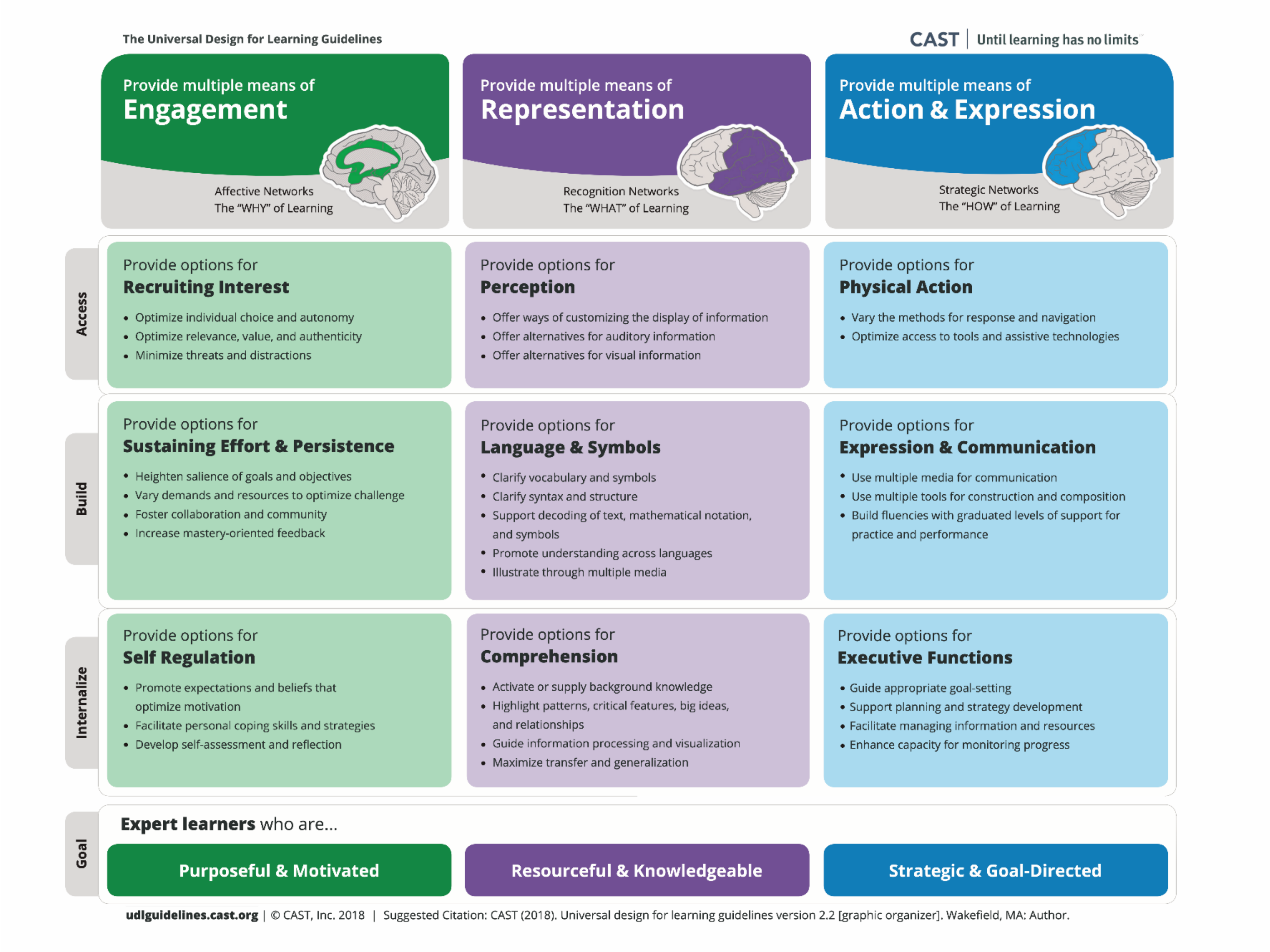

***Figure 4.1** A schematic outlining the three Universal Design for Learning principles and their respective guidelines and checkpoints* (CAST, 2021a).

First-year undergraduate students engage in learning in different manners (Dynan, Cate and Rhee, 2008; McKeown and Anderson, 2016; Sawyer *et al.*, 2018). Teaching methods which suit one individual may not necessarily suit another. Variability among learners is found in every learning environment, for example, the rate at which students complete or approach a task, the way they interact with peers or the manner in which they process or organise learning material (Lowrey *et al.*, 2017; Zhang, Basham and Yang, 2020; Vasquez and Marino, 2021; Cullinane and Barry, 2022). Thus, there is a need to ensure that all learners have the opportunity to engage with the learning process and are provided with an inclusive education. UDL aims to help engage a wide variety of different learners within the one learning environment (CAST, 2021a). The aim of this study was to determine whether first-year undergraduate healthcare students studying medicine, dentistry, occupational therapy (OT) and speech and language therapy (SLT), were aware of the UDL pedagogical framework, whether they thought UDL had been utilised in the design or delivery of their anatomy curriculum and whether they thought UDL had benefitted or would benefit their learning of anatomy.

Methods and Materials

Study Context

First-year undergraduate medical, dental, OT and SLT students taking an anatomy module in the host university, as a part of their respective degree programmes, participated in this study. The majority of students were new entrants to third level education. Students enrolled in all four programmes attended lectures and cadaveric prosection-based laboratory practicals tailored to the anatomy curricula for each of the programmes. On average, students enrolled in each of the healthcare programmes attend 20 hours of lectures and 16 hours of anatomy practicals per anatomy module. Each of the anatomy modules are supported by the host university's Learning Management System (LMS), which provides students access to the learning material for their respective lectures and practical sessions.

The first author (A. M. K. D.) presented an overview of the UDL framework to the students during an anatomy practical session, as they neared completion of their respective anatomy modules. An information sheet was distributed to the students to make them aware of the purpose of the questionnaire. Once informed consent was obtained, a questionnaire was distributed to participants after the presentation. Participation by the students was entirely voluntary and remained anonymous throughout the entire process. Ethical approval was obtained from the institutional Social Research Ethics Committee [Log 2021-190].

Questionnaire Design

The authors developed the questionnaire which was divided into two sections. Section one gathered demographic information such as age, location of second level education and programme of study. Section two focused on the participants' awareness, experience, perception and opinion of the UDL pedagogical framework. The questions in section two were a mixture of both open-ended and yes–no closed-ended questions. Open-ended questions were included to allow participants to elaborate and expand on answers to the questions. Although the questionnaire was distributed during the COVID-19 pandemic, none of the questions specifically referred to the pandemic.

Data Analysis

Data were manually entered into Statistical Package for Social Scientists (SPSS), version 28 (IBM Corp., Armonk, NY) and frequency tables were created for categorical variables. Inductive content analysis was used to examine participants' perception of UDL through open-ended questions (Kyngäs, 2020). *Verbatim* quotes that captured the viewpoint expressed by a number of participants were included.

Results

Two-hundred and twenty-six students were invited to participate in the study. The overall response rate was 83% (n=188). The majority of anatomy students who participated in this study were female (69%, n=129), studied medicine (59%, n=111) and had completed their second level education in Ireland (81%, n=153). Just over half of the participants were 19 years old (55%, n=103). All demographic information is summarised in Table 4.1.

Table 4.1. Demographic information of first-year undergraduate healthcare students studying anatomy (n=188)

		Number (%) of Students	Number of Participants per Programme			
			Medicine	Dentistry	OT	SLT
Gender	Female	129 (69%)	63	19	20	27
	Male	59 (31%)	48	6	3	2
Age	18 years	46 (25%)	27	6	5	8
	19 years	103 (55%)	57	14	13	19
	20 years	23 (12%)	17	4	1	1
	Older than 20 years	16 (8%)	10	1	4	1
Location Second Level Education was Completed	Ireland	153 (81%)	79	23	22	29
	United Kingdom	5 (3%)	5	0	0	0
	Rest of Europe	1 (1%)	1	0	0	0
	Northern America	11 (6%)	11	0	0	0
	Asia	15 (8%)	13	2	0	0
	Other	3 (2%)	2	0	1	0

OT, Occupational Therapy; SLT, Speech and Language Therapy

Student awareness of UDL

The majority of participants (97%, n=183) had not heard of UDL prior to this study (Table 4.2). Of the five participants (3%) who had heard of UDL, one (0.5%) said they knew about UDL from a mental health seminar, one (0.5%) from the media, two (1%) from problem-based learning (PBL) sessions and one (0.5%) did not elaborate on where they had previously heard of UDL.

Implementation of UDL

Ninety one percent of participants (n=171) thought that UDL had been implemented in their anatomy laboratory sessions whereas 52% (n=98) of students thought UDL had been implemented in their anatomy lectures. Ninety-four percent of participants (n=176) thought that their anatomy learning material was represented in multiple ways in their laboratory sessions and 85% (n=159) thought that the material was presented in multiple ways in their lectures. However, only 55% (n=104) of participants thought that they had the opportunity to express their knowledge in multiple ways during assessments (Table 4.2).

Eighty five percent (n=159) of participants responded to the open-ended question '*How and where do you think UDL was implemented in the anatomy laboratory sessions*'. These participants identified several teaching methods which align with the UDL framework, such as the presentation of information in numerous formats for example through the use of cadavers (27%, n=43), computer programmes (26%, n=42), models (19%, n=31) and pre-recorded videos (8%, n=13). Participants highlighted that the anatomy demonstrators, who provided guided tutorials (n=29, 18%), were available to answer questions immediately (14%, n=22) and each had different approaches to teaching (11%, n=17). Participants identified that both group work and autonomy over their learning aligned with the UDL framework (Figure 4.2A). Participants were then asked, '*How and where do you think UDL was implemented in the anatomy lectures',* 45% (n=85) of the participants responded with 28% (n=24) highlighting the utilisation of videos to accompany text and 26% (n=22) identified the use diagrams and 11% (n=9) responded that quizzes were used (Figure 4.2B).

Table 4.2. First-year undergraduate healthcare student responses to the closed-ended questions

	Number of students (%) who answered "Yes" (n=188)	Number of students (%) who answered "No" (n=188)
Student awareness of UDL		
Prior to today, have you ever heard of UDL?	5 (3%)	183 (97%)
Implementation of UDL		
Do you think elements of UDL have been implemented in the anatomy laboratory sessions?	171 (91%)	17 (9%)
Do you think elements of UDL have been implemented in the anatomy lectures?	98 (52%)	90 (48%)
Do you think that the anatomy material is represented in multiple ways in laboratory sessions?	176 (94%)	12 (6%)
Do you think that the anatomy material is represented in multiple ways in lectures?	160 (85%)	28 (15%)
Do you think that you have the opportunity to express your knowledge in multiple ways during assessments?	104 (55%)	84 (45%)
Student perception of UDL		
Do you think that the anatomy laboratory sessions were inclusive of your learning needs?	183 (97%)	5 (3%)
Do you think that the anatomy lectures were inclusive of your learning needs?	159 (85%)	29 (15%)
Do you think UDL benefits student learning?	186 (99%)	2 (1%)
Do you think the implementation of the UDL framework increases student engagement?	183 (97%)	5 (3%)
Do you think the anatomy laboratory sessions motivate you to study anatomy?	183 (97%)	5 (3%)
Do you think the anatomy lectures motivate you to study anatomy?	116 (62%)	72 (38%)

UDL, Universal Design for Learning

Student perception of UDL

The majority of participants thought that their anatomy laboratory sessions (97%, n=183) and lectures (85%, n=159) were inclusive of their learning needs. All but two of the participants (99%, n=186) thought that UDL benefits student learning. The majority of participants (97%, n=183) thought that the utilisation of UDL increased student engagement; and that their current laboratory sessions motivated them to study, while 62% (n=116) thought their anatomy lectures motivated them to study (Table 4.2).

Eighty eight percent (n=166) of participants responded to the open-ended question '*In what way do you think UDL benefits student learning*'. Of these 166 participants, 27% (n=45) said that UDL accommodated the different learning needs of students, and 22% (n=36) responded that UDL provided all students with an opportunity to reach their individual optimum. Nineteen percent (n=31) of participants responded that UDL provided options for engagement; and that the incorporation of UDL helped to make learning inclusive and fair for all students. UDL also helped to consolidate learning (12%, n=20), promote engagement in the learning process (10%, n=17), allow students to determine which learning methods suited them the best (9%, n=15) and enhance student motivation to learn (5%, n=9) (Figure 4.2C). More specifically, participants identified the following benefits of UDL:

"UDL benefits everybody, regardless of learning ability"

"UDL acknowledges the unique differences in student learning"

"UDL includes everybody which leads to everybody learning, it provides variety which helps motivate students to engage in learning"

"UDL provides many different ways of interacting with the information, this helps us to see things from different aspects"

"Students learn best when they are taught in a way which will help them to retain information"

"Students will be more likely to engage with the material and learn more efficiently"

Sixteen percent (n=31) of participants responded to the open question '*How might the laboratory or lecture sessions be made more inclusive in future*'. Of these 31 participants, 35% (n=11) requested more interaction and also wanted increased opportunities for engagement, 19% (n=6) asked for more opportunities to ask questions, 16% (n=5) wanted more videos to be included, 13% (n=4) requested that quizzes be included. Students would also like an increased use of models and images (13%, n=4 and 10%, n=3, respectively) during lectures, and 3% (n=1) would like more group work (Figure 4.2D). The final open-ended question provided the participants with an opportunity to express their opinion of UDL or about how anatomy is currently being taught. Only 22 (12%) of the participants expressed an opinion. The responses were positive in relation to UDL and how they are currently being taught anatomy in their respective programmes. Specifically, participants stated that:

"It would be great if we could go through the quizzes after they are corrected"

"The anatomy laboratory sessions are very helpful"

"UDL takes into account different types of learners which is helpful in the laboratory sessions"

"UDL seems promising"

“I would like to continue the blended approach to learning as it offers students a greater opportunity to engage with the content and allows flexibility in their workload”

“I love the mixture and balance; I find the laboratory sessions extremely useful and insightful”

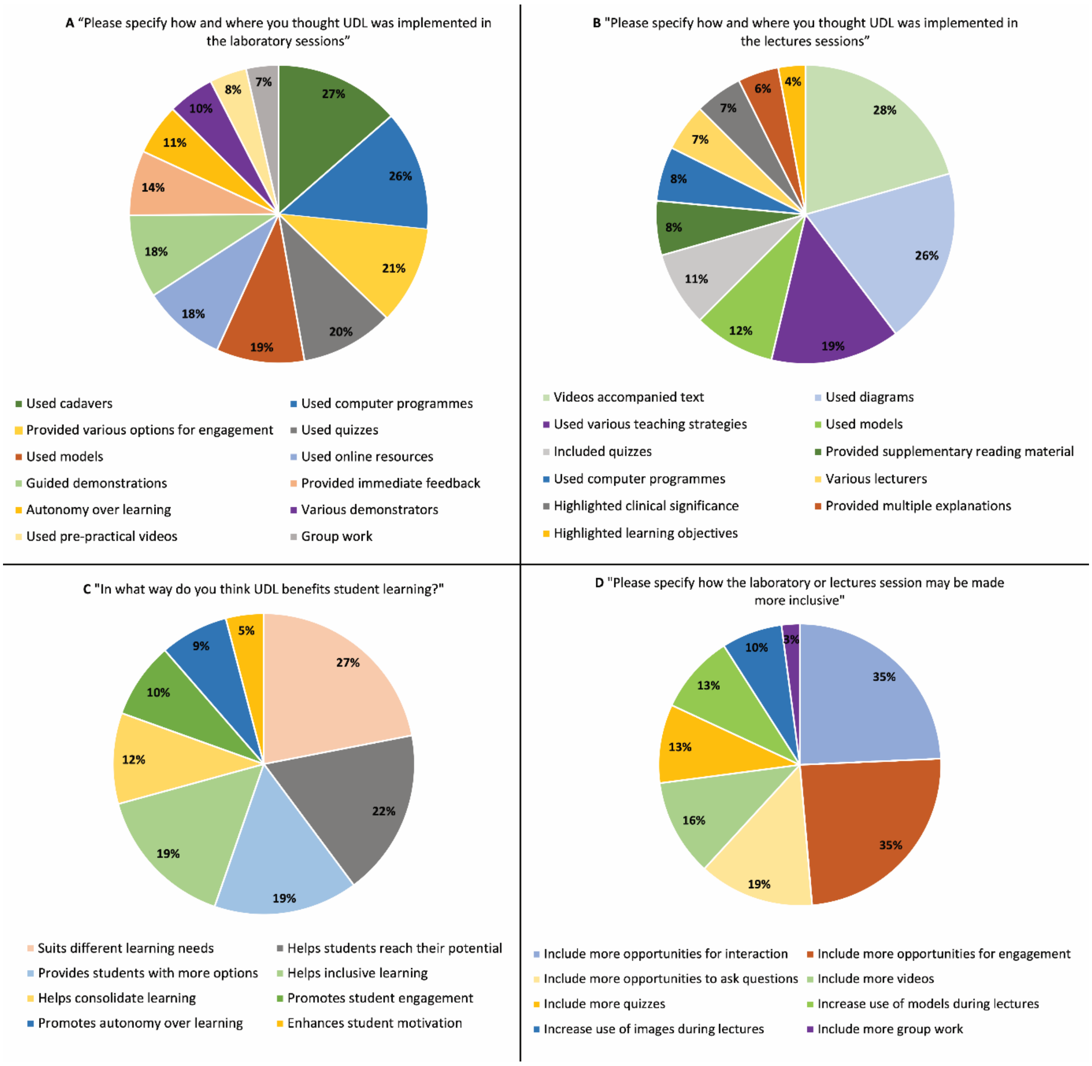

Figure 4.2 *Pie chart representing First-year undergraduate healthcare students’ responses to the various open-ended questions: A “Please specify how and where you thought UDL was implemented in the laboratory sessions”, B “Please specify how and where you thought UDL was implemented in the lectures sessions”, C “In what way do you think UDL benefits student learning” and D “Please specify how the laboratory or lectures session may be made more inclusive”.*

Discussion

This study gathered perspectives about UDL from first-year undergraduate medical, dental, OT and SLT students. More specifically it investigated whether students were aware of the UDL pedagogical framework, whether they thought UDL had been utilised in the design or delivery of their anatomy curriculum and whether they thought UDL had benefitted or would benefit their learning of anatomy.

Ninety seven percent (n=183) of students were not aware of UDL prior to this study. Hew and Lo (2018) recommend that educators should promote student understanding of certain teaching strategies and should explain the rationale and potential benefits for their learning. Guideline 7, Checkpoint 7.2 'Optimise relevance, value and authenticity' of the UDL framework (CAST, 2021a) not only refers to explaining the relevance of learning material to students but also explaining the relevance of the teaching approach used. When students are introduced to a new teaching strategy, they should be guided through the process to optimise their understanding. For example, if technology is introduced in anatomy curriculum design and delivery, learners should be guided on how to effectively use the technology. Appropriate scaffolds should be put in place to enhance the quality of students' e-learning as educators cannot assume that all learners will be proficient immediately (Das and Al Mushaiqri, 2021). Importantly, Davis et al. (2014) suggested that first-year undergraduate students require time to adjust to and engage in active learning as they progress to becoming independent learners. Thus, it is reasonable to recommend that students should be made aware of pedagogical frameworks and especially the rationale for certain teaching strategies to enhance their engagement in the learning process (Davis *et al.*, 2014).

The majority of the participants thought that UDL had been implemented in the design and delivery of their laboratory sessions as they identified aspects of UDL in their anatomy practicals. Specifically, teaching strategies which aligned with Guideline 1, Checkpoint 1.1 'Offer ways of customising the display of information', Guideline 6, Checkpoint 6.4 'Enhance capacity for monitoring progress', Guideline 8, Checkpoint 8.4 'Increase mastery-oriented feedback' and Guideline 9, Checkpoint 9.3 'Develop self-assessment and reflection' were identified by the participants. Evidence from the literature highlights that incorporating teaching strategies which align with these particular checkpoints enhances student learning and academic outcomes (Golenhofen *et al.*, 2020; Ashokka, Ching Lee and Dong, 2021; Azkue, 2021; Bhat *et al.*, 2022; McNamara and Nolan, 2022) and supports the rationale for implementing UDL in anatomy curricula design and delivery. In contrast, just over half of the participants thought that UDL had been implemented in the design and delivery of their anatomy lectures. However, 85% (n=159) of all participants thought that the learning material had been represented in multiple ways in their lectures, and participants commended the combination of diagrams, videos, models and quizzes which were used to compliment the detailed text in lectures. This teaching strategy aligns with all three of the UDL principles, as it provides varied opportunities for learners to engage with and interpret the learning material and thus lends to an inclusive educational experience. Studies have shown that including variety in the delivery of anatomy lectures increases student engagement and satisfaction (Stepan *et al.*, 2017; Pascoe and Betts, 2020; Sarkar, Sharma and Raheja, 2021) and that on average, anatomy examination scores improve by 6% when various learning strategies are implemented (Freeman *et al.*, 2014; Shaffer, 2016).

The majority of the participants agreed that the implementation of UDL would benefit student learning (99%) and increase student engagement (97%). The participants of this study affirmed, through their responses to the open-ended questions, the need for increased engagement and interaction in both their lectures and laboratory sessions to sustain learner interest and motivation. Both engagement and interaction have been identified as integral for successful and positive learning experiences (Rojas-López *et al.*, 2019; Eltahir *et al.*, 2021; Ferrer *et al.*, 2022). This aligns with the goal of the UDL principle, 'Multiple means of engagement' which aims to 'Optimise individual choice, vary demands and resources', 'Optimise challenge, increase mastery-oriented feedback', 'Promote expectations and beliefs that optimise motivation' and 'Develop self-assessment and reflection' to heighten the student learning experience and ensure all students are included and have an equal opportunity to learn (CAST, 2021a). Numerous studies highlight the necessity for learner engagement and motivation in anatomy curricula for positive academic outcomes and in turn the development of safe and effective healthcare professionals (Wilkinson *et al.*, 2020; Dugnol-Menéndez *et al.*, 2021; Nedimyer, Hirumi and Cendan, 2022). The participants of the current study stated that the learning material used in their lectures and practicals was presented in numerous formats, for example, through text, models, prosections, videos and images, all of which allowed the students to optimally engage with the material. This aligns with the UDL principles, 'multiple means of engagement' and 'multiple means of representation' (CAST, 2021a). Increasingly, anatomy educators are using a multimodal approach to deliver their anatomy curriculum (Estai and Bunt, 2016; Abu Bakar *et al.*, 2022). A meta-analysis carried out by Hew and Lo (2018) found that studies reported increased interaction among peers and more opportunities for students to apply their knowledge when using a ‘flipped classroom’ approach in health professions education (Hew and Lo, 2018). Educators stated that they had more opportunities to provide feedback to students as a result of integrating a flipped classroom into their curriculum design (Hew and Lo, 2018). Fostering collaboration, varying the methods for student response, and providing mastery-oriented feedback are all checkpoints of the UDL framework (CAST, 2021a) all of which helps to provide learners with an inclusive learning experience (Capp, 2017). Furthermore, it should be noted that as a result of the COVID-19 pandemic, many of the anatomy lectures referred to in the current study were recorded to ensure no student was disadvantaged due to illness or quarantine. The participants highlighted how this benefitted their learning as they had opportunity to work through the learning material at their own pace, something that may not be possible in live lectures. This provided participants with autonomy over their own learning which aligns with Guideline 7, Checkpoint 7.1 ‘Optimise individual choice and autonomy’ of the UDL framework (CAST, 2021a). More specifically, 11 of the participants stated that the recorded lectures allowed them to study at a time which was most appropriate for them. In particular, one student praised the recorded lectures stating:

> *“I find the lectures online are exceedingly beneficial. This allows me to focus on the more difficult topics and engage with the content when I am capable of doing so as I suffer from chronic migraines”*

Furthermore, the benefit of incorporating recorded lectures to compliment teaching and not to replace face-to-face teaching, has also been identified in recent studies (Nathaniel *et al.*, 2021; Lopez *et al.*, 2022; Özen, Erdoğan and Malas, 2022).

The participants were offered the opportunity to express any other opinions of UDL or about how anatomy is currently taught. Although, feedback was positive about UDL and the use inclusive learning strategies, there were a number of suggestions for improvements in the design and delivery of their anatomy curriculum. These included incorporating interactions with former therapy service users, providing feedback from online quizzes, providing refresher videos at the beginning of each practical and providing more resources so that students may remain engaged for the duration of the practicals. The participants' suggestions align with the following specific checkpoints: Guideline 3, Checkpoint 3.1 'Activate or supply background knowledge', Guideline 4, Checkpoint 'Vary the methods for response and navigation', Guideline 6, Checkpoint 6.3 'Facilitate managing information and resources', Guideline 7, Checkpoint 7.2 'Optimise relevance, value and authenticity', Guideline 8, Checkpoint 8.2 'Vary demands and resources to optimise challenge', Guideline 8, Checkpoint 8.4 'Increase mastery-oriented feedback and Guideline 9, checkpoint 9.3 'Develop self-assessment and reflection' (CAST, 2021a). Previous studies have highlighted the benefit of incorporating teaching strategies which align with these UDL checkpoints (Gross, Wright and Anderson, 2017; Langfield, Colthorpe and Ainscough, 2018; Diaz, Linden and Solyali, 2021; Patil and Patil, 2021; Baker, 2022; González Blum *et al.*, 2022).

It has been suggested that student engagement with assessment of their anatomy knowledge would help the development of lifelong skills such as self-regulation, teamwork, problem solving, communication skills and leadership for healthcare professionals (Ryan and Wilkinson, 2021), all of which are aims of UDL (CAST 2022). Forty five percent (n=84) of students in this study stated that they did not think they had the opportunity to express their anatomical knowledge in multiple ways during assessments. According to Ryan and Wilkinson (2021), assessments help to stimulate student motivation, particularly if a student notices a gap in their knowledge as a result of an assessment. They suggest that no single perfect assessment exists, but rather a variety of methods is required. This aligns with the UDL framework and further supports the suggestion that UDL would be an appropriate framework to aid the design and delivery of anatomy curricula, including assessment design. Relying on a single examination approach would result in a confined and restricted assessment, which in turn would likely result in inadequate educational impact (Ryan and Wilkinson, 2021).

The results of the current study suggest that educators consider and implement UDL in the design and delivery of anatomy curricula within healthcare programmes, supported by recent publications highlighting the varied learning preferences of healthcare students (Ang *et al.*, 2018; Khanal *et al.*, 2019; Hernandez *et al.*, 2020; Sadeesh, Prabavathy and Ganapathy, 2021). While cadaveric dissection is reputed to be the most popular method for teaching anatomy (Byram *et al.*, 2020; Singal *et al.*, 2021), there are a number of recent publications which suggest that a multi-modal teaching approach is preferable as one method in isolation is neither ideal nor optimal (Deming *et al.*, 2021; Lone, Mohamed and Toulouse, 2021;

Muraleedharan *et al.*, 2022). Multi-modal teaching strategies aid the creation of an inclusive and accessible educational experience for all learners (Bietzk *et al.*, 2019). Recently, Patra et al. (2022) highlight that one method in isolation is not efficient and that modern teaching methods should be used to complement more established teaching methods which educators are already familiar with and are comfortable executing.

A limitation of this study is that it was carried out among first year undergraduate healthcare students in a single institution, thus limiting generalisability of the findings. First year students enrolled in other institutions may already be aware of UDL and have a different perception to those described in this study.

Conclusion

In conclusion, this study investigated the awareness and perception of first-year undergraduate healthcare students, about UDL in anatomy curricula. Although the majority of the participants were not initially aware of UDL, they recognised the potential benefit of UDL in the design and delivery of anatomy curricula. Moreover, they identified aspects of UDL already being incorporated into their anatomy curriculum. There is scope for further incorporation of UDL to optimise healthcare students' study of anatomy and inclusive learning experience. Acknowledging that student opinion is paramount (Davis *et al.*, 2014), the design and delivery of anatomy curricula should include the opinions and perspectives of healthcare students.

Chapter Five

Awareness of Universal Design for Learning among anatomy educators in Higher Level Institutions in the Republic of Ireland and United Kingdom

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Abstract

There is an increasing need to facilitate enhanced student engagement in anatomy education. Higher education students differ in academic preferences and abilities and so, not all teaching strategies suit all students. Therefore, it is suggested that curricula design and delivery adapt to sustain learner engagement. Enhanced learner engagement is a fundamental feature of Universal Design for Learning (UDL). The aim of this study is to determine if anatomy educators in the Republic of Ireland (ROI) and United Kingdom (UK) are aware of UDL and to assess if, and to what extent, it has been implemented in the design and delivery of anatomy curricula for healthcare students. An anonymous online questionnaire was administered to anatomy educators in higher level institutions in the ROI and UK. Inductive content analysis was used to identify the impact of UDL on student learning, engagement and motivation, as perceived by the participants. The response rate was 23% (n= 61). Nineteen participants stated they knew of UDL. Of these, 15 had utilized UDL in their teaching of anatomy. Analysis indicated that the perception of UDL was mixed. However, the majority of responses relating to UDL were positive. The majority of the respondents were unaware of UDL but identified the frameworks' checkpoints within their curriculum, suggesting they have unknowingly incorporated elements of UDL in their curriculum design and delivery. There is a lack of information on the benefits of explicit utilization of UDL for engagement and motivation to learn anatomy in healthcare programs in the ROI and UK.

Keywords: anatomy; universal design for learning; curriculum design

Introduction

Anatomy is an essential pillar of healthcare programs and the foundation for safe and effective practice (Sugand, Abrahams and Khurana, 2010). Healthcare professionals have voiced their concern about poor anatomy knowledge among recent healthcare graduates (Bhangu *et al.*, 2010; O'Keeffe, Davy and Barry, 2019) in particular their poor anatomical competency and lack of preparedness upon entering residency programs (Fillmore *et al.*, 2016), suggesting that anatomy curriculum design requires reform.

In the modern curriculum there are constraints on the amount of time allocated to the formal teaching of anatomy within healthcare programs, and more specifically time dedicated to dissection (Harrison *et al.*, 2019; Jeyakumar, Dissanayake and Dissabandara, 2020). In the Republic of Ireland (ROI) and United Kingdom (UK), anatomy is typically taught using an in-person didactic format complemented with practical laboratory sessions to consolidate student learning (Smith *et al.*, 2021). Both of these teaching modalities have been identified as critical for students' anatomy learning experience (Farkas, Mazurek and Marone, 2016). Recent literature indicates that these traditional methods should not be used in isolation but rather alongside new innovative methods to enhance accessibility of learning material and to promote student engagement and interest in anatomy (Lochner *et al.*, 2016; Iwanaga, Loukas, *et al.*, 2021; Dempsey *et al.*, 2022). For example, studies have identified that modern teaching strategies, such as gamification, virtual and augmented reality which align with multiple means of representation, result in similar levels of knowledge acquisition and collaborative activity as traditional methods (Rezende *et al.*, 2020; Moro *et al.*, 2021). However, these modern methods have the added bonus of stimulating student autonomy and increasing satisfaction among learners (Alfalah *et al.*, 2019; Rezende *et al.*, 2020) all of which aligns with the Universal Design for Learning (UDL) framework. Furthermore, research has highlighted that certain teaching strategies may not suit all students, as students differ in academic preferences and abilities (Hu *et al.*, 2018; Quinn *et al.*, 2018; Ruthberg *et al.*, 2020). The learning styles and social and cultural background of the student population is continually changing as more learners are travelling and migrating to enter third level education (Vos, Çelik and de Vries, 2016; Nortvedt *et al.*, 2020). Specifically, in 2017 international students comprised 12.5% of the entire third level student population in the ROI (Department of Education, 2018) and this number is increasing as 18.4% of all graduates in the ROI in 2019 were international students (CSO, 2019). Additionally, widening participation agendas promote the accessibility of third-level education (House of Commons, 2022). Thus, more students from diverse socio-economic backgrounds or with learning difficulties or disabilities are entering higher education both in the ROI and UK (GOV, 2022; HEA, 2022b). Therefore, to sustain student interest and engagement in anatomy education, educators need to adapt their curriculum to the present student population and educational environment (Kahu and Nelson, 2018; Jeyakumar, Dissanayake and Dissabandara, 2020; Chan *et al.*, 2021).

In March 2020, all higher level institutions in the ROI and UK were required to pivot to online teaching during the global COVID-19 pandemic (Franchi, 2020; Longhurst *et al.*, 2020). Educators had to adapt quickly to ensure that students could continue to learn and engage with their material, albeit remotely (Evans *et al.*, 2020).

Anatomy educators became creative and innovative in their teaching methods (Dickinson and Gronseth, 2020; Evans *et al.*, 2020; de Carvalho Filho, Hafferty and Pawlina, 2021; Harmon *et al.*, 2021; Iwanaga, Loukas, *et al.*, 2021; Yoo *et al.*, 2021). For example, Harrell et al. (2021) incorporated online laboratory dissection videos, Flynn et al. (2021) introduced a 3D anatomical modelling program to medical students, and Zarcone and Saverino (2022) used Leica Acquire, a virtual microanatomy application, to teach pathological anatomy. Additionally, new teaching methods such as Augmented Reality (Iwanaga, Terada, *et al.*, 2021) and asynchronous and synchronous lectures (Byrnes *et al.*, 2021; Harrell *et al.*, 2021) were utilized. Opportunities for students to demonstrate their understanding in multiple formats such as presentations (Flynn *et al.*, 2021; Keet *et al.*, 2021) and online breakout rooms (Al-Neklawy and Ismail, 2022) were also provided. As we emerge from the pandemic and return to on-campus teaching there is an increasing awareness of the benefits of student engagement to allow students to express their knowledge and understanding in a format which is most appropriate and accessible for them (Singal *et al.*, 2021). These are fundamental features of UDL, a learning theory first articulated in the United States (US) in 1990.

Universal Design for Learning is an educational framework designed to ensure that all types of learners can participate, engage and thrive in the same learning environment (CAST, 2021a; Fornauf *et al.*, 2021). The framework was developed by the Centre for Applied Special Technology (CAST) in the US as a guide for educators to design an accessible curriculum with the aim of changing the design of the learning environment rather than changing the learner (Bedrossian, 2018). The authors propose that anatomy students are encouraged to become life-long and resilient learners through an enhanced educational experience that meets their learning preferences. To help accomplish this, three guiding principles were articulated, namely multiple means of engagement, multiple means of representation and multiple means of action and expression. Each principle is divided into three guidelines and each guideline has a set of associated checkpoints (31 in total) which educators may use in the design and delivery of curriculum, in order to enhance accessibility for all students (CAST, 2021a) (Figure 5.1). The aim of UDL is to afford the opportunity to all students to optimise their learning capabilities while also fulfilling the learning outcomes. If there are certain learning outcomes that need to be met or assessed, then there may be limited opportunity for flexibility. The authors contend that promoting and increasing knowledge and understanding of anatomy enhances safety in anatomy practice (Smith *et al.*, 2016), which is a core component of the skillset needed for a professional degree (Lewis *et al.*, 2016; Simons *et al.*, 2022). However, the incorporation of UDL in the design and development of assessments in vocational degree programs requires further research as there is currently little information available. CAST advocate that providing learners with multiple options to engage with the learning material will help learners achieve their potential (CAST, 2021a).

Since the inception of UDL in primary school settings, educators in Canada and the US have reported that students retained increased amounts of class content, that student communication skills were enhanced and that participation in classroom activities had increased (Katz, 2015; Lowrey *et al.*, 2017). A meta-analysis carried out by Capp (2017) reported that UDL is an effective teaching strategy for enhancing the learning experience of all students with and without disabilities in environments ranging from second level to third level education (Capp, 2017). However, it must be determined if these promising results and benefits, as a result of embedding UDL in the curriculum of primary and secondary education, would translate to students enrolled in higher level institutions.

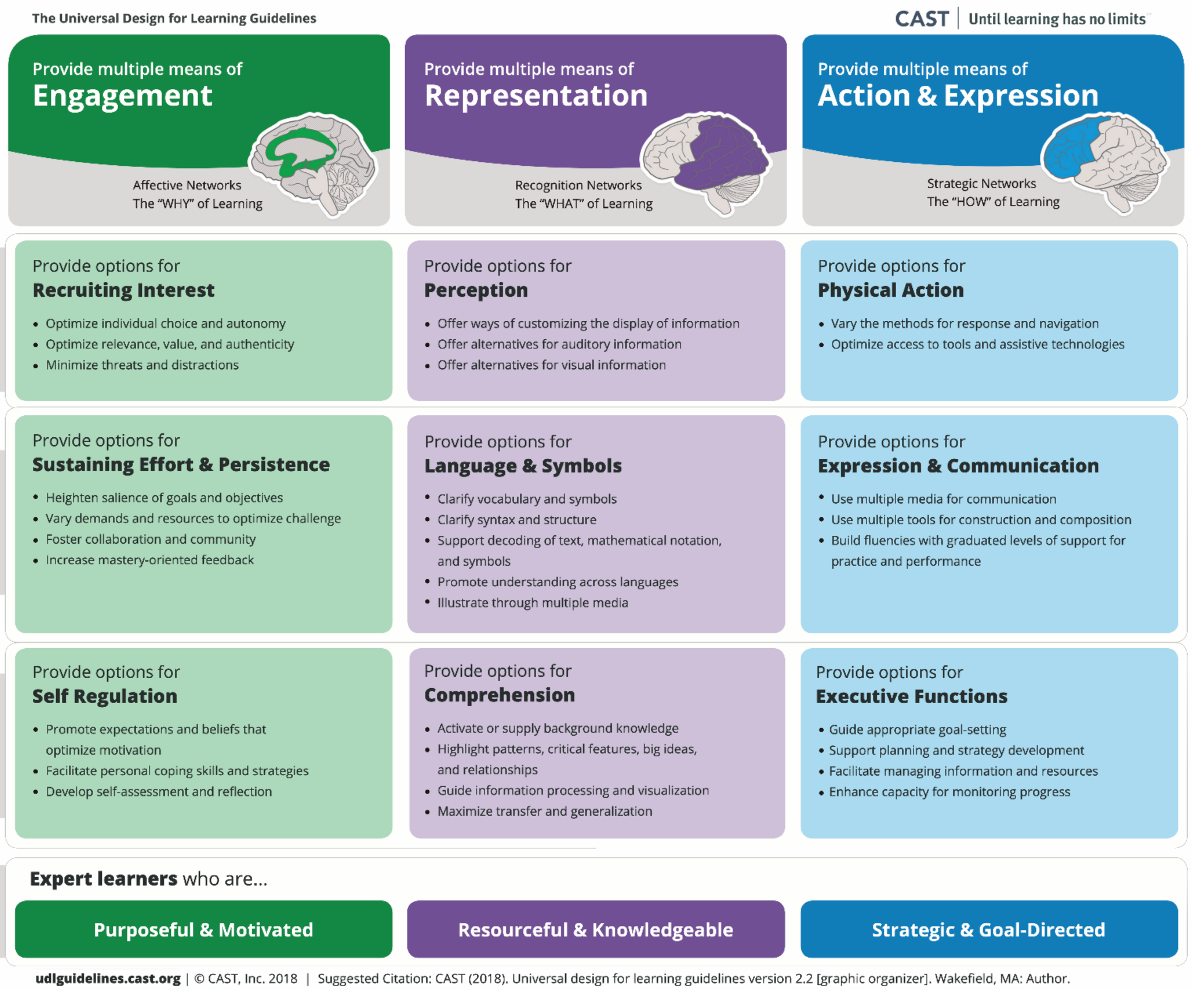

***Figure 5.1** A schematic outlining the three Universal Design for Learning principles and their respective guidelines and checkpoints* (CAST, 2021a).

Black et al. (2015) reported that presenting learning material in various formats, regularly providing students with constructive feedback and assessing students using diverse methods was beneficial to learning in a cohort of students enrolled in a higher level institution, in the US, all of which aligns with UDL checkpoints (CAST, 2021a). Murphy et al. (2020) suggested that because UDL has been implemented in an effective manner to aid students with disabilities in their transition to higher level institutions, then perhaps it could potentially be used to help students without disabilities in their transition to higher level institutions (Murphy *et al.*, 2020). The UDL framework incorporates strategies like flexibility and accessibility which any student enrolled in higher level education, regardless of ability, will find beneficial (Griful-Freixenet *et al.*, 2017).

The UDL educational framework offers potential for enhancing students' engagement in anatomy learning in higher level institutions (Dempsey *et al.*, 2022). Many of the teaching strategies incorporated into anatomy education during the pandemic are aligned with the UDL framework, although none of the studies (Byrnes *et al.*, 2021; Harmon *et al.*, 2021; Harrell *et al.*, 2021) specifically mention that UDL underpinned the change in approaches to teaching anatomy. Although there is a lack of published research about the explicit utilization of UDL in anatomy education in general (Dempsey *et al.*, 2022), it is considered an effective tool to enhance student learning of anatomy with a recognized need for multiple means of engagement, representation, action and expression. Research by Balta et al. (2021) and Dempsey et al. (2022) shows that anatomy educators currently, and perhaps unknowingly, use various teaching methods and strategies when designing their curricula including the use of technology in its many forms (Bell III *et al.*, 2019; Ruthberg *et al.*, 2020).

Particularly, Ruthberg et al. (2020) incorporated mixed reality as an alternative to cadaveric dissection to utilize students' time more efficiently and, in turn, improve practical examination scores. They concluded that their mixed reality platform "HoloAnatomy" reduced the amount of time required for learning musculoskeletal anatomy without compromising student understanding, but they also acknowledged that not all students benefited from 3D resources and that individuals with less developed spatial abilities required more time viewing the 3D images (Ruthberg *et al.*, 2020). This is an example of how implementing one teaching method in isolation will not cater for all students equally. Therefore, there is a need for a variety of teaching methods to ensure that content is accessible to all students.

Bell et al. (2019) included the use of ultrasound in their curriculum to nurture an active learning environment for medical students studying the anatomy of the floor of the mouth, a teaching method which 97% of participating students (n =31) agreed improved their learning. Furthermore, research has identified active learning as an essential element in creating a productive learning environment as it fosters student participation and engagement (Felder & Brent, 2009) all of which are aims of UDL (CAST, 2021a). The approach of Bell et al. (2019) to incorporate active learning to help students become independent thinkers, also aligns with the aim of UDL (CAST, 2021a).

Universal Design for Learning caters for students with diverse learning needs, such as poor spatial recognition. This can be accomplished in anatomy curricula by including teaching strategies such as 3D visualisation software (Jamil *et al.*, 2019;

Lone, Mohamed and Toulouse, 2021) which allows students to view the learning material in different ways, which in turn helps with comprehension among learners.

More specifically, recent publications have reported the use of UDL in healthcare programs. Dickinson and Gronseth (2020) described the benefits and utility of the UDL framework for surgical education during the COVID-19 pandemic when face-to-face interaction was limited. Specifically, Dickinson and Gronseth (2020) used simulation, online resources, and mobile applications to aid the delivery of their curriculum to surgical residents in the US. Murphy et al. (2020) investigated, by means of an online survey, the implementation and knowledge of the tenets of UDL among occupational therapy educators in the US. They concluded that there is a need for more extensive use of UDL in preparation for teaching and continuing professional development as they propose its implementation would improve student learning and preparation for entering the discipline of occupational therapy (Murphy *et al.*, 2020). Additionally, Murphy et al. (2020) highlighted throughout their study that, as the student population in higher level institutions and student preferences for learning are becoming more diverse, UDL will become the key to ensuring that all occupational therapy students can be ready for effective clinical practice. Studies analyzing healthcare education in higher level institutions indicate that when designing curricula, educators may incorporate methods which align with the UDL framework, without explicitly stating that UDL was utilized (Dempsey *et al.*, 2022). Furthermore, anatomy educators may be utilizing the UDL framework but may not have measured or published the impact of its utilization in healthcare programs. For both reasons, an exploration of anatomy educators' knowledge and use of UDL is necessary and timely.

The aim of this study was to determine if anatomy educators in the ROI and UK were aware of the UDL framework and to assess if, and to what extent, they have been incorporating UDL in their curriculum design and delivery for healthcare students. Furthermore, the study explored if anatomy educators have identified or measured an impact on student learning, engagement, or motivation as a result of utilizing UDL; if there is an association between teaching experience and the incorporation of UDL; and finally, if educators have identified any barriers to implementing the UDL framework in their anatomy curricula.

Methods and Materials

Study Design

The authors developed and administered an anonymous online questionnaire to academic anatomy educators who were teaching in the anatomy departments of higher-level institutions in the ROI and UK. A list of such higher-level institutions was available on the Anatomical Society's website (Anatomical Society, 2021). The Anatomical Society seeks to promote and advance research and education in all aspects of anatomical science. The email addresses of anatomy educators from the above listed higher-level institutions were accessed through each of the respective higher level institutions websites. The online questionnaire was distributed via email from the first author (A.M.K.D.) to potential participants. The questionnaire was accessible through the survey platform, Microsoft Forms (Microsoft Corp., Redmond, WA). Ethical approval was obtained from the Institutional Social Research Ethics Committee [Log 2021-082].

Questionnaire Design

The questionnaire was divided into two sections. Section one gathered demographic information such as academic position, methods of teaching and assessing anatomy and the healthcare programs on which educators taught anatomy. Section two focused on the respondents' knowledge, experience, and opinion of the UDL educational framework. The questions in section two were a mixture of both open and closed questions. Open-ended questions were included to allow participants to elaborate and expand on questions. The questionnaire was open to participants for 12 weeks from July 5, 2021 to October 1, 2021. Reminders were sent out fortnightly via email to all potential participants. Although the questionnaire was distributed during the COVID-19 pandemic, none of the questions specifically mention the pandemic.

Data Analysis

All data were exported to Microsoft Excel (Microsoft Corp., Redmond, WA). Data were entered manually into Statistical Package for Social Scientists (SPSS), version 22 (IBM Corp., Armonk, NY). Descriptive analyses were completed including the lambda coefficient to identify associations between teaching experience and the utilization of UDL and frequency tables were created for categorical variables. Inductive content analysis was used to explore anatomy educators' opinions of UDL through open-ended questions (Elo and Kyngäs, 2008; Kyngäs, 2020). Verbatim quotes that captured the concepts articulated by a number of participants were included.

Results

The overall response rate was 23% (n= 61). The majority of anatomy educators who participated in this study were at lecturer level (n = 29, 48%) and were located in England (n = 39, 64%). The teaching experience of the participants ranged from less than one year to over 20 years. The majority of anatomy educators who taught on undergraduate programs taught medical students. Similarly, the majority of anatomy educators who taught on graduate entry programs (to students who already had an undergraduate degree in another discipline) also taught medical students. A large variety of methods were utilized to teach anatomy. Plastic models were reported to be the most utilized method (n = 54, 89%), closely followed by imaging (n = 52, 85%), didactic teaching (n = 52, 85%), technology (n = 52, 85%) and prosections (n = 51, 84%). Teaching anatomy with microscopes was the least utilized method by anatomy educators (n = 16, 26%). Participating educators were asked to indicate the most commonly used assessment methods for anatomy. Multiple choice questionnaires (MCQ) were the most selected method of assessment among the respondents (n = 56, 92%), followed by short answer questions (n = 39, 64%). Student self-assessment was the least utilized method of assessment (n = 15, 25%). All information from section one of the questionnaire is summarized in Table 5.1.

TABLE 5.1. Demographic information of participating anatomy educators

		Number of educators
Gender	Female	30 (49%)
	Male	30 (49%)
	Non-Binary	1 (2%)
Academic Position	Professor	13 (21%)
	Senior Lecturer	15 (25%)
	Lecturer	29 (48%)
	Tutor	1 (2%)
	Other	3 (5%)
Location	Ireland	9 (15%)
	Northern Ireland	1 (2%)
	England	39 (64%)
	Scotland	9 (15%)
	Wales	3 (5%)
Teaching Experience	Less than 1 year	1 (2%)
	1 – 3 years	7 (11%)
	4 – 6 years	11 (18%)
	7 – 10 years	13 (21%)
	11 – 15 years	9 (15%)
	16 – 20 years	6 (10%)
	More than 20 years	14 (23%)
Undergraduate Programs	Dentistry	14 (23%)
	Diagnostic Radiography	2 (3%)
	Medicine	47 (77%)
	Nursing	7 (11%)
	Occupational Therapy	5 (8%)
	Physiotherapy	7 (11%)
	Speech and Language Therapy	8 (13%)
	Therapeutic Radiography	2 (3%)
Graduate Entry Programs	Dentistry	3 (5%)
	Diagnostic Radiography	1 (2%)

	Medicine	19 (31%)
	Physiotherapy	1 (2%)
	Speech and Language Therapy	2 (3%)
	Therapeutic Radiography	1 (2%)
Teaching Methods	Plastic Models	54 (89%)
	Didactic	52 (85%)
	Imaging	52 (85%)
	Technology	52 (85%)
	Prosections	51 (84%)
	Osteology	46 (75%)
	Surface Anatomy	46 (75%)
	Dissection	45 (74%)
	Gamification	28 (46%)
	Team-based learning	28 (46%)
	Plastination	23 (38%)
	Kinesthetic	18 (30%)
	Peer-instructed Learning	18 (30%)
	Microscopes	16 (26%)
Assessment Methods	Multiple Choice Questionnaires	56 (92%)
	Short answer Questions	39 (64%)
	Essay	27 (44%)
	Objective Structured Clinical Examination	22 (36%)
	Extended Match Questions	21 (34%)
	Oral Examination	20 (33%)
	Group based Assessment	16 (26%)
	Student Self-assessment	15 (25%)

Awareness of UDL

Of the 61 respondents, only 19 (31%) stated that they had heard of the term UDL prior to completing the questionnaire. Of these 19 educators, 15 (79%) (and thus 25% of all respondents) had incorporated elements of UDL in their teaching of anatomy.

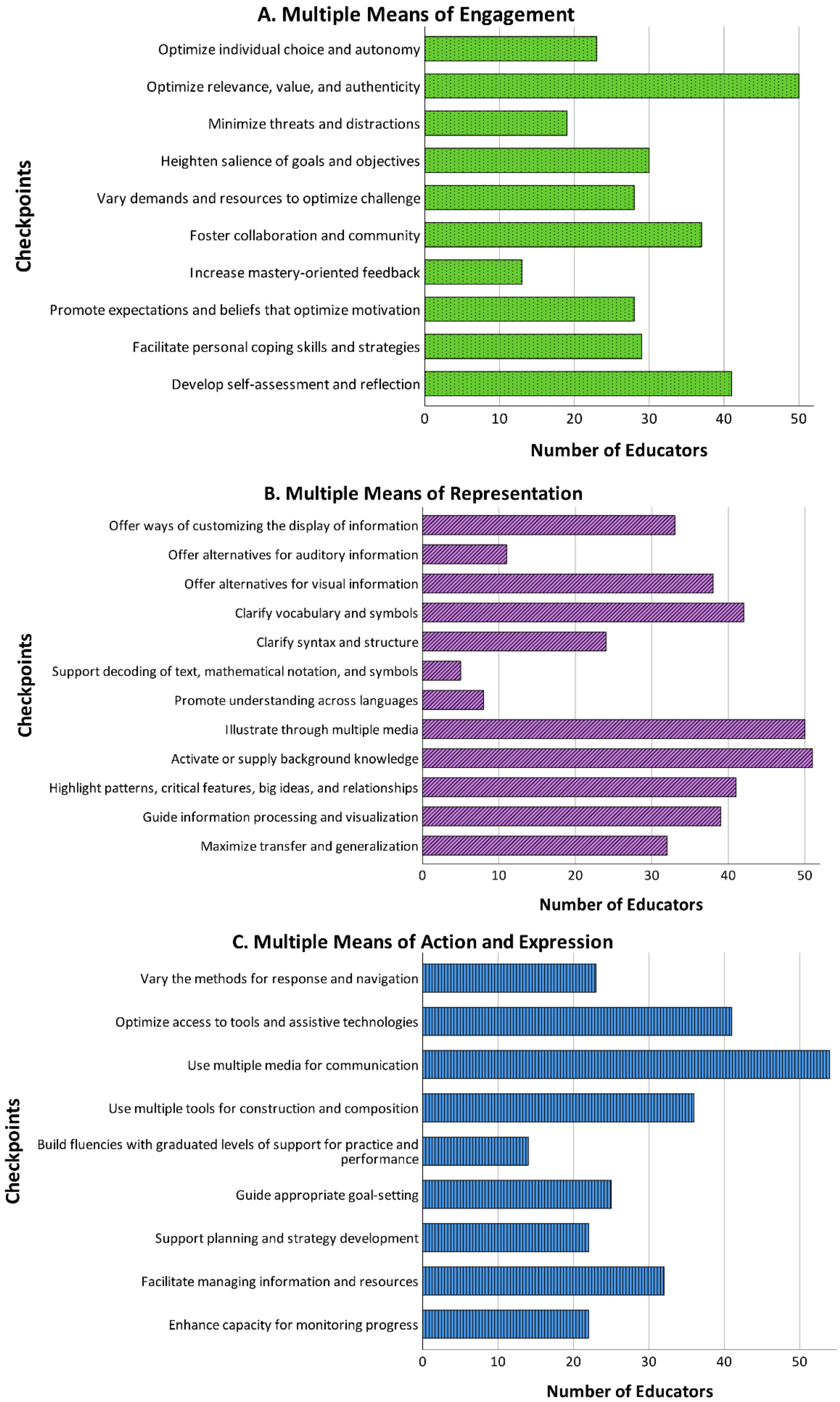

Figure 5.2 *The number of anatomy educators whose anatomy curriculum aligned with each checkpoint of the (A) multiple means of engagement principle, (B) multiple means of representation principle, and (C) multiple means of action and expression principle.*

Incorporation of UDL

Respondents were asked whether the design and delivery of their anatomy curriculum aligned with any of the UDL checkpoints. Every respondent identified at least one checkpoint from each of the three UDL principles in their curriculum. The most utilized checkpoint, from the multiple means of engagement principle, was "optimise relevance, value and authenticity" (n = 50) and the least utilized was "increase mastery-orientated feedback" (n = 13) (Figure 5.2A). The most utilized checkpoint from the multiple means of representation principle was "activate or supply background knowledge" (n = 51), followed closely by "illustrate through multiple media" (n = 50). The least utilized checkpoints from this principle were "support decoding of text, mathematical notation and symbols" (n = 5) and "promote understanding across languages" (n = 8) (Figure 5.2B). The most utilized checkpoint from the multiple means of action and expression principle was "use multiple media for communication" (n = 54) and the least utilized was "build fluencies with graduated levels of support for practice and performance" (n = 14) (Figure 5.2C).

Thirteen (21%) of the anatomy educators responded to the open-ended question "If you have utilized elements of UDL, can you give an example of how?". Eight of these 13 (62%) stated that they provide multiple means of representing the learning material. This is achieved by using several different formats including videos with closed captions, Microsoft PowerPoint slides with background information, digitally accessible documents, prosections, plastic models, and body painting. Five of these 13 (38%) respondents stated that they incorporate multiple means of engagement into their anatomy curricula by providing opportunities for the students to work together in pairs or small groups or by encouraging students to participate in self-directed learning. Two of these educators (15%) provided multiple means of action and expression by integrating a variety of assessment methods into the curriculum and by supporting the students to present their learning in a manner which best suits their learning style. For example, they encouraged students to palpate and draw surface anatomy and incorporate anatomy maps or applications when presenting their learning to their peers.

Impact of UDL on student learning, engagement, or motivation

Inductive content analysis was used to identify the impact of UDL on student learning, engagement and motivation, as perceived by the participants. Of the 13 anatomy educators who responded to the open-ended question "From your experience, how do you think UDL benefits teaching and learning within an anatomy module?", the majority (n = 11, 85%) stated that UDL provides students with options for interacting with the learning material which in turn promotes engagement among students, empowers them to learn, creates a nurturing environment and makes it easier for students to access information. More specifically educators stated that UDL *"reduces the need for reasonable adjustment"*, *"enables different cognitive processes to process information giving a richer learning experience and leading to deeper knowledge and longer-term retention. It offers flexibility and choice for learners but unless it is guided it can be overwhelming"* and *"improves engagement, appeals to wider variety of learners, helps students with self-assessment of progress and keeps instructors aware of individual learning needs of students"*. Furthermore, another educator commented that *"the (anatomical) language itself can be* *challenging and so it is important to ensure that this is clearly explained and providing a UDL approach gives students the best opportunity to be able to understand and engage not only with the physical anatomy but also with the language"* and *"variety is key as some students will engage with some aspects of the teaching and not in others"*.

Twelve respondents (20%) gave their opinion on whether the incorporation of UDL into curricula had an effect on student motivation to study anatomy. Two respondents did not think that the incorporation of UDL motivates students to learn anatomy. Three respondents said that they were not sure of the effect of UDL on motivation but that they were optimistic that it would have positive results. Specifically, one respondent said that they were *"not sure of the effect"* but that UDL has *"the potential for enhancing the student experience and in turn widening participation and motivation".* The remaining seven educators (58%) agreed that UDL has an effect on student motivation. Four of these educators did not elaborate on whether it was a positive or negative effect but of the other three, one stated that they have seen an increase in motivation among graduate entry students, another said that *"it (UDL) gives them (students) more freedom to learn in a way that is suitable for them and allows them to explore what works for them"* and the final respondent said *"it (UDL) has made the subject more 'fun' and less dry. Anatomy is not something to be learned and forgotten, it is meant to be applied to healthcare"*.

The anatomy educators were asked "if you are not familiar with UDL, from the description of the framework, what potential, if any, do you see UDL having for teaching and learning in anatomy curricula?". Of the educators who were not familiar with UDL (69%), their opinion of the framework was mixed. Six (14%) of these respondents reported minimal or no potential of UDL application for teaching and learning in anatomy curricula. The remaining responses in relation to the potential of UDL were positive. For example, comments included *“lots of potential, especially for enhancing the student experience and being inclusive to different groups”*, *“potential to give students a learning experience that best suits their individual needs within an intended outcome framework“*, “*it would seem that UDL encapsulates those principles that are crucial for recognizing that individuals learn differently and facilitating such individual learning”* and *“I think there is definitely scope for us to think more about providing variety of learning experiences within anatomy teaching”*. A word map was created to graphically represent the responses of participants to the open-ended question “what potential, if any, do you see UDL having for teaching and learning within anatomy curricula?” to emphasize the recurring opinions. The size of a particular word in the figure corresponds with how frequently it appeared in the responses of the educators (Figure 5.3). Word maps align with the UDL framework under the multiple means of representation principle. In particular, they align with Guideline 1, Checkpoint 1.1 “Offer ways of customising the display of information” (CAST, 2021a). For some readers, an image illustrating the most common responses may aid interpretation of the results.

Figure 5.3 *A word map created from anatomy educators' responses to the question "What potential, if any, do you see UDL having for teaching and learning within anatomy curricula?"*

Association between teaching experience and incorporation of UDL

A lambda coefficient statistical test was carried out to determine whether there was an association between respondents' teaching experience and their utilization of UDL. This resulted in a lambda score of 0.022 suggesting that there is no association between the number of years of teaching experience and the utilization of UDL among the responding anatomy educators.

Barriers to implementing the UDL framework in anatomy curricula

A small number (7%) of the anatomy educators commented on the practicalities of implementing UDL in anatomy curricula. Specifically, there was reference to a staff shortage *"with an intake of over 400 students per year and very few staff, personalization is not an option"* and *"it (UDL) is hard to formally implement when there is a staff shortage"*. Another educator said that UDL *"fits with best practice on teaching and learning but offers challenges in relation to assessment"*.

Discussion

At the outset of the present study, the majority of the respondents were unaware of the UDL framework. However, once they gained some information about UDL and the associated principles and checkpoints, they realized that they had, seemingly unknowingly, been implementing elements of the framework in their curriculum design and delivery. This suggests a need to inform educators of UDL and the potential benefits for teaching and learning of anatomy to healthcare students, especially when many of the respondents recognized the potential benefits of UDL in their responses to the open-ended questions. The present study did not investigate where educators, who were aware of the framework, had previously heard of UDL or if they received guidance on how to incorporate UDL into their curricula. Further research is needed to understand where and how educators are being made aware of the UDL framework, and whether supports are available to help guide them through the process of incorporating UDL into their anatomy curriculum design

Fifteen of the respondents (25%) stated that they had been incorporating UDL into their anatomy curriculum and all 61 respondents identified at least one checkpoint from each of the UDL principles in their curriculum. This suggests that educators are already incorporating elements of the UDL framework, albeit potentially unknown to themselves. A scoping review analyzing the design and delivery of anatomy curricula in healthcare programs in higher level institutions revealed that when designing curricula, educators may incorporate methods which align with the UDL framework, without explicitly stating that UDL was utilized

(Dempsey *et al.*, 2022). However, there are still a number of checkpoints which very few respondents of this study identified in their curriculum design. For instance, only 21% of educators identified the checkpoint “increase mastery-orientated feedback”, 31% identified the checkpoint “minimise threats and distractions” and 37% identified the checkpoint “optimise student choice and autonomy” (Figure 5.2A). Each of these checkpoints is categorized under the multiple means of engagement principle which helps foster self-directed and motivated learning. Various studies have shown that providing students with autonomy over their own learning is vital to sustain engagement and interest in the subject matter (Alsharari and Alshurideh, 2021; Goodman *et al.*, 2021; Hensley *et al.*, 2021). Similarly, it has been shown that providing students with immediate feedback allows students to engage with the learning process (Young *et al.*, 2021; Blondeel, Everaert and Opdecam, 2022).

There is no mandatory number of UDL checkpoints which educators should implement (Rao, Ok and Bryant, 2014), as some checkpoints are not appropriate for all subjects. For example, under the multiple means of representation principle, the checkpoint “support decoding of text, mathematical notation and symbols” is difficult to implement within anatomy curricula and therefore it was not surprising that only 8% of the respondents identified this checkpoint in their own curriculum design. Similarly, few respondents (13%) identified the checkpoint “promote understanding across languages” (Figure 5.2B). In comparison, a high number of respondents stated that their curriculum aligned with checkpoints such as “activate or supply background knowledge” (84%), “illustrate through multiple media” (82%) and “highlight patterns, critical features, big ideas and relationships” (67%) (Figure 5.2B), all of which are from the multiple means of representation principle and have been established as influencing successful student learning across various disciplines(Manthra Prathoshni, Vishnu Priya and Gayathri, 2018; Vieira *et al.*, 2019; List *et al.*, 2021; Ulfa *et al.*, 2021).

Specifically in anatomy education, Zafar and Zachar (2020) concluded that representing anatomy material in various formats, such as complementing the use of cadavers with AR, increased enjoyment and engagement among dental students. In relation to the multiple means of action and expression principle, some of the least identified checkpoints were “support planning and strategy development” (38%), “enhance capacity for monitoring progress” (36%) and “vary the methods for response and navigation” (36%) (Figure 5.2C). However, studies have identified that varying the way students navigate and participate in the learning environment, and guiding student goal-setting helps nurture strategic and goal-directed anatomy learners (Eleazer and Scopa Kelso, 2018; Hernandez *et al.*, 2020; Donkin and Rasmussen, 2021; Grønlien *et al.*, 2021). Incorporating each of these guidelines would provide learners with the opportunity to express their knowledge in a manner which is most appropriate to them, and to track their progress, which in turn would allow them to identify areas where they may be struggling, or indeed excelling, all of which helps learners to become strategic and goal driven (CAST, 2021a).

Edyburn and Edyburn (2021) describe the essential practices required to help any educator implement UDL in a manner which provides meaningful support for the diverse student population so that every learner can be successful. The authors emphasize that there is a requirement to understand the philosophy of UDL, but additionally that there is a need to bridge the gap between knowing about and implementing UDL. The authors propose the utilization of UDL for the design and delivery of anatomy curricula, as UDL encapsulates a number of pedagogical theories, such as self-determination theory (SDT) (Deci and Ryan, 2000; Hu and Zhang, 2017), generative learning theory (GLT) (Wittrock, 1974; Brod, 2021) and cognitive flexibility theory (CFT) (Spiro *et al.*, 1991) into one framework. Universal Design for Learning also aligns with the FAIR principles postulated by Harden and Laidlaw (2016). In particular, UDL checkpoint 7.1 “optimise individual choice and autonomy”, checkpoint 7.2 “optimise relevance, value and authenticity” and checkpoint 8.4 "increase mastery-oriented feedback" align with the FAIR principles to individualise learning to students needs, make learning relevant and provide feedback students with feedback. Thus, educators may look to one framework for guidance, when designing their curriculum delivery, rather than multiple different theories. The present study illustrates the knowledge and perceived impact of UDL among anatomy educators in the ROI and UK. At the outset of this study, many of the respondents stated that they were not aware of the UDL framework, but at the end of the questionnaire they stated that they believed they were implementing elements of the framework in their curriculum design and delivery. These anatomy educators utilized various accessible and inclusive teaching methods and, in a number of cases (12%), noticed improvements in student motivation and engagement as a result. The questionnaire provided educators with a very basic description of UDL. Perhaps with more detailed information they would be able to identify the areas in their curriculum that could be updated or modified. Teaching methods that align with the UDL framework have been reported to have a positive impact on learning among students with a variety of learning preferences across an array of programs in a higher level institution in the US (Black, Weinberg and Brodwin, 2015). The authors concluded that representing learning material in various formats, regularly providing students with constructive feedback, and assessing students using diverse methods was beneficial to student learning, all of which aligns with UDL checkpoints (CAST, 2021a). Murphy et al. (2020) suggested that since UDL has been effectively implemented in aiding the transition of students with disabilities to higher level institutions, then perhaps it could potentially be used to help students without disabilities in their transition to higher level institutions (Murphy *et al.*, 2020). Furthermore, the UDL framework incorporates strategies like flexibility and accessibility to learning material which any higher level education student, regardless of ability would find beneficial (Griful-Freixenet *et al.*, 2017).

The respondents' teaching experience ranged from less than one year to more than 20 years. Results from the lambda coefficient statistical test identified that there was no association between experience and the utilization of UDL, indicating that the educators' awareness of UDL and its implementation in anatomy curricula is not reliant on the extent of teaching experience.

Inductive content analysis was used to explore the participating anatomy educators' opinions of UDL. From this analysis it became clear that, according to the respondents, the main barrier of incorporating the UDL principles into anatomy curricula is a staff shortage. Staff shortage in anatomy programs has been documented (Kramer *et al.*, 2020; Wilson *et al.*, 2020). Thus, there may be a negative association with implementation of a new teaching framework to anatomy curricula due to the increased workload that typically accompanies curricular change.

However, respondents may not yet be aware of recent publications guiding educators to incorporate UDL into their curriculum design and delivery (Cotán *et al.*, 2021; Edyburn, 2021; Luke, 2021; Xie and Rice, 2021). Arguably, once anatomy educators are more knowledgeable about UDL, they will have an increased understanding of how easily they can tailor their curricula to accommodate all students, without the major workload they may have originally thought was required.

Lee and Griffin (2021) highlight that not all educators will be comfortable implementing UDL in their curriculum design and delivery right away. Rather, they will require time to become confident with potentially new teaching strategies. Incorporation of UDL into assessment is highlighted as a barrier by one respondent who stated that UDL *"fits with best practice on teaching and learning but offers challenges in relation to assessment"*. This could be addressed by the suggestions compiled by CAST to help educators implement UDL strategies in the design and delivery of their assessments. They propose that educators consider which actions are relevant to the information being assessed and which actions can be supported or varied in order to obtain an accurate account of what each individual has learned (CAST, 2021b). The authors propose including a variety of question styles within an end-of-year assessment paper such as multiple-choice questions (MCQs), extended match questions, short answer questions, labelling of diagrams, true or false questions, and essays. For continuous assessment, educators could allow the students to decide how they want to demonstrate their knowledge, either through essay, PowerPoint presentation, or pre-recorded video, whilst adhering to the learning outcomes of the module. Providing all the students with the same options removes the perception of unfairness, as they all have the same opportunity to choose which format they prefer to be examined in.

Specific examples of how anatomy educators may incorporate UDL into the design and delivery of their anatomy curricula include: highlight the relevance of the information, the clinical significance, if there are any notable anatomical variations; vary the level of demands posed to students, include both straight forward, simple questions and higher order questions. Incorporation of these examples of UDL would thus serve to challenge the high performing students to sustain engagement, whilst also catering for the weaker student so that they do not become overwhelmed and discouraged. Other suggestions of how UDL could be incorporated into anatomy education include: provide immediate feedback via self-assessed practice examinations or using game-based learning platforms like Kahoot! During lectures or tutorials; display information in a variety of formats including text, images, video, animations and voice over narration; allow students to choose, when appropriate, how to complete an assignment using PowerPoint presentation, video presentation or written essay.

The COVID-19 pandemic provided a unique opportunity for educators in higher level institutions to implement UDL more extensively in anatomy curricula, as educators had to adjust and adapt their curriculum design and delivery rapidly. The multiple ways in which anatomy can be taught both successfully and inclusively were highlighted when educators were forced to teach anatomy remotely (Byrnes *et al.*, 2021; Goldman *et al.*, 2021; Patra, Ravi and Chaudhary, 2021). Longhurst et al. (2020) investigated the adaptations made specifically to anatomy education in the ROI and

UK in response to the COVID-19 pandemic. It was reported that the most commonly expressed concern among anatomy educators from the participating higher-level institutions (n = 14) was in relation to the time investment required to develop new resources to replace traditional lectures and practical classes. This concern overlaps with the concerns expressed by the anatomy educators participating in this study with regards to incorporating UDL into their curriculum design. Furthermore, 36% of the respondents in the Longhurst et al. (2020) study highlighted that there was a reduction in student engagement since the start of the pandemic. Engagement is one of the main three principles of the UDL framework (CAST, 2021a). In Australia and New Zealand, Pather et al. (2020) concluded that flexibility and adaptability were essential for the continuity of anatomy education programs during the COVID 19 pandemic, both of which are aims of UDL. Perhaps if educators were more aware of UDL and the ways in which it can be incorporated into curriculum design and delivery, it may have eased some of the burden and stress among educators, in relation to teaching, during the COVID-19 pandemic.

The study is not without limitations. There was a 23% response rate and therefore the results cannot claim to be representative of all anatomy educators in ROI and the UK. However, the demographic of the respondents was quite varied, thus removing an opportunity for bias. Furthermore, only educators whose email address was accessible through their institution's website were contacted to participate. Although this study was carried out during the COVID-19 pandemic, the questionnaire did not specifically mention the pandemic. Therefore, it cannot be stated for certain whether the teaching strategies utilized by the respondents were always being used, or whether they were new strategies utilized in response to a global pandemic.

Conclusion

In conclusion, this study highlights that anatomy educators from higher level institutions in the ROI and UK are implementing teaching strategies which align with the UDL framework. However, the majority of respondents were not aware that a specific name can be used to collectively identify the teaching methods used. There is still a lack of information on the benefits of the explicit utilization of UDL in anatomy curricula of healthcare programs in higher level institutions. Furthermore, the authors conclude that it would be beneficial to introduce the UDL framework to anatomy educators in the ROI and UK. The potential positive impact of the explicit utilization of UDL on healthcare students' learning, engagement, motivation, and experience in higher level education is evident. The optimal method of distributing this information to educators requires consideration and research.

Chapter Six

General Discussion

6. 1 Overview

The design and delivery of anatomy curricula is currently undergoing transformation nationally and internationally (Evans and Pawlina, 2021; Iwanaga, Loukas, *et al.*, 2021; Smith *et al.*, 2021; Lachman and Pawlina, 2022). There are numerous reasons for this change including, but not limited to, the reduction in time allocated to teaching anatomy in healthcare programmes (Smith *et al.*, 2021), a shortage of anatomy educators (Wilson *et al.*, 2020) and more recently the Covid-19 pandemic (Evans *et al.*, 2020). Furthermore, the student population has evolved. Current first year undergraduate programmes typically comprise of learners from a generation accustomed to teaching strategies which utilise technology and active learning techniques, as opposed to solely didactic approaches (Boysen, Daste and Northern, 2016; Estai and Bunt, 2016; Hu, Wattchow and de Fontgalland, 2018), although this cannot be presumed for all learners (Das and Al Mushaiqri, 2021). Additionally, educators are also becoming more aware of students' individual learning needs and preferences, hence educational changes are being made (Hu *et al.*, 2018; Lorenzo-Alvarez *et al.*, 2020; Seidlein *et al.*, 2020). Notwithstanding these developments, there is minimal research on specific pedagogical frameworks for optimal design and delivery of anatomy curricula in healthcare education.

There is a consensus that a single approach to teaching anatomy is neither effective nor efficient for successful student learning but rather, a multimodal, blended, approach is required (Hernandez *et al.*, 2020; Stunden *et al.*, 2021; Abu Bakar *et al.*, 2022). In particular, the combination of traditional methods complemented with innovative, modern teaching strategies is reported to be optimal (Wish-Baratz *et al.*, 2020; Bölek, De Jong and Henssen, 2021; Shin *et al.*, 2022).

This research thesis investigated whether the Universal Design for Learning (UDL) pedagogical framework has been utilised in the design and delivery of anatomy curricula for healthcare students. The scoping review (Chapter Two) informed the development of three subsequent empirical studies. The first empirical study (Chapter Three) established the motivation levels of first year undergraduate healthcare students to study anatomy. The second (Chapter Four) and third empirical studies (Chapter Five) examined the awareness and perception of UDL among undergraduate healthcare students, specifically those studying medicine, dentistry, occupational therapy (OT) and speech and language therapy (SLT) and also the anatomy educators based in the ROI and UK. Overall, this thesis established a gap in knowledge regarding the utilisation and benefit of UDL in anatomy curricula for healthcare students. Moreover, this thesis reports that first year healthcare students were positive in their perception of UDL in their anatomy curricula. Additionally, the thesis established that a small number of anatomy educators in the ROI and UK are aware of the UDL framework and that even less are consciously incorporating UDL in the design of their curricula. This chapter will discuss the various findings of this research thesis in order of the initial thesis aims:

1. To investigate the utilisation of UDL in anatomy healthcare education, specifically in medical, dental, OT and SLT programmes.

2. To establish first year undergraduate medical, dental, OT and SLT students' motivation to study anatomy at the start and end of their respective anatomy modules and identify any changes that may occur.
3. To determine whether first year undergraduate medical, dental, OT and SLT students studying anatomy are aware of the UDL framework.
4. To explore whether third level anatomy educators in the ROI and UK are aware of the UDL framework.

6.2 Application of Universal Design for Learning in Anatomy Curricula

A scoping review was carried out to identify whether the UDL framework has been utilised in anatomy curricula of healthcare students, specifically medical, dental, OT and SLT programmes and whether any benefits of UDL have been reported. Importantly, the review established that there have not been any publications in the field of anatomy education which specifically mention using the UDL framework. Furthermore, the studies did not mention any other pedagogical framework as the basis for the design or delivery of the anatomy curricula. Nevertheless, many of the teaching strategies described in the identified studies aligned with the UDL framework. The studies also reported various benefits for the students due to the utilisation of the teaching strategies which aligned with UDL, strategies such as gamification, small group learning and informational videos. These observations suggest that UDL would be an appropriate pedagogical framework to formally implement in the design and delivery of anatomy curricula.

6.3 Motivation to Study Anatomy

Motivation has been identified as critical for successful student learning (Afflerbach and Harrison, 2017). Understanding how anatomy healthcare students are motivated is essential for future curriculum design (Zilundu, Chibhabha, Yu, *et al.*, 2022). Chapter Three investigated the level of academic motivation to study anatomy among first year undergraduate healthcare students, both at the start and end of their anatomy module. The study also identified changes in their level of motivation over the course of the respective anatomy modules. Such changes in self-reported motivation may be cause for revaluation of the design and delivery of anatomy curricula and more specifically, a focus on how students are, or could be, further motivated and engaged in the process of learning. Additionally, the study identified opportunities where the incorporation of UDL could potentially enhance motivation among first year healthcare students studying anatomy, such as emphasising the relevance of anatomy to help sustain student interest, varying the demands to optimise challenges and promote self-belief among learners.

The ability to identify why the level of self-reported motivation decreased over the duration of an anatomy module may help educators to avoid a repeat of such occurrences. Similarly, identifying how or why student motivation increased, could also benefit curriculum design. Test anxiety among three cohorts of students increased from the start of the anatomy module to the end, although the change was only significant among the medical students. This may have been, entirely or in part, due to impending summative examinations. Recent literature has reported the adverse effects of anxiety on student motivation and academic performance (Bolatli and Kizil, 2022). However, there remains a lack of research recommending teaching or other strategies to combat the negative effects of test anxiety on healthcare student motivation to study (Weiskittel *et al.*, 2021). Peer collaboration (Fournier *et al.*, 2017; Pickering and Bickerdike, 2017; Weiskittel *et al.*, 2021) and constructive feedback (Evans, Zeun and Stanier, 2014; Fournier *et al.*, 2017) have both been identified as strategies which help to alleviate anxiety among anatomy students. Each of these strategies aligns with a UDL checkpoint, specifically checkpoint 8.4 "Increase master-oriented feedback" and checkpoint 8.3 "Foster collaboration and community". Thus, it would be valuable to establish whether the inclusion of UDL in the design and delivery of anatomy curricula would help alleviate test anxiety among undergraduate first year healthcare students and in turn promote and enhance motivation. Additionally, there is a requirement to investigate whether the utilisation of UDL in anatomy curricula, specifically checkpoint 7.2 "Optimise relevance, value and authenticity", could enhance students' understanding of the relevance of anatomy to their chosen careers as all four cohorts of students reported a decrease in the motivational subscale "Task Value" by the end of their respective anatomy modules.

6.4 Healthcare Students' Perception of Universal Design for Learning

First year healthcare students studying anatomy as a part of their medical, dental, OT or SLT programme were surveyed during the academic year 2021/2022. The study gathered student perspectives and knowledge of UDL. There is a vast number of published research articles on student opinion and preference of anatomy teaching strategies, but there is no specific research study exploring students' opinion or perception of pedagogical frameworks utilised in anatomy curricula. More specifically, there is no research on healthcare anatomy students' awareness or perception of the UDL pedagogical framework. Understanding student opinion and perspective are paramount to ensure students' academic success (Davis *et al.*, 2014). Students should be informed as to why certain teaching strategies are being utilised during lectures, laboratory sessions, tutorials or self-directed learning (Hew and Lo, 2018). However, there are few studies investigating whether students understand the rationale behind teaching strategies and whether this understanding has an effect on learner engagement.

Participants of the student perspective study (Chapter Four) recognised that certain aspects of the UDL pedagogical framework had been implemented in their anatomy laboratory and lectures sessions. Furthermore, the students also identified the potential benefits of the formal utilisation of UDL in the design and delivery of their anatomy curriculum. Literature highlights that utilising teaching strategies which align with the UDL checkpoints improves student learning and academic outcomes (Golenhofen *et al.*, 2020; Ashokka, Ching Lee and Dong, 2021), specifically the checkpoint 3.3 "Guide information processing and visualisation" (Ben Awadh *et al.*, 2022), checkpoint 6.4 "Enhance capacity for monitoring progress" (Williams, Hawkins and Khalil, 2020) and checkpoint 8.4 "Increase mastery-oriented feedback" (Mogali *et al.*, 2020). Research has also shown that varying the method of delivering information in lectures enhances student engagement and satisfaction (Stepan *et al.*, 2017; Pascoe and Betts, 2020; Sarkar, Sharma and Raheja, 2021). Both student engagement and satisfaction are essential for the development of safe and knowledgeable healthcare professionals (Wilkinson *et al.*, 2020; Nedimyer, Hirumi and Cendan, 2022). Participants of the student perspective (Chapter Four) study were positive in their opinion of UDL and about how they were currently taught anatomy. Furthermore, the recommendations provided by the participants on how the design and delivery of their anatomy curricula could be improved align with the UDL framework. Student feedback included recommendations of visits and interactions with individuals who use the services of occupational therapists and speech and language therapists, which would be in accordance with checkpoint 7.2 "Optimise relevance, value and authenticity", and providing students with feedback from quizzes which aligns with checkpoint 8.4 "Increase mastery-oriented feedback".

6.5 Anatomy Educators' Perception of Universal Design for Learning

Educators teaching anatomy in third level institutions in the ROI and UK were surveyed (Chapter Five). The majority of respondents (69%) were unaware of UDL but they were able to identify elements of the framework in the design and delivery of their teaching, once they were informed about UDL. This suggests that anatomy educators have unknowingly incorporated elements of UDL into their curriculum design and delivery. However, it is worrisome that it was the minority, rather than the majority, of educators who identified the UDL checkpoint 7.1 "Optimise individual choice and autonomy" and checkpoint 8.4 "Increase mastery-oriented feedback" in their curriculum design as numerous studies have reported the importance of providing students with autonomy over their learning (Alsharari and Alshurideh, 2021; Goodman *et al.*, 2021; Hensley *et al.*, 2021). Autonomy is essential due to its ability to stimulate student engagement and motivation, which in turn improves student understanding (Marais *et al.*, 2019; Tripodi *et al.*, 2020). Studies have also identified the provision of feedback as critical for student engagement (Young *et al.*, 2021; Blondeel, Everaert and Opdecam, 2022). Although analysis indicated that the perception of UDL was mixed among participants, the majority of responses relating to UDL were positive and educators identified the benefit of UDL to enhance student engagement.

There is an increasing need to facilitate enhanced student engagement in anatomy education (Iwanaga, Loukas, *et al.*, 2021). However, not all teaching strategies suit every student equally (Hu *et al.*, 2018). Therefore, it is suggested that the curriculum design and delivery should adapt to sustain learner engagement (Chan *et al.*, 2021). One method of achieving this would be the utilisation of UDL in the design and delivery of third level anatomy curricula. However, UDL has yet to be formally utilised in anatomy curricula and thus there is no research study available on the specific benefits of UDL in anatomy education. However, the results of the educator perspective study (Chapter Five) suggest that anatomy educators are willing, perhaps even eager, to learn and be informed about methods and strategies which may enhance student learning. Previous studies outline how educators, of any discipline, could incorporate UDL into their curriculum design (Cotán *et al.*, 2021; Edyburn, 2021; Luke, 2021; Xie and Rice, 2021). Lee and Griffin (2021) comment that not all educators may be comfortable utilising UDL in their curriculum design and delivery immediately but rather, they will require time to become confident with potential new teaching strategies. Just as learners need to be guided through the learning process, educators too need to be guided and supported when bridging the gap between knowing about UDL and incorporating UDL. It should be noted that there is no obligatory number of checkpoints which educators should implement

(Rao, Ok and Bryant, 2014). The optimal way of distributing this information to educators requires further thought and research. However, an initial step could be the publication of a document on a platform, such as The Anatomical Society website, outlining and recommending ways in which UDL could be implemented specifically in design and delivery of anatomy curricula (Table 6.1). However, a single document would not be sufficient, educators would still require support and resources while they embark on the process of incorporating UDL in their anatomy curricula.

6.6 Covid-19 Pandemic

The COVID-19 pandemic resulted in many educators altering the design and delivery of their anatomy curriculum particularly when teaching was forced to occur remotely (Evans *et al.*, 2020; Pather *et al.*, 2020; Lone, Mohamed and Toulouse, 2021). In order for teaching to continue during those unprecedented times, innovative teaching methods were employed which were new and unfamiliar to some educators. Initially, it was not known how effective a new mode of delivery of anatomy curricula would be in comparison to face-to-face teaching (Poma *et al.*, 2022). The pandemic provided an opportunity for educators to incorporate teaching strategies which they, under normal circumstances, may have never considered (Evans *et al.*, 2020). Many of the innovative teaching strategies described in studies relating to anatomy teaching during the pandemic aligned with the UDL framework, such as gamification, self-assessment activities and the increased use of technology (Deepika *et al.*, 2020; Donkin and Rasmussen, 2021; Harrell *et al.*, 2021). The studies described in Chapter Four and Chapter Five were carried out during the outbreak of COVID-19. However, the pandemic is not explicitly mentioned in any of the studies in this thesis. Thus, it cannot be stated definitively whether the pandemic influenced any of the responses from those two studies. Educators reported utilisation of teaching strategies which aligned with UDL, such as video recording of lectures and tutorials. The incorporation of such teaching methods may have been in response to mandatory remote teaching. Similarly, the medical, dental, OT and SLT students reported the benefits of pre-recorded lectures, a teaching method which was not generally utilised prior to the pandemic.

6.7 Universal Design for Learning in Anatomy Curricula

There is limited literature critiquing the inclusion of UDL in higher level education. However, there are practicalities which must be overcome to optimally utilise UDL specifically in the design and delivery of anatomy curricula. For instance, in Chapter Five, anatomy educators in the ROI and UK expressed their concerns regarding the shortage of anatomy staff and the reduction in teaching hours. These concerns in turn caused the participants to have reservations about the incorporation of UDL and the time requirements that may be needed to implement the framework efficiently. It needs to be highlighted to anatomy educators that the utilisation of UDL does not require an entire redesign of their current curriculum. Although, it is more efficient to embed UDL from the start of curriculum design, it is possible to incorporate UDL into established curricula. Table 6.1 suggests specific ways in which anatomy educator could incorporate UDL into their curriculum design and delivery, such as adding captions to videos, using interactive game-based software like Kahoot! to provide immediate feedback and circulating learning material in a format which allows font or test size to be adjusted. As the premise of UDL is to guide and support learners on their educational journey, educators too need to be supported and guided on their journey towards accessible and inclusive teaching.

6.8 Recommendations for Future Studies

This thesis established that there are few anatomy educators in the ROI and UK who are aware of the UDL framework. There is an opportunity for future research to identify methods of optimally informing and supporting educators to incorporate UDL in their curriculum design and delivery. Indeed, there are a number of third level institutions in the ROI now promoting the uptake of postgraduate teaching and learning certificates by academic staff so that they may learn more about UDL and how to incorporate more inclusive and flexible teaching strategies (UCC, 2022b; UCD, 2022; UL, 2022). This development of these teaching and learning certificates for educators aligns with the goals of the Department of Further and Higher Educations' recent publication, '*National Access Plan: A strategic action plan for equity of access, participation and success in Higher Education 2022 – 2028'* (HEA, 2022a) and a discussion paper published by the Royal Irish Academy, '*Equity, Diversity and Inclusion in Higher Education in Ireland and Northern Ireland'* (Royal Irish Academy, 2021).

Furthermore, there is a lack of information on the potential benefits of the explicit utilization of UDL in anatomy curricula of healthcare programs in third level institutions. Thus, it is suggested that a future study should identify opportunities where UDL could be optimally incorporated into the design and delivery of an anatomy module. This could then be followed by a survey to establish student perception and opinion of specific teaching strategies which have been purposefully designed to align with the UDL pedagogical framework, and thus report on the observed utility of UDL. It is recommended that this study be carried out among all students but particularly among first year undergraduate medical, dental, OT and SLT students. Particular emphasis is required on the anatomy education of first year undergraduates as these students are generally adolescents and are at the beginning of their transition to third level education (Sawyer *et al.*, 2018). UDL considers learner variability and the developmental stage of learners, and thus the framework aims to provide students of varying abilities opportunities to engage in inclusive learning environments (Schreffler *et al.*, 2019). Additionally, undergraduate first year students are typically new to third level education and may require supports and guidance on how to develop learning strategies which will help them to fulfil their potential and become successful learners (Fives, Lone and Nolan, 2022).

Longitudinal studies should also be carried out to determine whether the utilisation of UDL has an impact on student retention of anatomy knowledge beyond their first year. This may identify whether the incorporation of UDL in the design and delivery of anatomy curricula would help to alleviate the concerns among healthcare professionals regarding the reportedly poor anatomy knowledge of new healthcare graduates (O'Keeffe, Davy and Barry, 2019; Kumar and Singh, 2020). Research is also needed to investigate whether the incorporation of UDL has an impact on students' perceived value of anatomy as studies have identified perceived value as a critical component of student engagement and motivation (Finn *et al.*, 2019; Grosser *et al.*, 2019; Carroll, Tracy-Bee and McKenzie, 2021).

6.9 Implications for Educational Policy

The research presented in this thesis is timely as educational policy in the EU, ROI and Northern Ireland (NI) is emphasising the requirement for teaching and learning to be more inclusive of all individuals (European Commission, 2017; Royal Irish Academy, 2021; HEA, 2022a). Thus, this research and recommended future studies may help to further support educators as they seek to enhance the accessibility and inclusivity of their curricula. Furthermore, discussing the incorporation of UDL in anatomy curricula now, allows for greater opportunities for examination and consideration regarding the most effective and optimal methods to utilise the framework in anatomy curricula. Discussions should occur before educational policy of individual higher level institutions make the utilisation of UDL mandatory, like it recently has in De Montfort University Leicester, UK (De Montfort University, 2022).

From a personal viewpoint as a Senior Medical Demonstrator in the Facility for Learning Anatomy, Morphology and Embryology (FLAME) laboratory, I could encounter more than 600 students over the duration of a single week, attending their respective anatomy practical sessions. In the laboratory, students have the opportunity and option to study using a variety of resources such as prosections, 3D models, anatomy atlases, plastinated specimen and computer programmes. The practical sessions are set up in a rotational manner with five stations in total. One station is demonstrator led and the students receive a tutorial using the prosections as visual aid. The remaining stations are student-led but a demonstrator is available to answer questions at these stations (Balta, Supple and O'Keeffe, 2021).

Figure 6.1 *Images of the FLAME laboratory showing some of the plastic models available to both educators and students* (UCC, 2022a).

I have noticed the different learning preferences among students. Some students prefer only to look at the prosections, whereas other need the combination of anatomy atlases, models and prosections to help orientate and identify various structures. In these instances, students do not need to verbalise their preferences, because the various options and materials are available for them to use when required. This is an example of UDL, as students are being provided with multiple means of representation and have the opportunity to choose which resource they prefer, aligning with checkpoint 7.1 “optimise individual choice and autonomy”. Similarly, some students spend majority of their time in the laboratory at the practice spot examination as they prefer to test themselves. This self-assessment provides students with immediate feedback and allows them to monitor their progress, each of which aligns with a UDL checkpoint, specifically checkpoint 6.4 “Enhance capacity for monitoring progress”, checkpoint 8.4 “Increase mastery-orientated feedback” and checkpoint 9.3 “Develop self-assessment and reflection”. Additionally, the practice examination helps to alleviate anxiety among the students as they can visualise and anticipate what the summative examination will entail, thus allowing them to concentrate on content of the examination rather than its set up. This aligns with checkpoint 7.3 “Minimise threats and distractions”. However, it should be emphasised to students that although there are numerous options for engaging with the learning material, they do not necessarily need to use them all. For instance, if a student prefers to study from lecture slides and an anatomy atlas, there is no requirement for them to study using computer programmes too.

The primary aim of UDL is to provide options for students, so that they may learn and participate in an inclusive environment with multiple resources available to utilise, which in turn allows them to fulfil their individual potential. From my observations as an anatomy educator and from the studies reported in this thesis, UDL is being implemented in anatomy curricula, but implementation does not appear to be occurring across anatomy curricula at the same rate either within the one institution, nationally or internationally. Thus, the new strategic plan published by the Department of Further and Higher Education (2022), ‘*National Access Plan: A strategic action plan for equity of access, participation and success in Higher Education 2022 – 2028’*, aims to standardise the incorporation of inclusive teaching practices. The information presented in this thesis may help guide anatomy educators to optimally incorporate UDL in their curriculum design and delivery, particularly those educators who may not be utilising any element of UDL yet.

6.10 Limitations of the Thesis

The limitations of each study were considered in each respective chapter of this thesis. Two of the empirical studies (Chapter Three and Chapter Four) were carried out only among students enrolled in UCC and therefore the generalisation of the results may be limited. Furthermore, two of the studies (Chapter Four and Chapter Five) were carried out during the COVID-19 pandemic. Although the strict "stay at home" order had been lifted in the ROI when the questionnaires were circulated, social distancing was still being employed for campus activities. The pandemic was not mentioned in the questionnaires distributed for either of the studies but may have influenced some participants' answers.

6.11 Conclusion

To summarise, this thesis established a large gap in the literature concerning the utilisation of the UDL pedagogical framework in the design and delivery of anatomy curricula in third level institutions. The studies described in each chapter highlight the potential benefits that the formal incorporation of UDL could have on student learning, engagement, motivation and on an overall inclusive learning experience.

Many anatomy educators utilise a multimodal approach to teach healthcare students by incorporating modern methods alongside more traditional teaching strategies (Deming *et al.*, 2021; Lone, Mohamed and Toulouse, 2021; Muraleedharan *et al.*, 2022). This blended approach promotes multiple means of student engagement, multiple means of representing learning material and multiple means of student action and expression of knowledge, which in turn aligns with the UDL pedagogical framework (CAST, 2021a). Utilisation of UDL provides students with an inclusive educational experience and more opportunities for students to excel in learning environments. Teaching strategies which align with UDL have been shown to enhance academic performance, collaboration and engagement among healthcare students studying anatomy (Felszeghy *et al.*, 2019; Oakes *et al.*, 2019; Abdullah, Lone and Balta, 2020; Mogali *et al.*, 2020; Rao Bhagavathula *et al.*, 2022). However, as identified in the research of this thesis, there is a paucity of information regarding the formal utilisation of UDL in anatomy healthcare curricula.

The incorporation of UDL in the design and delivery of anatomy curricula within healthcare programmes is supported by recent research emphasising the varied learning preferences of healthcare students (Ang *et al.*, 2018; Khanal *et al.*, 2019; Hernandez *et al.*, 2020; Sadeesh, Prabavathy and Ganapathy, 2021). Furthermore, educational policy in the ROI and NI is aiming towards a more inclusive, flexible and accessible learning experience for all individuals, regardless of academic abilities, physical abilities, personal circumstances and specific learning preferences, all of which UDL can accommodate when utilised optimally. The use of UDL in undergraduate healthcare student anatomy education can enable all students to reach their individual potential while enhancing and promoting an inclusive third level educational experience, and in turn support students to become safe and effective healthcare practitioners.

In conclusion, further research is required to formally identify the benefits of UDL in the design and delivery of third level anatomy curricula. However, results from the studies described in each chapter of this thesis indicate that the utilisation of UDL could greatly enhance healthcare students' motivation and engagement with the study of anatomy. Overall, both third level anatomy students and educators have reported the benefit of UDL and its potential positive impact on healthcare student learning and their overall educational experience.

Table 6.1. Candidate's suggestions for how each UDL checkpoint may be incorporated into the design and delivery of anatomy curricula

UDL Checkpoint	**Authors suggestions for incorporating UDL into anatomy curricula**
	Multiple Means of Engagement
7.1 Optimise individual choice and autonomy	- Provide various resources so that students can choose the method which they prefer o *Eg. Provide students the opportunity to choose between resources such as models, computer programmes, prosection atlases, animated atlases or augmented reality to aid their study*
7.2 Optimise relevance, value, and authenticity	- When discussing different anatomical structures, highlight whether there is any clinical significance associated with the structure o *Eg. Potential damage to the long thoracic nerve during a mastectomy* - Ensure that the learning outcomes are clear to the students o *Eg. List the learning outcomes at the start and end of lecture notes / presentations* - Incorporate activities which are relevant to students chosen careers o *Eg. Highlight the function and relevance of the larynx to SLT students, emphasise muscle action and movements to OT students, reiterate the importance of nerve pathways around the mouth for dental students administering anaesthetic*
7.3 Minimise threats and distractions	- Help students anticipate what is expected of them so that they can prepare for tasks o *Eg. Provide examples of an 'A' and 'F' standard answer / essay / presentation*
	Guideline 8 Provide options for Sustaining Effort and Persistence
8.1 Heighten salience of goals and objectives	- Reiterate the initial goal o *Eg. Mention the learning goals when starting and finishing a particular topic* - Use prompts to highlight desired learning outcomes o *Eg. List the learning outcomes at the start and end of lecture notes / presentations* - Use relevant examples which connect students' interests with the goal of the lesson o *Eg. Students need to know the position of the lungs and heart in relation to the thoracic cage and intercostal spaces so that they understand the correct positioning of the stethoscope*

8.2
Vary demands and resources to optimise challenge
	- Vary the degree of difficulty of core tasks
	    o *Eg. In examinations have a mixture of lower order questions and higher order questions*
	- When appropriate, provide alternative methods for completing tasks
	    o *Eg. A review of a topic could be completed through the submission of an essay, an oral presentation or pre-recorded video*

8.3
Foster collaboration and community
	- Introduce small group learning activities
	    o *Eg. Divide OT students into small groups to perform movement tasks*
	- Utilise opportunities for peer interactions
	    o *Eg. In practical sessions have students work in pairs at some stations but then have the opportunity to mix with other students at another station*

8.4
Increase mastery-oriented feedback
	- Provide opportunities for students to receive immediate feedback
	    o *Eg. Include practice spot examinations in practical sessions*
	    o *Eg. Use Kahoot! (or similar platform) in lectures*
	- Provide opportunities for students to participate in discussions about the learning material
	    o *Eg. Organise specific question and answer tutorial sessions*
	    o *Eg. Use the discussion board in your institutions Learning Management System (Canvas, Blackboard)*
	- Provide feedback on assessments
	    o *Eg. If the assessment was to design a presentation describing the embryological development of the nervous system, provide students with feedback not only on their knowledge of content, but their slide design or presentation skills*
	    o *Eg. If the wrong answer is repeatedly appearing in assessments, address the topic again*

Guideline 9 Provide options for Self Regulation	

9.1
Promote expectations and beliefs that optimise motivation
	- Increase the frequency of self-reflection
	   ○ *Eg. At the end of a topic give a short informal quiz and provide the students with the answers, this allows the students to reflect on their understanding of a certain topic before it is formally assessed*
	- Encourage students to set individual appropriate goals which acknowledge personal strengths
	   ○ *Eg. When learning insertion of the teres minor muscle, one student may be able to remember that it is the inferior facet of the greater tubercle of the humerus, another may only be able to remember greater tubercle and a final student may only remember it is the humerus*

9.2 Facilitate personal coping skills and strategies	- Guide students on where to find external emotional support ○ *Eg. Contact details for student health and services*

9.3
Develop self-assessment and reflection
	- Include tasks which provide students with feedback so that they may track their progress and reflect on said progress
	   ○ *Eg. At the end of a topic give a short informal quiz and provide the students with the answers, this allows the students to reflect on their understanding of a certain topic before it is formally assessed*
	   ○ *Eg. Include practice spot examinations in practical sessions*
	   ○ *Eg. Use Kahoot! (or similar platform) in lectures*

Multiple means of Representation	
Guideline 1 Provide options for Perception	

1.1
Offer ways of customising the display of information
	- Use formats which allow students to customise the display of information for instance:
	   ○ *The size of text, images or graphs*
	   ○ *The contrast between backgrounds and text*
	   ○ *The volume or rate of speech*
	   ○ *The font used for printed materials*

1.2
Offer alternatives for auditory information
	- Accompany auditory information with visual diagrams, charts or written transcripts
	    o *Eg. When discussing the pathway of the recurrent laryngeal nerve, an image may make it easier to emphasise that the pathway is different on either side of the body*
	    o *Eg. Use captions in videos*

1.3
Offer alternatives for visual information
	- Accompany imagery with descriptions
	    o *Eg. Include descriptions alongside images and graphics*
	    o *Eg. Provide 3-Dimensional models to help with spatial understanding of anatomical relationships and positioning*

Guideline 2 Provide options for Language and Symbols	

2.1
Clarify vocabulary and symbols
	- Highlight whether certain vocabulary to help create connections between learners' experience and prior knowledge
	    o *Eg. When students are labelling muscles and identifying landmarks, if they already know that supra means above this can help them label supraspinatus as it is above the spine of the scapula*
	- Emphasise terms and phrases and show how they may be composed of simpler language and still retain the same meaning
	    o *Eg. The Foramen of Magendie is also the median aperture of the fourth ventricle*

2.2 Clarify syntax and structure	- Make connections to information learned previously o *Eg. The muscles sternocleidomastoid, can be broken down to help students understand its origins and insertion, the muscles will originate from the sternum and clavicle and will insert into the mastoid process*
2.3 Support decoding of text, mathematical notation, and symbols	- Include lists of key terms o *Eg. Provide a list of recurring anatomical terminology such as anterior, posterior, dorsal and ventral that students can refer back to throughout the module*

2.4
Promote understanding across languages
	- Provide electronic translation tools or multilingual glossaries
	    ○ *Eg. Microsoft translator for Education (https://www.microsoft.com/en-us/translator/education/)*
	- Create a list of structures or landmarks which mean the same thing
	    ○ *Eg. Hepatic flexure is the same as left colic flexure, bicipital groove is the same as intertubercular sulcus*
	- Include visual aids to support the clarification of vocabulary
	    ○ *Eg. When discussing complex topics, an image or model helps understanding*

2.5
Illustrate through multiple media
	- Convey key information through various mediums
	    ○ *Eg. Use text, illustrations, animations and / or 3D models to emphasise a particular point*
	- Highlighting the connections between the different formats
	    ○ *Eg. After describing a structure on a model and then pointing out the same structure on a prosection, ensure to highlight certain landmarks that are clear on both the model and prosection so that the student can orientate themselves on the prosection*

Guideline 3 Provide options for Comprehension	

3.1
Activate or supply background knowledge
	- Highlight prerequisite information
	    ○ *Eg. If the students have already studied the mediastinum and are now moving on to the head and neck, make it clear that they already learned where the common carotid arteries branch from*
	- Activate students background knowledge
	    ○ *Eg. If the students studied the phrenic nerve in the posterior triangle but do not study it again until they are studying the respiratory system, remind them that they have seen this nerve before*

3.2 Highlight patterns, critical features, big ideas, and relationships	- Remind learners of the material or skills which they have already learned to help overcome unfamiliar problems ○ *Eg. If students are struggling to identify a structure on a prosection, remind them to look at the entire prosection and identify a landmark that they know and work from that point*

<table>
<tr><td>3.3
Guide information processing and visualisation</td><td>- Provide numerous entry points to a topic or subject
    o Eg. Use images, videos and / or models to guide understanding</td></tr>
<tr><td>3.4
Maximise transfer and generalisation</td><td>- Include dedicated time for review and practice
    o Eg. Assign an entire or half of a lecture, tutorial or practical session for a review of the material with opportunities for students to gain immediate feedback
- Introduce prompts that link new information with prior learnings
    o Eg. If the students studied the phrenic nerve in the posterior triangle but do not study it again until they are studying the respiratory system, remind them that they have seen this nerve before</td></tr>
<tr><td colspan="2" align="center">Multiple Means of Action and Expression</td></tr>
<tr><td colspan="2" align="center">Guideline 4 Provide options for Physical Action</td></tr>
<tr><td>4.1
Vary the methods for response and navigation</td><td>- Provide options for how students navigate an activity
    o Eg. Vary the time or speed required to carry out particular activities</td></tr>
<tr><td>4.2
Optimise access to tools and assistive technologies</td><td>- Choose educational software which work smoothly with keyboard alternatives
    o Eg. Some students may not be able to use a computer mouse and prefer to use the arrow keys on a keyboard instead
    o Eg. Provide keyboard commands which can substitute for mouse action</td></tr>
<tr><td colspan="2" align="center">Guideline 5 Provide options for Expression and Communication</td></tr>
<tr><td>5.1
Use multiple media for communication</td><td>- For the completion of assignments, allow students to communicate via text, speech, video or illustration
    o Eg. When presenting a clinical scenario in small group learning sessions, encourage the students to use multiple media in their discussion for instance a video portraying a patient with Bell’s Palsy</td></tr>
</table>

5.2
Use multiple tools for construction and composition
	- Promote software such as:
	  ○ *Text-to-speech*
	  ○ *Spelling and grammar checkers*
	  ○ *Concept mapping tools*
	  ○ *Relevant web applications*

5.3
Build fluencies with graduated levels of support for practice and performance
	- Include tutors or working professionals who may approach teaching and motivation in a new way
	  ○ *Eg. Demonstrators in practical sessions*
	  ○ *Eg. Healthcare professionals currently working may know strategies that enhance learning in third level education but will also stand to the students when they are working professionals*
	- Provide individual, personalized feedback
	  ○ *Eg. If the assessment was to design a presentation describing the embryological development of the nervous system, provide students with feedback not only on their knowledge of content, but their slide design or presentation skills*

Guideline 6 Provide options for Executive Functions	

6.1
Guide appropriate goal setting
	- Provide prompts so that students may estimate effort and difficulty
	  ○ *Eg. All students should know the five terminal branches of the brachial plexus, but it may require more effort for some students to learn the nerves branching from the roots and trunks*
	- Highlight learning outcomes and objectives
	  ○ *Eg. List the learning outcomes and objectives at the start and end of lecture notes / presentations*

6.2
Support planning and strategy development
	- Provide checklists and planning templates
	  ○ *Eg. There are various websites (www.ithinkwell.com.au) which have numerous free templates for agendas, to do lists, and planners*
	- Encourage students to breakdown long term goals into more attainable short-term objectives
	  ○ *Eg. If a students aims to get top marks in the module as their long term goal, encourage them to use continuous assessments / practice spot examinations as short term objectives*

6.3 Facilitate managing information and resources	- Encourage the utilisation of checklists and graphic organisers to help students collect their thoughts and resources ○ *Eg. Give an example of how to use mind mapping effectively in a tutorial session*
6.4 Enhance capacity for monitoring progress	- Supply feedback in a timely fashion which is, enlightening and explicit ○ *Eg. Applications such as Kahoot! provide immediate feedback for students as well as informing educators of the class's understanding of a topic*

Appendices

Appendix 1 Supplementary information for scoping review

Search Strategy and Search Results

Database: ERIC Date Searched: 30 September 2021

Articles Retrieved: 361

Search strategy:

1. "universal design for learning" AND "healthcare education"
2. "universal design for learning" AND "anatomy education"
3. "universal design for learning" AND "undergraduate" AND "medical"
4. "universal design for learning" AND "education" AND "health"
5. "universal design for learning" AND "occupational therap*" AND "education"
6. "universal design for learning" AND "medic*" AND "education"
7. "universal design for learning" AND "speech – language therap*" AND "education"
8. "universal design for learning" AND "dent*" AND "education"
9. "accessib*" AND "healthcare education" AND "anatomy"
10. "inclusi*" AND "intervention" AND ("education" OR training") AND "allied health"
11. "collab*" AND "allied health" AND "education"
12. "inclusi*" AND "college student*" AND "healthcare education"
13. ("accessib*" OR "inclusi*") AND ("healthcare education" OR "allied health") AND "education"
14. "universal design for learning" AND "speech-language patholog*" AND "education"
15. ("inclusi*" OR "collab*") AND "motivation" AND "healthcare education"
16. ("inclusi*" OR "collab*") AND "motivation" AND "anatomy education"

Database: CINAHL Date Searched: 30 September 2021

Articles Retrieved: 92965

Search strategy:

1. TX = “universal design for learning” AND “healthcare education”
2. TX = “universal design for learning” AND “anatomy education”
3. TX = “universal design for learning” AND “undergraduate” AND “medical”
4. TX = “universal design for learning” AND “education” AND “health”
5. TX = “universal design for learning” AND “occupational therap*” AND “education”
6. TX = “universal design for learning” AND “medic*” AND “education”
7. TX = “universal design for learning” AND “speech – language therap*” AND “education”
8. TX = “universal design for learning” AND “dent*” AND “education”
9. TX = “accessib*” AND “healthcare education” AND “anatomy”
10. TX = “inclusi*” AND “intervention” AND (“education” OR training”) AND “allied health”
11. TX = “collab*” AND “allied health” AND “education”
12. TX = “inclusi*” AND “college student*” AND “healthcare education”
13. TX = (“accessib*” OR “inclusi*”) AND (“healthcare education” OR “allied health”) AND “education”
14. TX = “universal design for learning” AND “speech-language patholog*” AND “education”
15. TX = (“inclusi*” OR “collab*”) AND “motivation” AND “healthcare education”
16. TX = (“inclusi*” OR “collab*”) AND “motivation” AND “anatomy education”

Database: PubMed Date Searched: 30 September 2021

Articles Retrieved: 2252

Search strategy:

1. (ALL Fields) = (“universal design for learning” AND “healthcare education”)
2. (ALL Fields) = (“universal design for learning” AND “anatomy education”)
3. (ALL Fields) = (“universal design for learning” AND “undergraduate” AND “medical”)
4. (ALL Fields) = (“universal design for learning” AND “education” AND “health”)
5. (ALL Fields) = (“universal design for learning” AND “occupational therap*” AND “education”)
6. (ALL Fields) = (“universal design for learning” AND “medic*” AND “education”)
7. (ALL Fields) = (“universal design for learning” AND “speech – language therap*” AND “education”)
8. (ALL Fields) = (“universal design for learning” AND “dent*” AND “education”)
9. (ALL Fields) = (“accessib*” AND “healthcare education” AND “anatomy”)
10. (ALL Fields) = (“inclusi*” AND “intervention” AND (“education” OR training”) AND “allied health”)
11. (ALL Fields) = (“collab*” AND “allied health” AND “education”)
12. (ALL Fields) = (“inclusi*” AND “college student*” AND “healthcare education”)
13. (ALL Fields) = ((“accessib*” OR “inclusi*”) AND (“healthcare education” OR “allied health”) AND “education”)
14. (ALL Fields) = (“universal design for learning” AND “speech-language patholog*” AND “education”)
15. (ALL Fields) = ((“inclusi*” OR “collab*”) AND “motivation” AND “healthcare education”)
16. (ALL Fields) = ((“inclusi*” OR “collab*”) AND “motivation” AND “anatomy education”)

Database: Web of Science Core Collection   Date Searched: 30 September 2021

Articles Retrieved: 1231

Search strategy:

1. (ALL Fields) = (“universal design for learning” AND “healthcare education”)
2. (ALL Fields) = (“universal design for learning” AND “anatomy education”)
3. (ALL Fields) = (“universal design for learning” AND “undergraduate” AND “medical”)
4. (ALL Fields) = (“universal design for learning” AND “education” AND “health”)
5. (ALL Fields) = (“universal design for learning” AND “occupational therap*” AND “education”)
6. (ALL Fields) = (“universal design for learning” AND “medic*” AND “education”)
7. (ALL Fields) = (“universal design for learning” AND “speech – language therap*” AND “education”)
8. (ALL Fields) = (“universal design for learning” AND “dent*” AND “education”)
9. (ALL Fields) = (“accessib*” AND “healthcare education” AND “anatomy”)
10. (ALL Fields) = (“inclusi*” AND “intervention” AND (“education” OR training”) AND “allied health”)
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13. (ALL Fields) = ((“accessib*” OR “inclusi*”) AND (“healthcare education” OR “allied health”) AND “education”)
14. (ALL Fields) = (“universal design for learning” AND “speech-language patholog*” AND “education”)
15. (ALL Fields) = ((“inclusi*” OR “collab*”) AND “motivation” AND “healthcare education”)
16. (ALL Fields) = ((“inclusi*” OR “collab*”) AND “motivation” AND “anatomy education”)

Database: Science Direct Date Searched: 30 September 2021

Articles Retrieved: 149

Search strategy:

1. “universal design for learning” AND “healthcare education”
2. “universal design for learning” AND “anatomy education”
3. “universal design for learning” AND “undergraduate” AND “medical”
4. “universal design for learning” AND “education” AND “health”
5. “universal design for learning” AND “occupational therap!” AND “education”
6. “universal design for learning” AND “medic!” AND “education”
7. “universal design for learning” AND “speech – language therap!” AND “education”
8. “universal design for learning” AND “dent!” AND “education”
9. “accessib!” AND “healthcare education” AND “anatomy”
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11. “collab!” AND “allied health” AND “education”
12. “inclusi!” AND “college student!” AND “healthcare education”
13. (“accessib!” OR “inclusi!”) AND (“healthcare education” OR “allied health”) AND “education”
14. “universal design for learning” AND “speech-language patholog!” AND “education”
15. (“inclusi!” OR “collab!”) AND “motivation” AND “healthcare education”
16. (“inclusi!” OR “collab!”) AND “motivation” AND “anatomy education”

Database: PsycINFO Date Searched: 30 September 2021

Articles Retrieved: 766

Search strategy:

1. TX = “universal design for learning” AND “healthcare education”
2. TX = “universal design for learning” AND “anatomy education”
3. TX = “universal design for learning” AND “undergraduate” AND “medical”
4. TX = “universal design for learning” AND “education” AND “health”
5. TX = “universal design for learning” AND “occupational therap*” AND “education”
6. TX = “universal design for learning” AND “medic*” AND “education”
7. TX = “universal design for learning” AND “speech – language therap*” AND “education”
8. TX = “universal design for learning” AND “dent*” AND “education”
9. TX = “accessib*” AND “healthcare education” AND “anatomy”
10. TX = “inclusi*” AND “intervention” AND (“education” OR training”) AND “allied health”
11. TX = “collab*” AND “allied health” AND “education”
12. TX = “inclusi*” AND “college student*” AND “healthcare education”
13. TX = (“accessib*” OR “inclusi*”) AND (“healthcare education” OR “allied health”) AND “education”
14. TX = “universal design for learning” AND “speech-language patholog*” AND “education”
15. TX = (“inclusi*” OR “collab*”) AND “motivation” AND “healthcare education”
16. TX = (“inclusi*” OR “collab*”) AND “motivation” AND “anatomy education”

Database: Scopus Date Searched: 30 September 2021

Articles Retrieved: 18312

Search strategy:

1. (ALL (“universal design for learning” AND “healthcare education”))
2. (ALL (“universal design for learning” AND “anatomy education”))
3. (ALL (“universal design for learning” AND “undergraduate” AND “medical”))
4. (ALL (“universal design for learning” AND “education” AND “health”))
5. (ALL (“universal design for learning” AND “occupational therap*” AND “education”))
6. (ALL (“universal design for learning” AND “medic*” AND “education”))
7. (ALL (“universal design for learning” AND “speech – language therap*” AND “education”))
8. (ALL (“universal design for learning” AND “dent*” AND “education”))
9. (ALL (“accessib*” AND “healthcare education” AND “anatomy”))
10. (ALL (“inclusi*” AND “intervention” AND (“education” OR training”) AND “allied health”))
11. (ALL (“collab*” AND “allied health” AND “education”))
12. (ALL (“inclusi*” AND “college student*” AND “healthcare education”))
13. (ALL ((“accessib*” OR “inclusi*”) AND (“healthcare education” OR “allied health”) AND “education”))
14. (ALL (“universal design for learning” AND “speech-language patholog*” AND “education”))
15. (ALL ((“inclusi*” OR “collab*”) AND “motivation” AND “healthcare education”))
16. (ALL ((“inclusi*” OR “collab*”) AND “motivation” AND “anatomy education”))

Appendix 2 Information sheet about student motivation study

Information Sheet

Learning Strategies, Academic Motivation, Mindset, Perceived Stress and Well-Being of First-Year Undergraduate Anatomy Students.

Purpose of the study: To examine the learning strategies, academic motivation, mindset, perceived stress and well-being of first year undergraduate anatomy students.

What will the study involve? An anonymous paper questionnaire will be distributed which contains statements related to your learning strategies, motivation to learn, mindset, perceived stress and well-being. You will be asked to circle the response which is most relevant to you. There will be questions at the start of the questionnaire that will be used to establish your background and any previous experience of anatomy. The survey will take approximately 20 minutes to complete.

Why have you been asked to take part? You are a first-year student taking an anatomy module as a part of your degree programme in UCC.

Do you have to take part? Participation is completely voluntary. You will be giving consent to participate in the study if you complete and submit the consent form and questionnaire. You can change your mind and not complete or submit the questionnaire at any stage you wish during the 20 minutes of class time.

Will your participation in the study be kept confidential? The survey will be completely anonymous.

What will happen to the information which you give? Data will be securely stored in the Department of Anatomy and Neuroscience, UCC. After a ten-year period, data will be destroyed. Summary data will be available upon request.

What will happen to the results? The results will be analysed by the research team. The study may be published in a peer-reviewed journal, professional journal, teaching award submission or presented at a conference.

What are the possible disadvantages of taking part? They are no disadvantages to completing the questionnaire. It will not affect your studies.

Who has reviewed this study? Ethical approval for this study has been granted by the UCC Social Research Ethics Committee.

Any further queries? If you need any further information, you can contact me:

Name: Audrey Dempsey **Contact email:** audrey.dempsey@ucc.ie

Further Support

Thank you very much for filling out this questionnaire. This is an anonymous questionnaire so you cannot be identified from the answers you give. Some of the questions you answered were about feelings and thoughts of stress, study and exam pressure.

If you feel upset by these questions, you may wish to avail of the support services in the university by contacting any or all of the following:

First-Year Student Experience Co-ordinator	Nóirín Deady	firstyears@ucc.ie
Student Health Department	021 4902311	no email available
UCC Skills Centre	021 4903839	skillscentre@ucc.ie

Appendix 3 Consent form for student motivation study

Coláiste na hOllscoile Corcaigh, Éire
University College Cork, Ireland

Consent Form

Learning Strategies, Academic Motivation, Mindset, Perceived Stress and Well-Being of First-Year Undergraduate Anatomy Students.

1. I voluntarily agree to participate in this research study.
2. I am aged 18 or over.   YES / NO
3. This research study has been explained to me as fully as possible.
4. I have been given a copy of written information about this project.
5. I have had the opportunity to ask questions about any and all aspects of the study.
6. I am aware that my participation is voluntary and that I may withdraw from the study during the 20 minutes of class time without any consequences.
7. I am aware that my decision not to participate will not affect my module grades.
8. I understand that all information I provide for this study will be treated with anonymity.
9. I understand that the research group, comprising of Audrey Dempsey, Dr. Yvonne Nolan and Dr. Eithne Hunt, may write or talk about this study for educational/ research purposes but will always show confidentiality and respect for me.
10. I understand that I am free to contact any of the people involved in the research to seek further clarification and information.

Please tick to indicate consent ☐   Date ___________________

Appendix 4 Questionnaire for student motivation survey

Coláiste na hOllscoile Corcaigh, Éire
University College Cork, Ireland

Learning Strategies, Academic Motivation, Mindset, Perceived Stress and Well-Being of First-Year Undergraduate Anatomy Students.

Research Group:

Audrey Dempsey

Dr. Yvonne Nolan

Dr. Eithne Hunt

- Thank you for taking the time to complete this questionnaire.
- Please remember, there are no wrong answers, just answer as accurately as possible.
- You are not obliged to take part, but your participation is very much appreciated.

Demographic Information

What is your gender?

□ Male

□ Female

□ Other

Please state your age.

□ 18	□ 19	□ 20
□ 21	□ 22	□ Other

Please state where your second level education was completed.

□ Ireland	□ United Kingdom	□ Rest of Europe
□ Norther America	□ Asia	□ Other

In what year did you complete your second level education?

____

What programme are you currently registered for?

□ Medicine	□ Dentistry
□ Occupational Therapy	□ Speech and Language Therapy

Is this your first year in third level education?

□ Yes □ No

Have you completed any post-secondary anatomy education?

□ Yes □ No

If yes, please specify ______________________________________

Motivated Strategies for Learning Questionnaire Manual

The following questions ask about your motivation for and attitudes about this anatomy module. Remember there are no right or wrong answers, just answer as accurately as possible. Use the scale below to answer the questions. If you think the statement is very true of you, circle 7; if a statement is not at all true of you, circle 1. If the statement is more or less true of you, find the number between 1 and 7 that best describes you.

1	**2**	**3**	**4**	**5**	**6**	**7**
Not at all true of me						Very true of me

1.	In a module like this, I prefer material that really challenges me so I can learn new things.	1	2	3	4	5	6	7
2.	If I study in appropriate ways, then I will be able to learn the material in this module.	1	2	3	4	5	6	7
3.	When I take a test, I think about how poorly I am doing compared with other students.	1	2	3	4	5	6	7
4.	I think I will be able to use what I learn in this module in other modules.	1	2	3	4	5	6	7
5.	I believe I will receive an excellent grade in this module.	1	2	3	4	5	6	7
6.	I'm certain I can understand the most difficult material presented in the readings for this module.	1	2	3	4	5	6	7
7.	Getting a good grade in this module is the most satisfying thing for me right now.	1	2	3	4	5	6	7
8.	When I take a test, I think about items on other parts of the test I can't answer.	1	2	3	4	5	6	7
9.	It is my own fault if I don't learn the material in this module.	1	2	3	4	5	6	7

	Not at all true of me						Very true of me
10. It is important for me to learn the lecture material in this module.	1	2	3	4	5	6	7
11. Right now, my main concern in this module is getting a good grade.	1	2	3	4	5	6	7
12. I'm confident I can learn the basic concepts taught in this module.	1	2	3	4	5	6	7
13. If I can, I want to get better grades in this module than most of the other students.	1	2	3	4	5	6	7
14. When I take tests I think of the consequences of failing.	1	2	3	4	5	6	7
15. I'm confident I can understand the most complex material presented by the lecturer in this module.	1	2	3	4	5	6	7
16. In a module like this, I prefer lecture material that arouses my curiosity, even if it is difficult to learn.	1	2	3	4	5	6	7
17. I am very interested in the content area of this module.	1	2	3	4	5	6	7
18. If I try hard enough, then I will understand the lecture material.	1	2	3	4	5	6	7
19. I have an uneasy, upset feeling when I take an exam.	1	2	3	4	5	6	7
20. I'm confident I can do an excellent job on the assignments and tests in this module.	1	2	3	4	5	6	7
21. I expect to do well in this module.	1	2	3	4	5	6	7
22. The most satisfying thing for me in this module is trying to understand the content as thoroughly as possible.	1	2	3	4	5	6	7
23. I think the lecture material in this module is useful for me to learn.	1	2	3	4	5	6	7
24. When I have the opportunity in this module, I choose assignments that I can learn from even if they don't guarantee a good grade.	1	2	3	4	5	6	7

	Not at all true of me						Very true of me
25. If I don’t understand the lecture material, it is because I didn’t try hard enough.	1	2	3	4	5	6	7
26. I like the subject matter of this module.	1	2	3	4	5	6	7
27. Understanding the subject matter of this module is very important to me.	1	2	3	4	5	6	7
28. I feel my heart beating fast when I take an exam.	1	2	3	4	5	6	7
29. I’m certain I can master the skills being taught in this module.	1	2	3	4	5	6	7
30. I want to do well in this module because it is important to show my ability to my family, friends, employer, or others.	1	2	3	4	5	6	7
31. Considering the difficulty of this module, the lecturer, and my skills, I think I will do well in this module.	1	2	3	4	5	6	7

Appendix 5 Ethical approval for student motivation study – SREC, UCC

University College Cork, Ireland Coláiste na hOllscoile Corcaigh	Social Research Ethics Committee (SREC) **ETHICS APPROVAL FORM** srec@ucc.ie https://www.ucc.ie/en/research/about/ethics/

Introduction

UCC academic staff and postgraduate research students who are seeking ethical approval should complete this approval form. Ethical review by the Social Research Ethics Committee (SREC) is required where the methodology is not clinical or therapeutic in nature and proposes to involve:

direct interaction with human participants for the purpose of data collection using research methods such as questionnaires, interviews, observations, focus groups etc.;

indirect observation with human participants for example using observation, web surveys etc.;

access to, or utilisation of, anonymised datasets;

access to, or utilisation of, data or case files/records concerning identifiable individuals;

conducting Internet Research or research online.

SREC @ UCC considers itself an enabling committee, promoting strong research ethics amongst UCC's community of staff and student researchers. We are open to all types of research in the social research domain and if your research approach does not readily fit into this research form, do not be discouraged. Please add additional relevant notes to convey what you think is pertinent about the ethical aspects of your study.

Application Checklist

This checklist includes all of the items that are required for an application to be deemed complete. In the event that any of these are not present, the application will be returned to the applicant *without* having been sent for review. Please ensure that your application includes all of these prior to submission. Thank you and best of luck with your research.

All relevant files are combined into one PDF file (SREC application form, consent/assent forms, information sheets, data collection instruments, permission letters, etc.)	Yes
Completed SREC Application Form	Yes
Information Sheet(s) / Information Statement (i.e. at the beginning of an electronic survey) included	Yes
Consent Sheet(s) / Consent Statement (i.e. at the beginning of an electronic survey) included	Yes
Data Collection Instrument: Psychometric Instruments / Interview Guide / Focus Group Schedule / Survey Questionnaire / etc. included	Yes
Copy of permission letters to undertake research from relevant agencies/services included (if available)	Yes
If you are under academic supervision, your supervisor(s) have approved the wording of and co-signed this application prior to submission	Yes

If this is a resubmission, all the revised and new text is highlighted in yellow	N/A
Have you applied for ethical approval for this project from another UCC ethics committee?	No

APPLICANT(S) DETAILS

Name of UCC applicant(s)	Audrey Dempsey	Date	3rd July 2019
Department / School / Research Institute / Centre / Unit / College	Department of Anatomy & Neuroscience	Contact No.	087 9550442
Correspondence Address	Department of Anatomy & Neuroscience, Western Gateway Building, UCC	Email Address	208nonym.dempsey@ucc,ie
Name and year of course (students only)	PhD	Name of supervisor(s) (students only)	Dr. Yvonne Nolan Dr. Eithne Hunt
Is this a resubmission?	No	SREC Log No. (if a resubmission):	
Obtaining ethical approval from SREC does not free you from securing permissions and approvals from other institutional decision-makers and agency ethical review bodies. These bodies may accept the SREC approval, but researchers are responsible for ensuring they are compliant in advance of collecting data.			

Project working title	Learning Strategies, Academic Motivation, Mindset, Perceived Stress and Well-Being of First-Year Undergraduate Anatomy Students.

If this is a collaborative project / community-based participatory research project / *joint* application with another agency, please complete this additional section:

Names of research partners / civil society organisations collaborating on this project (this section must be completed for participatory / community-based participatory research studies)	N / A
Agency contact person and position	
Agency address	
Details of the partnership (Please identify clearly the roles and responsibilities held by each party in the partnership in relation to the	

different aspects of the research).	

ETHICAL APPROVAL SELF-EVALUATION

If your answer falls into any of the shaded boxes below, please address each point later on in the application form

		YES	NO
1	Do you consider that this project has significant ethical implications?		X
2	Will you describe the main research procedures to participants in advance, so that they are informed about what to expect?	X	
3	Will participation be voluntary?	X	
4	Will you obtain informed consent in writing from participants?	X	
5	Will you tell participants that they may withdraw from the research at any time and for any reason, and (where relevant) omit questionnaire items / questions to which they do not wish to respond?	X	
6a	Will data be treated with full confidentiality / anonymity (as appropriate)?	X	
6b	Does your project require you to carry out a Data Protection Impact Assessment (DPIA) in compliance with UCC Data Protection Policy?		X
7	Will data be securely held for a minimum period of ten years after the completion of a research project, in line with the University's *Code of Research Conduct* (2016)?	X	
8	If results are published, will anonymity be maintained and participants not identified? (see Q. 30 below regarding open data considerations, if relevant)	X	
9	Will you debrief participants at the end of their participation (i.e. give them a brief explanation of the study)?	X	
10	Will your project involve deliberately misleading participants in any way?		X
11	Will your participants include children / young persons (under 18 years of age)?		X
12	If yes to question 11, is your research in compliance with the UCC *Child Safeguarding Statement* which sets out the legal requirements under the Children First Act 2015? (see: https://www.ucc.ie/en/media/support/ocla/policies/UCC_Child_Protection_Policy_5April2018-Final.pdf)		N/A
13	Will your project require you to carry out "relevant work" as defined in the National Vetting Bureau (Children and Vulnerable Persons) Acts 2012 to 2016?		X
14	Do you require official Garda Vetting through UCC before collecting data from children or vulnerable adults? (Please note that having a Garda Vetting through another body is not sufficient; a separate UCC Garda Vetting is always required.)		X
15	Will your participants include people with learning or communication difficulties?		X
16	Will your participants include patients / service users / clients?		X
17	Will your participants include people in custody?		X
18	Will your participants include people engaged in illegal activities (e.g. drug taking, illegal Internet behaviour, crime, etc.)?		X

19a	Is there a realistic risk of participants experiencing either physical or psychological distress?		X
19b	Is there a realistic risk of the researcher experiencing either physical or psychological distress?		X
20	If yes to question 19a, has a proposed procedure for linking the participants to an appropriate support, including the name of a contact person, been given? (see Q. 33)	N/A	
21	If yes to question 19b, has a proposed procedure/support structure been identified?	N/A	
22	Are your research participants students with whom you have some current/previous connection (module coordinator, research supervisor, professional tutor, etc.)?	X	
23	Will your study participants receive payment / gifts / voucher / etc. for participating in this study?		X
24	If your research is conducted on the internet, does it involve human participants? (e.g. through web surveys, social media, accessing or utilising data (information) generated by or about the participant/s; or involve observing human participants in their online interactions/behaviour). If yes, please review and utilise the UCC policy for conducting Internet Research see GUIDANCEDOCUMENTFORCONDUCTINGRESEARCHONONLINEPLATFORMS		N/A

DESCRIPTION OF THE PROJECT

Ethical review requires that you reflect and seek to anticipate ethical issues that may arise,

rather than reproduce copious text from existing research proposals into these boxes.

Entries should be concise and relevant to the point / question.

25. Very brief description of your study (15-25 words max.) [e.g. This is a qualitative study of primary school teachers' attitudes towards religious teaching using focus groups to collect original data]
This study will investigate the learning strategies, academic motivation, mindset, perceived stress and well-being in cohorts of first year undergraduate students taking anatomy modules in UCC.

26. What is your study about? (100-200 words max.)
The majority (88% in 2017/2018) (HEA, 2018) of undergraduate students that transition into higher education institutions (HEI) are still adolescents, without fully developed cognitive, social, emotional and self-regulatory capacities. Thus students first year in HEI is a sensitive time for learning and socio-cultural development. The aim of this study is to assess learning strategies, academic motivation, mindset, perceived stress and well-being in cohorts of first year undergraduate students who are taking anatomy modules as part of their programme of study. (Occupational Therapy, Speech and Language Therapy, Medicine, Dentistry and Sports Studies and Physical Education) Data will be gathered through distribution of validated questionnaires (Motivated Strategies for Learning Questionnaire; The Growth Mindset Scale; Perceived Stress Scale; Warwick-Edinburgh Mental Well-Being Scale (WEMWBS))*. Data gathered from the questionnaires will inform teaching, learning and assessment approaches for future cohorts of first-year undergraduate students.

27. What are your research questions?
What are the preferred learning strategies of first year undergraduate anatomy students? What is the academic motivation of first year undergraduate anatomy students? Do first year undergraduate anatomy students have a fixed or growth mindset? What is the perceived stress of first year undergraduate anatomy students? What is the mental well-being of first year undergraduate anatomy students?

28. Who are the participants in your study? (recruitment methods, number, age, gender, exclusion/inclusion criteria, detail permissions to be sought / secured already, and how will you recruit participants?)
The participants of this study will be first-year undergraduate students enrolled in an anatomy module as part of their programme; Occupational Therapy, Speech and Language Therapy, Dentistry, Sports Studies and Physical Education or Medicine. Approximately 320 students will be recruited. All genders will be included in the study. Students will be over 18 years of age. Only students with previous exposure to anatomy will be excluded. These students will be identified from the demographic part of the survey. The students will be recruited during the first weeks of registration on an anatomy module in UCC. The researcher will visit the class groups and share written and oral information about the study and answer any questions arising. Consent forms and questionnaires will be distributed to those who wish to participate. Consent forms and anonymous questionnaires will be collected when completed. Participation will be voluntary and confidential. Declining to participate will not have an impact on the students' grade. Permission has been sought from the module coordinators of each cohort to be surveyed.

29. Concise statement of *anticipated* ethical issues raised by your project. How do you intend to deal with them? Please address *all* items where your answers fell into a shaded box in the self-evaluation above. (350 words max.)
There are no significant ethical issues anticipated for this study. Here are some considerations: Informed Consent Participation in the research will be voluntary. Potential participants will be informed that they are under no obligation to take part in the research and that they have the right to refuse to participate or to withdraw from involvement in the research at any time during the data collection, without consequences. Potential participants will be supplied in advance with information about the purpose of the research and who is conducting it, to ensure that informed consent is obtained. Participants will be required to fill in and sign an informed consent form prior to their participation. Potential Distress It is possible that some of the items on the Motivated Strategies for Learning Questionnaire; The Growth Mindset Scale; Perceived Stress Scale; Warwick-Edinburgh Mental Well-Being Scale (WEMWBS) instruments may give rise to emotional distress. To minimise this risk, participants will be encouraged to avail of identified supports within the university setting, if necessary. Power Imbalance Audrey Dempsey (the researcher) works as a Senior Medical Demonstrator in the FLAME Laboratory in the Department of Anatomy and Neuroscience and teaches the students during their practical sessions. She does not have any impact on how they are assessed.

30. Data.
(a) How will you collect your data? Brief description and justification of methods and data collection measures to be used.
(b) What type of data will you be storing?
I How and where will you store your data? (provide details for both physical *and* electronic documents. See page 7, Electronic Data Storage for guidance around data storage).
(d) For how long will you store the data? (A minimum storage period of 10 years is required)
I Who will you share the data with? (*Sample* prompts: If you plan to make your raw research dataset available publicly as part of the open data movement, or if you are required to do so as part of funding/journal requirements, please address your protocol here (make explicit links to Q. 32 below and show that you have addressed this in your consent form and information sheet). For collaborative/community-based participatory research, please address issues such as shared ownership of data, publication of findings, etc. If your funder contractually requires you to give them access to the 'raw' dataset, examine relevant implications, including appropriate anonymisation, protocols for secure access to the dataset, etc.).
(f) If you are planning to analyse an existing dataset, please outline how the original consent process allows for your data analysis.
(g) If you are planning to request access to health/case files/personal records that were not created for research purposes, please address Data Protection considerations, provide a strong rationale and comprehensively address associated ethical issues.
(h) If you ticked yes to Q.6 above, have you submitted your DPIA?

Anonymous paper questionnaires (Motivated Strategies for Learning Questionnaire; The Growth Mindset Scale; Perceived Stress Scale; Warwick-Edinburgh Mental Well-Being Scale (WEMWBS)) will be used to collect the data in a designated time period during the first weeks of students' exposure to anatomy lectures (September 2019). The same questionnaires will again be administered to the students when they have completed the anatomy modules. The questionnaires will be used with the appropriate permissions.

Hard copy consent forms and anonymised numerical and text data with no identifiers will be scanned and the originals destroyed. UCC supplied OneDrive will be used to store the electronic data.

As per the requirements of the recently enacted General Data Protection Regulation (GDPR, 2018) data will be stored securely, coded and assigned pseudonyms / study numbers so that the research participants cannot be identified. Hard copy consent forms and anonymised numerical and text data with no identifiers will be scanned and the originals destroyed. All electronic data will be stored on UCC OneDrive anonymised form for the duration of the project and then stored in the Departments NAS local storage. In case of data loss or breaches to the data integrity due to operational errors, hacking / viruses or disasters, the researcher will perform routine backups of all data at fixed intervals (for examples: daily, weekly). All laptops and PCs used to access data will be encrypted and password protected. The people who have access to the data will be the research group comprising of Audrey Dempsey, Dr. Yvonne Nolan and Dr. Eithne Hunt.

Data will be retained only for the period required by regulations and only data required for the project will be retained. In line with University's Code of Research Conduct (2016) data will be securely held for a minimum of ten years after the completion of the research project and will then subsequently be destroyed by Dr. Yvonne Nolan.

The data will be accessed by the research group. Results may be published in a peer reviewed journal, a professional journal, in a teaching award submission and / or presented at a conference.

Not Applicable
Not Applicable
Not Applicable

31. Arrangements for informing participants about the nature of the study (e.g. information sheets, letters of invitation, social media information, participant recruitment, focus group welcome/schedule etc.)
A short talk will be given to the potential participants during one of their anatomy lectures in the first weeks of the semester (September 2019). Written information will be distributed. The rationale and aim of the project will be explained and an information sheet will be distributed by the researcher. The researcher shall give the students time to complete the questionnaire and once they are ready, will collect the consent forms and questionnaires of those who choose to participate in the study.

32. How you will ensure that participants provide informed consent? (cf. Question 4 – attach relevant form(s); address special considerations in terms of children / young people / vulnerable persons / adults who have difficulty in making decisions unaided)
Participants will be informed that participation is voluntary, and that the information will be gathered anonymously. Their studies will not be affected. After completing and returning the questionnaire for collection, it will not be possible to withdraw information.

33. Outline of debriefing process at the end of the data collection process (cf. Question 9). If you answered Yes to Questions 19a or 19b, give details here. State what you will advise participants to do if they should experience problems (e.g. who to contact for help).
The researcher will share the results with any participant who wishes to see them, once data analysis is complete.

34. Estimated start date and duration of project
Start date: 1st September 2019 Duration: 3 years

35. Additional information of relevance to your application
Not Applicable

36. Declarations	
I/we agree that should there be unexpected ethical issues arising during the course of this study, that I/we will utilise my/our professional/disciplinary code of ethics, and/or notify UCC SREC, where appropriate.	Yes
I/we have consulted the UCC *Code of Research Conduct* (2016) and believe my/our proposal is in line with its requirements.	Yes

I/we have consulted the UCC *Child Protection Policy* and believe my/our proposal is in line with its requirements.	Yes
I/we have consulted the UCC GDPR guidelines and declare that our project is GDPR compliant. Where required under the UCC GDPR Guidelines, I have submitted a DPIA.	Yes N/A
I/we have consulted the UCC Garda Vetting Guidelines, and where appropriate, researchers on this project have valid Garda vetting through UCC (having a valid Garda Vetting through another body is insufficient).	Yes

37. Signatures	
UCC Applicant(s)	Academic Supervisor / Tutor / Principal Investigator (where applicable)
A.Dempsey	Yvonne Nolan [illegible]
Date: 3rd July 2019	Date: 3rd July 2019

Please submit a *signed* copy this form and all relevant attachments as one PDF file to srec@ucc.ie. No hard copies are required.

SREC is not primarily concerned with methodological issues, but we may comment on such issues in so far as they have ethical implications.

Website links and helpful resources

UCC *Code of Research Conduct*	https://www.ucc.ie/en/media/research/researchatucc/documents/UCCCodeofResearchConduct.pdf
UCC *Child Protection Policy*	https://www.ucc.ie/en/media/support/ocla/policies/UCCChildProtectionPolicyFINAL.pdf
Guidance Document for Conducting Internet Research	GUIDANCEDOCUMENTFORCONDUCTINGRESEARCHONONLINEPLATFORMS
Garda Vetting of UCC Staff	https://www.ucc.ie/en/hr/gardavetting/
UCC Student Garda Vetting Policy	https://www.ucc.ie/en/media/studyatucc/undergrads/downloadabledocumentssection/StudentVettingPolicyandProcedure.pdf Students for whom Garda Vetting is required, should contact studentgardavetting@ucc.ie.
UCC Data Protection Impact Assessment (DPIA) policy and templates	https://www.ucc.ie/en/gdpr/procedures/
UCC GDPR website	https://www.ucc.ie/en/gdpr/
IT Support for UCC Researchers	http://www.ucc.ie/en/it/services/research/

EU Commission, Responsible Research and Innovation & H2020 RRI Tools Website	https://ec.europa.eu/programmes/horizon2020/en/h2020-section/responsible-research-innovation http://www.rri-tools.eu /
Irish Qualitative Data Archive (IQDA)	https://www.maynoothuniversity.ie/social-sciences-institute/research/iqda
Irish Social Science Data Archive (quantitative datasets)	http://www.ucd.ie/issda/
Data Protection Commissioner's Guidelines on Research in the Health Sector	https://www.dataprotection.ie/documents/guidance/Health_research.pdf
Health Service Executive National Consent Policy	http://www.tusla.ie/uploads/content/National-Consent-Policy-August-2017.pdf

Electronic data storage

UCC Research Data Store and UCC Cloud Storage	https://www.ucc.ie/en/it/services/datastore/	As researchers, it is imperative that we can assure our participants that their data will be stored securely; this is of course particularly important where potentially sensitive personal details are involved. It is not adequate to simply say that the data will be stored safely. Exact detail is required as to the use (and location) of locked cabinets, management of audio files, encryption of laptops, electronic storage and so on. Where possible physical data such as survey forms etc. should be converted to electronic format as soon as possible and the originals shredded, however if you must retain physical data then it should be safely stored on premises at UCC in a locked cabinet/office. Treating Identifiable Data Data should be converted to anonymous form as soon as is possible, thus opening the possibility of storing the data on OneDrive etc. If data is not 216nonymized then the UCC IT Department recommend using *Research Data Store OR Departments/Schools own local secure storage, (e.g. UCC NAS etc) if this exists. If identifiable data is not stored on *Research Data Store or NAS the researcher must provide a justification for this and must ensure that the laptop or pc on which the data is stored is encrypted and password protected. Applicants should never store research data on a USB and only use an encrypted portable hard drive for short term storage until data has been anonymised. Applicants must consider how to maintain safe storage of their data beyond the life of their laptop/pc to meet the 10-year requirement in the UCC Code of Research Conduct. All laptops and PCs used to access data must be encrypted and password protected Treating Anonymised Data If confidential data has been anonymised or if you have public or non-sensitive data, then the UCC-supplied OneDrive for Business through UCC Office 365 or Google Drive through

		the UCC-supplied G-Suite (formerly Google Apps for Education), can be used for data storage. The personal versions of OneDrive and G-Suite should not be used to store research data. If you have questions about these services, please contact UCC IT Helpdesk. *Research Data Store provides a network based shared data storage facility for the UCC Research community. It is for active research projects and is not an archive service. A Principal Investigator or Head of Department can request storage (maximum 1TB) for a research project. Research Groups will have access to 1TB of storage and folders can be shared with researchers in either the central or student domains. This service can be requested by a PI or by a Head of Department on behalf of members of a research team/students. To make a request to use Research Data Store, visit http://Servicedesk.ucc.ie and select option 4 (Data Storage and NASAccess). "https://www.ucc.ie/en/it/services/datastore/"
UCC Device Encryption Service	http://www.ucc.ie/en/it/services/encryptionlaptop/	--
UCC Staff IT Services	http://www.ucc.ie/en/it/services/staff/	List of all UCC staff IT services.
HEAnet FileSender	http://www.heanet.ie/services/hosting/filesender	HEAnet FileSender is a way to share large files. It works through your web browser and allows you send encrypted files to any email address in a safe manner.

*Although ethical permission was originally sought and granted to distribute The Growth Mindset Scale, Perceived Stress Scale and Warwick-Edinburgh Mental Well-Being Scale (WEMWBS), the direction of the thesis changed and thus this data was not analysed.

Appendix 6 Information sheet for student perspective of UDL study

Information Sheet

First year undergraduate healthcare students' perception of Universal Design for Learning (UDL) in an Anatomy Module.

Purpose of the study: The aim of the study is to investigate the opinion of first year anatomy students on the benefits of Universal Design for Learning in the design and delivery of anatomy curricula.

What will the study involve? An anonymous paper questionnaire will be distributed which contains statements related to your opinion of the UDL educational framework. There will be questions at the start of the questionnaire that will be used to establish your background. The survey will take approximately 10 minutes to complete.

Why have you been asked to take part? You are a first-year undergraduate healthcare student aged 18 years or older taking an anatomy module as a part of your degree programme in UCC.

Do you have to take part? Your participation in this study is completely voluntary. You will be asked to confirm your consent before you proceed to answer the questionnaire. You may withdraw from the questionnaire at any time up to the point that you return the questionnaire to the researcher.

Will your participation in the study be kept confidential? The survey will be completely anonymous.

What will happen to the information which you give? Data from the questionnaire will be entered in Microsoft Excel and will be securely stored in a password protected file and kept on UCC OneDrive. After a ten-year period, data will be destroyed. The file will be accessible to the research team (Audrey Dempsey, Dr Mutahira Lone, Dr Eithne Hunt and Prof Yvonne Nolan). After a ten-year period, data will be destroyed. Summary data will be available upon request.

What will happen to the results? Anonymised findings may be published, for example in a peer-reviewed journal, professional journal, teaching award submission and/or presented at conferences.

Who has reviewed this study? Ethical approval for this study has been granted by the UCC Social Research Ethics Committee.

Any further queries? If you need any further information, you can contact me:

Name: Audrey Dempsey **Contact email:** audrey.dempsey@ucc.ie

Appendix 7 Consent form for student perspective of UDL study

Consent Form

1. I verify that the purpose and nature of the study has been explained to me in writing.
2. I confirm that I am participating voluntarily.
3. I understand that I can withdraw from participation in the study, without repercussions, at any time, whether before it starts or while I am participating.
4. I understand that once the questionnaire has been completed and returned to the researcher, I cannot withdraw my data.
5. I understand that all information I provide for this study will be treated with anonymity.
6. I understand that the research group, comprising of Audrey Dempsey, Prof. Yvonne Nolan, Dr. Eithne Hunt and Dr. Mutahira Lone, may write or talk about this study for educational/ research purposes but will always show confidentiality and respect for me.
7. I understand that I am free to contact any of the people involved in the research to seek further clarification and information.

Please tick to indicate consent ☐

Appendix 8 Questionnaire for student perspective of UDL survey

Coláiste na hOllscoile Corcaigh, Éire
University College Cork, Ireland

First year undergraduate healthcare students' perception of Universal Design for Learning (UDL) in an Anatomy Module.

- Thank you for taking the time to complete this questionnaire.
- Please remember, there are no wrong answers, just answer as accurately as possible.
- The questionnaire is completely anonymous.
- You are not obliged to take part, but your participation is very much appreciated.

<u>Research Group:</u>

Audrey Dempsey

Dr. Mutahira Lone

Dr. Eithne Hunt

Prof. Yvonne Nolan

Demographic Information

What is your gender?

□ Male □ Female □ Non-binary □ Other

Please state your age.

□ 18 □ 19 □ 20

□ 21 □ 22 □ Other _____

Please state where your second level education was completed.

□ Ireland □ United Kingdom □ Rest of Europe

□ North America □ Asia □ Other _____

In what year did you complete your second level education?

____

What programme are you currently registered for?

□ Occupational Therapy □ Speech and Language Therapy

□ Medicine □ Dentistry

Is this your first year in third level education?

□ Yes □ No

Have you completed any post-secondary anatomy education?

If yes, please specify _____________________________________

→

<u>Universal Design for Learning</u>

Prior to today, have you ever heard of Universal Design for Learning (UDL)?

□ Yes □ No

If yes, please specify where / when you have heard of UDL

____

____

From what you have learned from the short talk today, do you think elements of UDL have been implemented in the anatomy <u>laboratory</u> sessions?

□ Yes □ No

If yes, please specify how and where you thought UDL was implemented

____

____

From what you have learned from the short talk today, do you think elements of UDL have been implemented in the anatomy <u>lectures</u>?

□ Yes □ No

If yes, please specify how and where you thought UDL was implemented

____

____

Do you think UDL benefits student learning?

□ Yes □ No

If yes, in what way do you think UDL benefits student learning?

____

____

→

Do you think the implementation of the UDL framework increases student engagement?

□ Yes □ No

Do you think that the anatomy material is represented in multiple ways in <u>lectures</u>? (eg. Written text, PowerPoint, images, models, prosections)

□ Yes □ No

Do you think that the anatomy material is represented in multiple ways in <u>laboratory</u> sessions? (eg. Written text, PowerPoint, images, models, prosections)

□ Yes □ No

Do you think that you have the opportunity to express your knowledge in multiple ways during <u>lectures</u>?

□ Yes □ No

Do you think that you have the opportunity to express your knowledge in multiple ways during <u>laboratory</u> sessions?

□ Yes □ No

Do you think that you have the opportunity to express your knowledge in multiple ways during <u>examinations</u>?

□ Yes □ No

Do you think the anatomy <u>laboratory</u> sessions motivate you to study anatomy?

□ Yes □ No

Do you think the anatomy <u>lectures</u> motivate you to study anatomy?

□ Yes □ No

Do you think that the anatomy <u>laboratory</u> sessions were inclusive of your learning needs?

□ Yes □ No

→

Do you think that the anatomy <u>lectures</u> were inclusive of your learning needs?

□ Yes □ No

If no, please specify how we may make the laboratory or lecture sessions more inclusive in future?

____

____

How are your anatomy <u>lectures</u> currently taking place?

□ Online □ Face-to-face

□ A Hybrid (a mixture of online and face-to-face)

Do you have a preference for how you are taught anatomy, either during the lectures or the laboratory sessions?

____

____

Please use the following space if you would like to express any other opinions of UDL or about how anatomy is currently taught.

____

____

____

Thank you again for your participation. It is greatly appreciated.

END

Appendix 9 Ethical approval for student perspective of UDL study – SREC, UCC

Social Research
Ethics Committee (SREC)

SREC ETHICS APPROVAL FORM

Introduction

UCC academic staff and postgraduate research students who are seeking ethical approval should complete this approval form. Ethical review by the Social Research Ethics Committee (SREC) is required where the methodology is not clinical or therapeutic in nature and proposes to involve:

direct interaction with human participants for the purpose of data collection using research methods such as questionnaires, interviews, observations, focus groups etc.;

indirect observation with human participants for example using observation, web surveys etc.;

access to, or utilisation of, anonymised datasets;

access to, or utilisation of, data or case files/records concerning identifiable individuals;

conducting Internet Research or research online.

SREC considers itself an enabling committee, promoting strong research ethics amongst UCC's community of staff and student researchers. We are open to all types of research in the social research domain. If your research approach does not readily fit into this form, do not be discouraged: please add additional relevant notes to convey what you think is pertinent about the ethical aspects of your study.

Contact us: srec@ucc.ie

Click here for further information about research ethics at UCC.

Click here for further information on SREC, training videos, and

sample informed consent / information sheet / assent forms.

APPLICATION CHECKLIST

This checklist includes all of the items that are required for an application to be deemed complete. In the event that any of these are not present, the application will be returned to the applicant *without* having been sent for review. Please ensure that your application includes all of these items prior to submission. Thank you and best of luck with your research!

Please complete prior to submission	*Delete as applicable*
All relevant files are combined into one PDF file (SREC application form, consent/assent forms, information sheets, data collection instruments, permission letters, etc.)	Yes
Completed SREC Application Form	Yes
Information Sheet(s) / Information Statement (i.e. at the beginning of an electronic survey) included	Yes
Consent / Assent Form(s) / Consent Statement (i.e. at the beginning of an electronic survey) included	Yes
Data Collection Instrument: Psychometric Instruments / Interview Guide / Focus Group Schedule / Survey Questionnaire / etc. included	Yes
Copy of permission letters / external ethical approvals to undertake research from relevant agencies/services included (if available)	NA
Have you applied for ethical approval for this project from another UCC ethics committee?	No
If you are under academic supervision, your supervisor(s) have approved the wording of and co-signed this application prior to submission	Yes
If this is a resubmission, all the revised and new text is highlighted in yellow	NA

NOTES

Your SREC application form should be concise: please do not copy and paste a research proposal. Applications typically range between 10-20 pages (including appendices) with some longer applications at 25-30 pages. Overly long applications will be returned without a review.

Your SREC application form should be written so that researchers outside of your discipline can understand how you plan to undertake your study.

If your study requires a Data Protection Impact Assessment (DPIA), you do not need to include a copy of the DPIA with your SREC application form.

Resources and services:

UCC Code of Research Conduct	**EU Commission, Responsible Research and Innovation** **RRI Tools Website**
UCC Child Safeguarding Statement	**Irish Qualitative Data Archive** (IQDA)

Guidance Document for Conducting Internet Research	Irish Social Science Data Archive (quantitative datasets)
Garda Vetting of UCC Staff	Health Service Executive National Consent Policy
UCC Student Garda Vetting Policy	IT Service Catalogue
UCC Data Protection Policy and Procedures	UCC GDPR website
UCC Library Research Data Service	UCC Guidance for Researchers Conducting Research with Vulnerable People
UCC Supplied Survey Platforms	SREC FAQs and Amendment Process
UCC Device Encryption Service	

APPLICANT(S) DETAILS

Name of UCC applicant(s)	Audrey Dempsey		Date	18 / 10 / 2021
Name of Department / School / Research Institute / Centre / Unit / College	Department of Anatomy & Neuroscience		Contact No.	0879550442
Correspondence Address	Department of Anatomy & Neuroscience, Western Gateway Building, UCC		Email Address	audrey.dempsey@ucc.ie
Course Code/Name and year of course (students only)	PhD		Name of supervisor(s) (students only)	Prof. Yvonne Nolan Dr. Eithne Hunt Dr. Mutahira Lone
Is this a resubmission?	No		SREC Log No. (if a resubmission):	
Is this research funded?	No	If Yes please provide name/s of Funding Agencies	N/A	
Obtaining ethical approval from SREC does not free you from securing permissions and approvals from other institutional decision-makers and agency ethical review bodies. These bodies may accept the SREC approval, but researchers are responsible for ensuring they are compliant in advance of collecting data.				

Project working title	First year undergraduate healthcare students' perception of Universal Design for Learning (UDL) in an Anatomy module.

If this is a collaborative project / community-based participatory research project / *joint* application with another agency, please complete this additional section:

Names of research partners / civil society organisations collaborating on this project (this section must be completed for participatory / community-based participatory research studies)	N/A
Agency contact person and position	
Agency address	
Details of the partnership (Please identify clearly the roles and responsibilities held by each party in the partnership in relation to the different aspects of the research).	

ETHICAL APPROVAL SELF-EVALUATION

	If your answer falls into any of the shaded boxes below, please address each point later in the application form	YES	NO
		Use X or NA	
1	Do you consider that this project has significant ethical implications?		X
2	Will you describe the main research procedures to participants in advance, so that they are informed about what to expect?	X	
3	Will participation in this project be voluntary?	X	
4	Will you obtain informed consent in writing from participants?	X	
5	Will you tell participants that they may withdraw from the research at any time and for any reason, and (where relevant) omit questionnaire items / questions to which they do not wish to respond?	X	
6a	Will data be treated with full confidentiality / anonymity (as appropriate)?	X	
6b	Does your project require you to carry out a Data Protection Impact Assessment (DPIA) in compliance with UCC Data Protection Policy?		X
7	Will data be securely held for a minimum period of ten years after the completion of a research project, in line with the University's *Code of Research Conduct* (2016)?	X	
8	If results are published, will anonymity be maintained and participants not identified? (see Q. 30 below regarding open data considerations, if relevant)	X	
9	Will you debrief participants at the end of their participation (i.e. give them a brief explanation of the study)?	X	

10	Will your project involve deliberately misleading participants in any way?		X
11	Will your participants include children / young persons (under 18 years of age)?		X
12	If yes to question 11, is your research in compliance with the UCC *Child Safeguarding Statement* which sets out the legal requirements under the Children First Act 2015?		N/A
13	Will your project require you to carry out "relevant work" as defined in the National Vetting Bureau (Children and Vulnerable Persons) Acts 2012 to 2016?		X
14	Do you require official Garda Vetting through UCC before collecting data from children or vulnerable adults? (Please note that having a Garda Vetting through another body is not sufficient; a separate UCC Garda Vetting is always required for UCC researcvhers)		X
15	Will project participants include people with learning or communication difficulties?		X
16	Will project participants include patients / service users / clients? A service user or client is a person who is served by or uses the services under consideration as part of this research.		X
17	Will project participants include people in custody?		X
18	Will project participants include people engaged in illegal activities (e.g. drug taking, illegal Internet behaviour, crime, etc.)?		X
19a	Is there a realistic risk of participants experiencing either physical or psychological distress?		X
19b	Is there a realistic risk of the researcher experiencing either physical or psychological distress?		X
20	If yes to question 19a, has a proposed procedure for linking the participants to an appropriate support, including the name of a contact person, been given? (see Q. 33)	N/A	
21	If yes to question 19b, has a proposed procedure/support structure been identified?	N/A	
22	Are the research participants students with whom you have some current/previous connection (module coordinator, research supervisor, professional tutor, etc.)?		X
23	Will the research participants receive payment / gifts / voucher / or other incentives for participating in this study?		X
24	If your research is conducted on the internet, does it involve human participants? (e.g. through web surveys, social media, accessing or utilising data (information) generated by or about the participant/s; or involve observing human participants in their online interactions/behaviour). If yes, please review and utilise the UCC policy for conducting Internet Research.		X

DESCRIPTION OF THE PROJECT

Ethical review requires that you reflect and seek to anticipate ethical issues that may arise,

rather than reproduce copious text from existing research proposals into these boxes.

Entries should be concise and relevant to the point / question.

25. Very brief description of your study (15-25 words max.) [e.g. This is a qualitative study of primary school teachers' attitudes towards religious teaching using focus groups to collect original data]
This study will investigate first year undergraduate healthcare students' opinion of the educational framework, Universal Design for Learning (UDL), in the design of their anatomy module.

26. What is your study about? (100-200 words max.)
Universal Design for Learning (UDL) was developed by the Center of Applied Special Technology (CAST), USA as a method to enhance student experience, remove barriers to learning and ensure that education is inclusive for all learners. It posits that a "typical" or "average" student does not exist, but instead that all students learn differently. Thus, UDL is constructed to incorporate more flexible approaches to teaching and assessment so that students of differing abilities are catered for. It is suggested that educators should adhere to three UDL principles when designing learning, namely multiple means of engagement, multiple means of representation and multiple means of action and expression. The aim of the study is to investigate whether first year undergraduate healthcare students are aware of the UDL framework and furthermore when they are informed about the framework, do they think its utilization will benefit student learning, engagement or motivation. Data will be gathered through distribution of a paper questionnaire. Data gathered from the questionnaire will inform teaching, learning and assessment approaches when designing future anatomy curricula.

27. What are your research questions? (The research questions are the overall aim(s)/objective(s) of your study)
Are first year undergraduate healthcare students aware of the UDL educational framework? Do first year undergraduate healthcare students think UDL has been utilised in their anatomy curriculum? Do first year undergraduate healthcare students think UDL benefits their learning of anatomy? Do first year undergraduate healthcare students prefer online, face-to-face or hybrid teaching of anatomy?

28. Who are the participants in your study? (recruitment methods including details of how you will engage with participants, number, age, gender, exclusion/inclusion criteria, detail permissions to be sought / secured already, and how will you recruit participants?)
The participants of this study will be first-year undergraduate healthcare students studying anatomy. Specifically, those enrolled in either occupational therapy, speech and language therapy, dental or medical programmes. Approximately 320 students will be recruited in person.

Potential participants will be identified by their enrolment in an anatomy module. The researcher will engage with the students and inform them about the study when they attend their practical anatomy session in the FLAME Laboratory. Written and oral information about the study will be shared with the students. The researcher will answer any questions arising. Consent forms and questionnaires will be distributed to those who wish to participate. Consent forms and anonymous questionnaires will be collected when completed. Participation will be voluntary. Declining to participate will not have an impact on the students' grade. Permission has been sought from the module coordinators of each cohort to be surveyed. All genders will be included in the study. Participants will be 18 years of age and above. The occupational therapy, speech and language therapy and medical students will be recruited in November 2021. The dental students will be recruited in semester 2 of the academic year 2021 / 2022 when they return to campus for face-to-face teaching.

29. Concise statement of ***anticipated*** ethical issues raised by your project. How do you intend to deal with them? Please address ***all*** items where your answers fell into a shaded box in the self-evaluation above. (350 words max.)
We envision no significant ethical issues arising from this study. Informed Consent Participation in the research will be voluntary. Potential participants will be informed that they are under no obligation to take part in the research and that they have the right to refuse to participate or to withdraw from involvement in the research at any time during data collection up to the point that they return the questionnaire to the collection station at the exit of the laboratory, without any consequences. Potential participants will be supplied with an information sheet prior to the distribution of the questionnaire, which will outline the purpose of the research and who is conducting it, to ensure that informed consent is obtained. Participants will be required tick a box indicating their consent prior to their participation and completion of the questionnaire. Power Imbalance Audrey Dempsey (the researcher) works as a Senior Medical Demonstrator in the FLAME Laboratory in the Department of Anatomy and Neuroscience and teaches the students during their practical sessions. She does not have any impact on how they are assessed.

What apps and platforms can I use to collect, securely store, transcribe, and share research data? Please read before completing Q. 30

As researchers, it is imperative that we can assure participants in our study that their data will be collected, transported, stored and archived securely; this is particularly important where sensitive personal details are involved. Exact details are required as to the use (and location) of locked cabinets, management of audio files, encryption of laptops, electronic data collection / storage / sharing, and so on. We have prepared this 1-page summary guidance to support you in articulating your plan; however, in the case of conflicting advice, official UCC policies will take precedence over this guidance.

I / we would like to undertake online survey / interviews / focus groups

All data, both anonymised and non-anonymised, including sensitive personal data, can be collected and stored on the following cloud platforms; Microsoft Products (OneDrive, Teams, SharePoint, Microsoft Forms, etc.) and Google Workspace Products (formerly Google G-Suite; Google Forms, Meet, Sheets, Drive etc.) *subject to* *logging in to these services with your UCC credentials*. The only other app approved for survey data collection is Qualtrics (UCC does not have a site licence for Qualtrics; some Colleges and units may have a licence). *Personal versions* of Microsoft and Google Workspace apps should not be used to collect and/or store research data.

Only apps / platforms that have been approved through the central UCC procurement system (Agresso) should be used for data collection, data sharing and data storage. If you would like to use an app / platform that is not covered here please seek approval *prior* to applying to SREC. The first step to getting an app approved for use in research is to complete the "IT System Request Form". Please note that SREC has no role in approving apps / platforms for collecting, storing, transcribing or sharing research data.

I / we have audio to be transcribed by a person / software

If transcription is being outsourced, the transcription service used needs to be trustworthy, reliable, and confidential. It is essential that data transferred outside of UCC is done securely (see HEAnet FileSender). Please note that the only software and cloud-based transcription services approved by UCC for use in research for transcribing audio data are the tools embedded in Microsoft's products: use the dictate tool in newer versions of Microsoft Word, and the dictate and transcribe audio file upload tool through the online Office 365 Microsoft Word when using your UCC credentials, and Microsoft Stream/Microsoft Teams when using your UCC credentials.

We are a team and would like to collaborate online (UCC colleagues only and/or UCC and external team members)

UCC-supplied collaboration and storage services like Microsoft Teams and the equivalent Google Workspace apps, can facilitate you to safely collaborate and communicate on research studies with UCC staff and students, and to collaborate with partners outside of the university. Data saved in Microsoft Teams / Google Workspace apps when you login with your UCC credentials are stored on the UCC's tenancies on Microsoft and Google's servers. Data is encrypted in transit and at rest. Features such as version control, external sharing and audit logging are available. Microsoft Teams sites can also be archived after the research is completed. If you have questions about these services, please contact the UCC IT Helpdesk. For collaborative projects, research data should only be stored on approved storage and collaboration services (Microsoft Teams and Google Workspace apps using your UCC credentials). If applying for ethical approval through SREC for collaborative, multi-agency projects and the data will not be stored in UCC / EU, please include comprehensive details on how these external services meet the relevant standards.

Although UCC students currently have access to institutional cloud storage, access to Microsoft Office 365 does not extend beyond their period of being a UCC student. Relying on one person's access to online data storage is not best practice. To ensure that the minimum data storage period of 10 years is adhered to, data should be stored in a shared Google Drive or Microsoft SharePoint site using your UCC credentials (UCC email address & password) to login.

Anything else I need to know?

Further details on IT Services Storage Options: click here. Information on data storage and backup during research click here.

If data does not need to be identifiable, it should be converted to anonymous form as soon as is possible.

Microsoft Azure Information Protection - AIP - enables you to protect documents on your computer before sharing them, and also enables you to protect emails in Outlook before sending them (PCs only). Click here for the Azure how to guide. Click here to download the software.

Applicants must consider how to maintain safe storage of their data beyond the life of their laptop/pc to meet the 10-year requirement in the UCC Code of Research Conduct.

Do not use free versions of services of services and platforms for data collection, sharing data, and/or data storage.

All laptops and PCs used to access data must be encrypted and password protected. Applicants should never store research data on a USB and only use an encrypted portable hard drive for short-term storage until data has been anonymised.

30. Data. (Please provide your answers to these questions in the white area below; see advice on data collection and data storage on the previous page) (a) How will you collect your data? Provide a brief description and justification of methods and data collection measures to be used. If conducting an online survey/questionnaire, what survey platform do you plan to use? If you plan to use a virtual meeting platform such as MS Teams or Google Meet (using your UCC credentials to login), please outline the steps you will take in the event of a security breach or an interruption during a virtual call. (b) If you are creating audio/video recordings, who will perform the transcription? (If transcription is being outsourced the transcription service needs to be trustworthy, reliable, and confidential. Ensure that data transfer is done securely. Recorded data must be deleted from a mobile recording device. When will the data recordings be deleted from the recording device and who will be assigned responsibility for this?) (c) What type of data will you be storing? (Briefly describe the <u>type</u> of data you plan to collect). (d) How and where will you store your data? (Provide details about both physical <u>*and*</u> electronic documents). (e) For how long will you store the data? (A minimum storage period of 10 years is required) (f) Who will you share the data with? (*Sample* prompts: If you plan to make your raw research dataset available publicly as part of the open data movement, or if you are required to do so as part of funding/journal requirements, please address your protocol here (make explicit links to Q. 32 below and show that you have addressed this in your consent form and information sheet). For collaborative/community-based participatory research, please address issues such as shared ownership of data, will data be transferred (how?), publication of findings, etc. If your funder contractually requires you to give them access to the 'raw' dataset, examine relevant implications, including appropriate anonymisation, protocols for secure access to the dataset, etc.). (g) If you are planning to analyse an existing dataset, please outline how the original consent process allows for your data analysis. (h) If you are planning to request access to health/case files/personal records that were not created for research purposes, please address Data Protection considerations, provide a strong rationale and comprehensively address associated ethical issues. (i) If you ticked yes to Q.6b in the SREC Checklist (above), have you submitted your DPIA?
(a) Anonymous paper questionnaires will be used to collect the data from the healthcare students. Potential participants will be identified by their attendance at the anatomy laboratory session. Demographic data will be collected. The questionnaire consists of questions relating to the student's opinion of UDL and how they are currently taught anatomy. Both open and closed questions will be used to gather the data. The questionnaire does not collect any personal identifiers or personal information and thus questionnaires and data will be completely anonymous. (b) Not Applicable (c) Hard copy consent forms and anonymised numerical and text data with no identifiers will be scanned and the originals destroyed. UCC supplied OneDrive will be used to store the electronic data. (d) As per the requirements of the recently enacted General Data Protection Regulation (GDPR, 2018) data will be stored securely, coded and assigned pseudonyms / study

numbers so that the research participants cannot be identified. Hard copy consent forms and anonymised numerical and text data with not identifiers will be scanned and the originals destroyed. All electronic data will be anonymized and stored on UCC OneDrive. In case of data loss or breaches to the data integrity due to operational errors, hacking / viruses or disasters, the researcher will perform routine backups of all data at fixed intervals (for examples: daily, weekly). All laptops and PCs used to access data will be encrypted and password protected. The people who have access to the data will be the research group comprising of Audrey Dempsey, Prof. Yvonne Nolan, Dr. Eithne Hunt and Dr. Mutahira Lone (e) Data will be retained only for the period required by regulations and only data required for the project will be retained. In line with University's Code of Research Conduct (2016) data will be securely held for a minimum of ten years after the completion of the research project and will then subsequently be destroyed by Prof. Yvonne Nolan. (f) The data will be accessed by the research group only (Audrey Dempsey, Prof. Yvonne Nolan, Dr. Eithne Hunt and Dr. Mutahira Lone). Results may be published in a peer reviewed journal, a professional journal, in a teaching award submission and / or presented at a conference. (g) Not Applicable (h) Not Applicable (i) Not Applicable

In the exceptional case where there is a requirement for on premise storage (e.g. a requirement of a data-sharing agreement with a third party), Research Data Store can be accessed by researchers for storing research data. UCC Network File Store (NAS) can be used for secure storage if the researcher has access to it (UCC staff).

The HEAnet's FileSender is a way to share large files with strong encryption to any email address in a safe manner, which is useful for sending audio files to a transcriber or between team members outside of UCC if not using Microsoft Teams / Google Workspace using your UCC credentials.

Where possible, physical data such as survey and consent forms etc. should be converted to electronic format as soon as possible and the originals shredded; however, if you need to retain physical data then it should be safely stored on premises at UCC in a locked cabinet/office.

31. Arrangements for informing participants about the nature of the study (e.g. information sheets, letters of invitation, social media information, participant recruitment, focus group welcome/schedule, withdrawal, etc.)
A short talk will be given to the potential participants during one of their anatomy practical laboratory sessions. The rationale and aim of the project will be explained and an information sheet will be distributed by the researcher. The researcher shall give the students time to complete the questionnaire and once they are ready, will collect the consent forms and questionnaires from those who choose to participate in the study. Potential participants will be informed that they have the right to refuse to participate or to withdraw from involvement in the research at any time during data collection up to the point that they return the questionnaire to the collection station at the exit of the laboratory, without any consequences.

32. How you will ensure that participants provide informed consent? (cf. Question 4 - attach relevant form(s); address special considerations in terms of children / young people / vulnerable persons / adults who have difficulty in making decisions unaided)
An information sheet (Appendix A) outlining the purpose and nature of the study will be attached to the questionnaire. Participants will be directed to read the information sheet prior to starting the questionnaire so that they may provide informed consent. Participants who choose to participate in the study will then be directed to the start of the questionnaire where they are required to select a tick-box option that they "consent to participate in this study" (Appendix B). Only data from participants who have provided consent may be analysed.

33. Outline of debriefing process at the end of the data collection process (cf. Question 9). If you answered Yes to Questions 19a or 19b, give details here. State what you will advise participants to do if they should experience problems (e.g. who to contact for help – provide name and contact details where required.)
The researcher will share the results of the overall study with any participant who wishes to see them, once data analysis is complete. No individual-level results will be available as the questionnaire does not have any identifiers.

34. Estimated start date and duration of project (by months)
Start Date: November 1st 2021 Duration 1 year

35. Additional information of relevance to your application
N/A

36. Declarations (clickable links to policies and codes quoted here are on the next page)	Delete as applicable
I/we agree that should there be unexpected ethical issues arising during the course of this study, that I/we will utilise my/our professional/disciplinary code of ethics, and/or notify UCC SREC, where appropriate.	Yes
I/we have consulted the UCC *Code of Research Conduct* and believe my/our proposal is in line with its requirements.	Yes
I/we have consulted the UCC *Child Protection Policy* and believe my/our proposal is in line with its requirements.	NA
I/we have consulted the UCC GDPR guidelines and declare that our project is GDPR compliant. Where required under the UCC GDPR Guidelines, I have submitted a DPIA to the UCC Information Compliance Department	Yes NA
I/we have consulted the UCC Garda Vetting Guidelines, and where appropriate, researchers on this project have valid Garda vetting through UCC (having a valid Garda Vetting through another body is insufficient).	Yes

37. Signatures	
UCC Applicant(s)	Academic Supervisor / Principal Investigator / Tutor

	All academic supervisors (where applicable) must approve the contents of this application
A.Dempsey	Yvonne Nolan [illegible] [illegible]
Date: 18 / 10 / 2021	Date: 18 / 10 / 2021

Please submit a *signed* copy of this form and all relevant attachments as one PDF file to srec@ucc.ie. A picture of signatures pasted into section 37 is acceptable once the application is emailed to srec@ucc.ie from your UCC email address. However, if you cannot paste a picture of your signature, please type your name in section 37 and email this form to SREC using your UCC email account. No hard copies of this application are required.

SREC is not primarily concerned with methodological issues, but we may comment on such issues in so far as they have

ethical implications.

Appendix 10 Online information sheet about educator perspective of UDL study

Information Sheet

Design of Human Anatomy Curricula in Universities in Ireland and the United Kingdom.

Purpose of the study: The aim of the study is to investigate how anatomy educators in Ireland and the United Kingdom are designing the curricula of human anatomy modules in third level healthcare programmes.

What will the study involve? Following a link to an anonymous online questionnaire. You will be asked to click the responses which are most relevant to you. The questionnaire will take approximately 15 minutes to complete.

Why have you been asked to take part? You are an anatomy educator involved in a healthcare programme in a University in Ireland or the United Kingdom. You have been identified via your institution's website and have a publicly available e-mail address.

Do you have to take part? Your participation in this study is completely voluntary. You will be asked to confirm your consent before you proceed to answer the questionnaire. You may withdraw from the questionnaire at any time up to the point that you press "submit".

Will your participation in the study be kept confidential? The survey will be completely anonymous.

What will happen to the information which you give? Data will be securely stored in the survey software programme before it is downloaded to a password protected file and kept on UCC OneDrive. The file will be accessible to the research team (Audrey Dempsey, Dr

Mutahira Lone, Dr Eithne Hunt and Prof Yvonne Nolan). After a ten-year period, data will be destroyed. Summary data will be available upon request.

What will happen to the results? Anonymised findings may be published, for example in a peer-reviewed journal, professional journal, teaching award submission and/or presented at conferences.

Who has reviewed this study? Ethical approval for this study has been granted by the UCC Social Research Ethics Committee.

Any further queries? If you need any further information, you can contact me:

Name: Audrey Dempsey **Contact email:** audrey.dempsey@ucc.ie

Appendix 11 Online consent form for educator perspective of UDL study

Consent Form

Anatomy Educators knowledge of Universal Design for Learning in Ireland and the United Kingdom

I verify that the purpose and nature of the study has been explained to me in writing. I confirm that I am participating voluntarily. I understand that I can withdraw from participation in the study, without repercussions, at any time, whether before it starts or while I am participating. I understand that once the questionnaire has been completed and submitted, I cannot withdraw my data. I understand that anonymity and privacy will be maintained in the write-up of the results in this study. I understand that results from this questionnaire may be quoted in any subsequent publications if l give permission below.

□ I consent to the above

□ I do not consent to the above

Appendix 12 Online questionnaire for educator perspective of UDL study

Please indicate your academic position

□ Professor

□ Senior Lecturer

□ Lecturer

□ Tutor

Please state your gender

□ Female

□ Male

□ Non-binary

□ Prefer not to say

Please state how long you have been teaching anatomy to third level students

□ Less than a year □ 1-3 years □ 4-6 years □ 7-10 years

□ 11-15 years □ 16-20 years □ More than 20 years

Please state your gender

□ Female

□ Male

□ Non-binary

□ Prefer not to say

Please state how long you have been teaching anatomy to third level students

□ Less than a year

□ 1-3 years

□ 4-6 years

□ 7-10 years

□ 11-15 years

□ 16-20 years

□ More than 20 years

Please indicate the highest qualification which you have obtained

____

Have you completed any further training in teaching and learning?

□ No

□ Yes. PG Cert

□ Yes. PG Dip

□ Yes. MSc

□ Yes. Digital Badge or Micro-credential

□ Yes. CPD or PhD

□ Yes. Other

Please indicate the number of students, on average, which you teach anatomy to each year

____

Please indicate which undergraduate programme(s) you teach anatomy to (if any)

□ N/A

□ Dental Nursing

□ Dentistry

□ Diagnostic Radiography

□ BSc Human Anatomy

□ Medicine

□ BSc Neuroscience

□ Nursing

□ Occupational Therapy

□ Pharmacy

□ Physiotherapy

□ Podiatry

□ Speech and Language Therapy

□ BSc Sport Science

□ Therapeutic Radiography

□ Other

Please indicate which graduate entry programme(s) you teach anatomy to (if any)

□ N/A

□ Dental Nursing

□ Dentistry

□ Diagnostic Radiography

□ MSc Human Anatomy

□ Medicine

□ MSc Neuroscience

□ Nursing

□ Occupational Therapy

□ Pharmacy

□ Physiotherapy

□ Podiatry

□ Speech and Language Therapy

□ MSc Sport Science

□ Therapeutic Radiography

□ Other

Please indicate which re-registration programme(s) you teach anatomy to (if any)

□ N/A

□ Dental Nursing

□ Dentistry

□ Diagnostic Radiography

□ Medicine

□ Nursing

□ Occupational Therapy

□ Physiotherapy

□ Podiatry

□ Speech and Language Therapy

□ Therapeutic Radiography

□ Other

Please select which teaching methodologies you utilise in your teaching of anatomy (select all that apply)

□ Didactic

□ Dissection

□ Prosection

□ Plastination

□ Plastic models

□ Real bones

□ Plastic bones

□ Microscopes

□ Surface Anatomy

□ Kinesthetic (eg. Body Painting)

□ Imaging (eg. Radiography)

□ Gamification (eg. Kahoot, Socrative)

□ Team-based learning

□ Peer-instructed learning

□Technology (3D imaging, computer assisted learning)

Please select which type of assessments you utilise in your anatomy teaching (select all that apply)

□ Objective Structured Clinical Examination (OSCE)

□ Multiple Choice Questionnaire (MCQ)

□ Essay

□ Oral

□ Continuous Assessment

□ End of Year Examination

□ Group Based Assessment

□ Student Self-Assessment

□ Short Answer Questions

□ Extended Match Questions

In your opinion, does the curriculum design of your anatomy module align with any of the following guidelines? (select all that apply)

□ Optimise student choice and autonomy

□ Optimise relevance, value and authenticity

□ Minimise threats and distractions

□ Heighten salience of goals and objectives

□ Vary demands and resources to optimise challenge

□ Foster collaboration and community

□ Increase mastery orientated feedback

□ Promote expectations and beliefs that optimise motivation

□ Facilitate personal coping skills and strategies

□ Develop self-assessment and reflection

In your opinion, does the curriculum design of your anatomy module align with any of the following guidelines? (select all that apply)

□ Offer ways of customising the display of information

□ Offer alternatives for sudatory information

□ Offer alternatives for visual information

□ Clarify vocabulary and symbols

□ Clarify syntax and structure

□ Support decoding of text, mathematical notation and symbols

□ Promote understanding across languages

□ Illustrate through multiple media

□ Activate or supply background knowledge

□ Highlight patterns, critical features, big ideas, and relationships

□ Guide information processing and visualisation

□ Maximise transfer and generalisation

In your opinion, does the curriculum design of your anatomy module align with any of the following guidelines? (select all that apply)

□ Vary the methods for response and navigation

□ Optimise access to tools and assistive technologies

□ Use multiple media for communication

□ Use multiple tools for construction and composition

□ Build fluencies with graduated levels of support for practice and performance

□ Guide appropriate goal-setting

□ Support planning and strategy development

□ Facilitate managing information and resources

□ Enhance capacity for monitoring progress

Are you familiar with the Universal Design for Learning (UDL) educational framework?

□ Yes

□ No

If you ARE familiar with UDL, have you utilised elements of the framework in your teaching of anatomy?

□ Yes

□ No

□ N/A

If you have utilised elements of UDL, can you give an example of how?

____

***From your experience, how do you think UDL benefits teaching and learning within an anatomy module*?**

____

From your experience, do you think that the incorporation of UDL has had any effect on student motivation to study anatomy?

____

If you are NOT familiar with UDL, please read the following passage:

UDL was developed by the Center of Applied Special Technology (CAST), USA as a method to enhance student experience, remove barriers to learning and ensure that education is inclusive for all learners. It posits that a "typical" or "average" student does not exist, but instead that all students learn differently. Thus, UDL is constructed to incorporate more flexible approaches to teaching and assessment so that students of differing abilities will be catered for. It is suggested that teachers should adhere to three UDL principles when designing learning, namely multiple means of engagement, multiple means of representation and multiple means of action and expression.

From the description above what potential, if any, do you see UDL having for teaching and learning within anatomy curricula?

___

If you are NOT familiar with UDL, from the description above, do you think that you have been using the UDL framework in your teaching of anatomy, perhaps unknown to yourself?

□ Yes

□ No

END

Appendix 13 Ethical approval for educator perspective of UDL study – SREC, UCC

UCC University College Cork, Ireland Coláiste na hOllscoile Corcaigh	Social Research Ethics Committee (SREC) ETHICS APPROVAL FORM srec@ucc.ie https://www.ucc.ie/en/research/about/ethics/

Introduction

UCC academic staff and postgraduate research students who are seeking ethical approval should complete this approval form. Ethical review by the Social Research Ethics Committee (SREC) is required where the methodology is not clinical or therapeutic in nature and proposes to involve:

direct interaction with human participants for the purpose of data collection using research methods such as questionnaires, interviews, observations, focus groups etc.;

indirect observation with human participants for example using observation, web surveys etc.;

access to, or utilisation of, anonymised datasets;

access to, or utilisation of, data or case files/records concerning identifiable individuals;

conducting Internet Research or research online.

SREC @ UCC considers itself an enabling committee, promoting strong research ethics amongst UCC's community of staff and student researchers. We are open to all types of research in the social research domain and if your research approach does not readily fit into this research form, do not be discouraged. Please add additional relevant notes to convey what you think is pertinent about the ethical aspects of your study.

Application Checklist

This checklist includes all of the items that are required for an application to be deemed complete. In the event that any of these are not present, the application will be returned to the applicant *without* having been sent for review. Please complete the checklist below, and ensure that your application includes all of these prior to submission. Thank you and best of luck with your research. If you require additional guidance, click here.

	Delete as applicable
All relevant files are combined into one PDF file (SREC application form, consent/assent forms, information sheets, data collection instruments, permission letters, etc.)	Yes
Completed SREC Application Form	Yes
Information Sheet(s) / Information Statement (i.e. at the beginning of an electronic survey) included	Yes

Consent Sheet(s) / Consent Statement (i.e. at the beginning of an electronic survey) included	Yes
Data Collection Instrument: Psychometric Instruments / Interview Guide / Focus Group Schedule / Survey Questionnaire / etc. included	Yes
Copy of permission letters to undertake research from relevant agencies/services included (if available)	NA
If this is a resubmission, all the revised and new text is highlighted in yellow	NA
Have you applied for ethical approval for this project from another UCC ethics committee?	No
If you are under academic supervision, your supervisor(s) have approved the wording of and co-signed this application prior to submission	Yes

APPLICANT(S) DETAILS

Name of UCC applicant(s)	Audrey Dempsey	Date	04/05/2021
Name of Department / School / Research Institute / Centre / Unit / College	Department of Anatomy & Neuroscience	Contact No.	0879550442
Correspondence Address	Department of Anatomy & Neuroscience, Western Gateway Building, UCC	Email Address	audrey.dempsey@ucc.ie
Course Code/Name and year of course (students only)	PhD	Name of supervisor(s) (students only)	Prof. Yvonne Nolan Dr. Eithne Hunt Dr. Mutahira Lone
Is this a resubmission?	No	SREC Log No. (if a resubmission):	
Is this research funded?	No	If Yes please provide name/s of Funding Agencies	N/A

Obtaining ethical approval from SREC does not free you from securing permissions and approvals from other institutional decision-makers and agency ethical review bodies. These bodies may accept the SREC approval, but researchers are responsible for ensuring they are compliant in advance of collecting data.

Project working title	Anatomy Educators Knowledge of Universal Design for Learning in Ireland and the United Kingdom

If this is a collaborative project / community-based participatory research project / *joint* application with another agency, please complete this additional section:

Names of research partners / civil society organisations collaborating on this project (this section must be completed for participatory / community-based participatory research studies)	N/A
Agency contact person and position	
Agency address	
Details of the partnership (Please identify clearly the roles and responsibilities held by each party in the partnership in relation to the different aspects of the research).	

ETHICAL APPROVAL SELF-EVALUATION

		YES	NO
	If your answer falls into any of the shaded boxes below, please address each point later in the application form	Use X or NA to mark selection	
1	Do you consider that this project has significant ethical implications?		X
2	Will you describe the main research procedures to participants in advance, so that they are informed about what to expect?	X	
3	Will participation in this project be voluntary?	X	
4	Will you obtain informed consent in writing from participants?	X	
5	Will you tell participants that they may withdraw from the research at any time and for any reason, and (where relevant) omit questionnaire items / questions to which they do not wish to respond?	X	
6a	Will data be treated with full confidentiality / anonymity (as appropriate)?	X	
6b	Does your project require you to carry out a Data Protection Impact Assessment (DPIA) in compliance with UCC Data Protection Policy?		X
7	Will data be securely held for a minimum period of ten years after the completion of a research project, in line with the University's *Code of Research Conduct* (2016)?	X	
8	If results are published, will anonymity be maintained and participants not identified? (see Q. 30 below regarding open data considerations, if relevant)	X	
9	Will you debrief participants at the end of their participation (i.e. give them a brief explanation of the study)?	X	
10	Will your project involve deliberately misleading participants in any way?		X

11	Will your participants include children / young persons (under 18 years of age)?		X
12	If yes to question 11, is your research in compliance with the UCC *Child Safeguarding Statement* which sets out the legal requirements under the Children First Act 2015?		N/A
13	Will your project require you to carry out "relevant work" as defined in the National Vetting Bureau (Children and Vulnerable Persons) Acts 2012 to 2016?		X
14	Do you require official Garda Vetting through UCC before collecting data from children or vulnerable adults? (Please note that having a Garda Vetting through another body is not sufficient; a separate UCC Garda Vetting is always required.)		X
15	Will project participants include people with learning or communication difficulties?		X
16	Will project participants include patients / service users / clients? A service user or client is a person who is served by or uses the services under consideration as part of this research.		X
17	Will project participants include people in custody?		X
18	Will project participants include people engaged in illegal activities (e.g. drug taking, illegal Internet behaviour, crime, etc.)?		X
19a	Is there a realistic risk of participants experiencing either physical or psychological distress?		X
19b	Is there a realistic risk of the researcher experiencing either physical or psychological distress?		X
20	If yes to question 19a, has a proposed procedure for linking the participants to an appropriate support, including the name of a contact person, been given? (see Q. 33)	N/A	
21	If yes to question 19b, has a proposed procedure/support structure been identified?	N/A	
22	Are the research participants students with whom you have some current/previous connection (module coordinator, research supervisor, professional tutor, etc.)?		X
23	Will the research participants receive payment / gifts / voucher / or other incentives for participating in this study?		X
24	If your research is conducted on the internet, does it involve human participants? (e.g. through web surveys, social media, accessing or utilising data (information) generated by or about the participant/s; or involve observing human participants in their online interactions/behaviour). If yes, please review and utilise the UCC policy for conducting Internet Research.	X	

DESCRIPTION OF THE PROJECT

Ethical review requires that you reflect and seek to anticipate ethical issues that may arise,

rather than reproduce copious text from existing research proposals into these boxes.

Entries should be concise and relevant to the point / question.

25. Very brief description of your study (15-25 words max.)

[e.g. This is a qualitative study of primary school teachers' attitudes towards religious teaching using focus groups to collect original data]

This study will investigate knowledge and utilisation of the educational framework, Universal Design for Learning in third level anatomy educators in Ireland and the United Kingdom.

26. What is your study about? (100-200 words max.)
Universal Design for Learning (UDL) was developed by the Center of Applied Special Technology (CAST), USA as a method to enhance student experience, remove barriers to learning and ensure that education is inclusive for all learners. It posits that a "typical" or "average" student does not exist, but instead that all students learn differently. Thus, UDL is constructed to incorporate more flexible approaches to teaching and assessment so that students of differing abilities are catered for. It is suggested that educators should adhere to three UDL principles when designing learning, namely multiple means of engagement, multiple means of representation and multiple means of action and expression. The aim of the study is to investigate whether third level anatomy educators are aware of the UDL framework and furthermore whether they are utilizing the framework in the curricula of their anatomy modules for healthcare students. Data will be gathered through distribution of an online questionnaire. Data gathered from the questionnaire will inform teaching, learning and assessment approaches when designing future anatomy curricula.

27. What are your research questions? (The research questions are the overall aim(s)/objective(s) of your study)
Do anatomy educators in Ireland and the UK have knowledge of the UDL education framework? Do anatomy educators utilise the UDL framework in their curriculum design? Do anatomy educators think UDL benefits student learning?

28. Who are the participants in your study? (recruitment methods including details of how you will engage with participants, number, age, gender, exclusion/inclusion criteria, detail permissions to be sought / secured already, and how will you recruit participants?)
The participants of this study will be third level anatomy educators in Ireland and the United Kingdom. Approximately 100 educators will be recruited via email. Potential participants will be identified via their institution's website and have publicly available e-mail addresses. All genders will be included in the study. Participants will be over 18 years of age. The educators will be recruited during 2021. They will receive an email from the researcher outlining the study and requesting their participation. If they choose to partake in the study, they will follow a link to an online MicroSoft Forms. Details of the study will be provided via an information sheet and participants will be asked to indicate their consent by ticking a box before proceeding with the questionnaire. Participation will be voluntary and confidential.

29. Concise statement of *anticipated* ethical issues raised by your project. How do you intend to deal with them? Please address *all* items where your answers fell into a shaded box in the self-evaluation above. (350 words max.)
We envision no significant ethical issues arising from this study. Informed Consent Participation in the research will be voluntary. Potential participants will be informed that they are under no obligation to take part in the research and that they have the right to refuse to participate or to withdraw from involvement in the research at any time during the questionnaire up to the point that they press "submit", without any consequences. Potential participants will be supplied with an information sheet which will outline the purpose of the research and who is conducting it, to ensure that informed consent is obtained. Participants will be required tick a box indicating their consent prior to their participation and completion of the questionnaire.

30. Data. (Please provide your answers to these questions in the white area below) (a) How will you collect your data? Provide a brief description and justification of methods and data collection measures to be used. If conducting an online survey/questionnaire, what survey platform do you plan to use? If you plan to use a virtual meeting platform such as MS Teams or Google Meet, please outline the steps you will take in the event of a security breach or an interruption during a virtual call. (b) If you are creating audio/video recordings, who will perform the transcription? (If transcription is being outsourced the transcription service needs to be trustworthy, reliable, and confidential. Ensure that data transfer is done securely. Recorded data must be deleted from a mobile recording device. When will the data recordings be deleted from the recording device and who will be assigned responsibility for this?) (c) What type of data will you be storing? (Briefly describe the <u>type</u> of data you plan to collect). (d) How and where will you store your data? (Provide details about both physical <u>*and*</u> electronic documents. See page 7, Electronic Data Storage for guidance on data storage). (e) For how long will you store the data? (A minimum storage period of 10 years is required) (f) Who will you share the data with? (*Sample* prompts: If you plan to make your raw research dataset available publicly as part of the open data movement, or if you are required to do so as part of funding/journal requirements, please address your protocol here (make explicit links to Q. 32 below and show that you have addressed this in your consent form and information sheet). For collaborative/community-based participatory research, please address issues such as shared ownership of data, will data be transferred (how?), publication of findings, etc. If your funder contractually requires you to give them access to the 'raw' dataset, examine relevant implications, including appropriate anonymisation, protocols for secure access to the dataset, etc.). (g) If you are planning to analyse an existing dataset, please outline how the original consent process allows for your data analysis. (h) If you are planning to request access to health/case files/personal records that were not created for research purposes, please address Data Protection considerations, provide a strong rationale and comprehensively address associated ethical issues. (i) If you ticked yes to Q.6b in the SREC Checklist (above), have you submitted your DPIA?
(a) Anonymous electronic questionnaire will be used to collect data from anatomy educators in Ireland and the UK. MicroSoft Forms will be the survey platform used. No virtual meetings are planned. Potential participants will be identified via their institution's website and have publicly available e-mail addresses. (b) Not Applicable (c) Anonymised electronic data (questionnaires) with no identifiers will be stored on UCC OneDrive. No hard copies will exist. (d) As per the requirements of the recently enacted General Data Protection Regulation (GDPR, 2018) data will be stored securely, coded and assigned pseudonyms / study numbers so that the research participants cannot be identified. Potential participants will be identified via their institution's website and have publicly available e-mail addresses. All electronic data will be stored on UCC OneDrive anonymised form for the duration of the project and then stored in the Departments NAS local storage. In case of data loss or breaches to the data integrity due to operational errors, hacking / viruses or disasters,

the researcher will perform routine backups of all data at fixed intervals (for examples: daily, weekly). All laptops and PCs used to access data will be encrypted and password protected. The people who have access to the data will be the research group comprising of Audrey Dempsey, Prof. Yvonne Nolan, Dr. Eithne Hunt and Dr. Mutahira Lone. (e) Data will be retained only for the period required by regulations and only data required for the project will be retained. In line with University's Code of Research Conduct (2016) data will be securely held for a minimum of ten years after the completion of the research project and will then subsequently be destroyed by Prof. Yvonne Nolan. (f) The data will be accessed by the research group only (Audrey Dempsey, Prof. Yvonne Nolan, Dr. Eithne Hunt and Dr. Mutahira Lone). Results may be published in a peer reviewed journal, a professional journal, in a teaching award submission and / or presented at a conference. (g) Not Applicable (h) Not Applicable (i) Not Applicable

31. Arrangements for informing participants about the nature of the study (e.g. information sheets, letters of invitation, social media information, participant recruitment, focus group welcome/schedule, withdrawal, etc.)
Participants will be informed about the purpose and nature of the study in a recruitment email (Appendix A) and also in an information sheet (Appendix B) attached to the email. The body of the email itself will include a brief explanation of the study. It will give directions to participants on how to take part in the study via a link to the survey. The information sheet (Appendix B) will outline the following: study aims, voluntary participation, right to withdraw, data management and protection and how their data will be used in the study. Participants are required to read the information sheet prior to providing informed consent.

32. How you will ensure that participants provide informed consent? (cf. Question 4 - attach relevant form(s); address special considerations in terms of children / young people / vulnerable persons / adults who have difficulty in making decisions unaided)
An information sheet (Appendix B) outlining the purpose and nature of the study will be attached to the recruitment email. Participants will be directed to read the information sheet prior to starting the questionnaire so that they may provide informed consent. Participants who chose to participate in the study will then be directed to the start of the questionnaire where they are required to select a tick-box option that they "consent to participate in this study" or they "do not consent" (Appendix C). Only data from participants who have provided consent may be analysed.

33. Outline of debriefing process at the end of the data collection process (cf. Question 9). If you answered Yes to Questions 19a or 19b, give details here. State what you will advise participants to do if they should experience problems (e.g. who to contact for help – provide name and contact details where required.)

The researcher will share the results with any participant who wishes to see them, once data analysis is complete.

34. Estimated start date and duration of project (by months)
Start Date: 1st June 2021 Duration: 1 year

35. Additional information of relevance to your application
N/A

36. Declarations (clickable links to policies and codes quoted here are on the next page)	Delete as applicable
I/we agree that should there be unexpected ethical issues arising during the course of this study, that I/we will utilise my/our professional/disciplinary code of ethics, and/or notify UCC SREC, where appropriate.	Yes
I/we have consulted the UCC *Code of Research Conduct* (2019) and believe my/our proposal is in line with its requirements.	Yes
I/we have consulted the UCC *Child Protection Policy* and believe my/our proposal is in line with its requirements.	NA
I/we have consulted the UCC GDPR guidelines and declare that our project is GDPR compliant. Where required under the UCC GDPR Guidelines, I have submitted a DPIA.	Yes NA
I/we have consulted the UCC Garda Vetting Guidelines, and where appropriate, researchers on this project have valid Garda vetting through UCC (having a valid Garda Vetting through another body is insufficient).	Yes

37. Signatures – Reminder all academic supervisors (where applicable) must approve the contents of this application	
UCC Applicant(s)	Academic Supervisor / Principal Investigator /Tutor (where applicable)
A.Dempsey	Yvonne Nolan [illegible] [illegible]
Date: 17/05/2021	Date: 17/05/2021

Please submit a *signed* copy of this form and all relevant attachments as one PDF file to srec@ucc.ie.

A picture of signatures pasted into section 37 is acceptable. No hard copies of this application are required.

SREC is not primarily concerned with methodological issues, but we may comment on such issues in so far as they have

ethical implications.

Key UCC links and resources (all blue links are clickable links):

UCC Code of Research Conduct	**EU Commission, Responsible Research and Innovation** & H2020 **RRI Tools Website**
UCC Child Safeguarding Statement	**Irish Qualitative Data Archive** (IQDA)
Guidance Document for Conducting Internet Research	**Irish Social Science Data Archive** (quantitative datasets)
Garda Vetting of UCC Staff	**Health Service Executive National Consent Policy**
UCC Student Garda Vetting Policy	**IT Support for UCC Researchers**
UCC Data Protection Impact Assessment (DPIA) policy and templates	**UCC GDPR website**
UCC Library Research Data Service	**UCC Guidance for Researchers Conducting Research with Vulnerable People**
Survey Platforms	**SREC Amendment Process**

Electronic data storage

UCC Approved IT Storage and Collaboration Platforms **Data Storage & Backup**	As researchers, it is imperative that we can assure our participants that their data will be stored securely; this is of course particularly important where potentially sensitive personal details are involved. It is not adequate to simply say that the data will be stored safely. Exact detail is required as to the use (and location) of locked cabinets, management of audio files, encryption of laptops, electronic storage and so on. Where possible physical data such as survey forms etc. should be converted to electronic format as soon as possible and the originals shredded, however if you need to retain physical data then it should be safely stored on premises at UCC in a locked cabinet/office. If transcription is being outsourced the transcription service used needs to be trustworthy, reliable and confidential and ensure that data transfer is done securely. Treating and Storing Data If data does not need to be identifiable it should be converted to anonymous form as soon as is possible. Applicants should never store research data on a USB and only use an encrypted portable hard drive for short term storage until data has been anonymised. Applicants must consider how to maintain safe storage of their data beyond the life of their laptop/pc to meet the 10-year requirement in the UCC Code of Research Conduct. All laptops and PCs used to access data must be encrypted and password protected. All data both anonymised and non-anonymised can be stored on the following cloud platforms; UCC provided MS OneDrive, MS Teams (in the associated default MS SharePoint), MS SharePoint, Google Drive, and G-Suite Shared Drive.. In the exceptional case where there is a requirement for on premise storage (e.g. a requirement of a data-sharing agreement with a third-party), the Research Data Store can be accessed by researchers for storing research data. UCC NAS can be used for secure storage if the researcher has access to it, e.g. UCC staff. Although UCC students currently have access to institutional cloud storage, and although this access does extend beyond their period of being a student, we advise that relying on one person's access to this account for data storage is not best practice, and advise students to set up a shared UCC Supported Microsoft or Google Drive, with their supervisor, using their UCC credentials (e.g. email address/password), until guidelines for the storage of student research data are updated within UCC. For more information on data storage see **Data Storage & Backup** *Personal versions* of OneDrive and Google Drive should not be used to store research data. For collaborative projects (see below and Microsoft Teams), research data should only be stored on

	approved storage services, ideally on approved UCC storage options. If applying for ethical approval through SREC for collaborative projects and the data will not be stored in UCC, please include comprehensive details on how these external services meet the relevant approved standards. Collaboration Platforms (internal teams and working with external partners) UCC-supplied collaboration and storage services like Microsoft Teams (part of Office 365) and the equivalent in G-Suite, can facilitate you to safely collaborate and communicate on research studies with UCC staff and students, and to collaborate with partners outside the university. Data saved in Microsoft Teams is stored in the University tenancy in the Microsoft cloud. Data is encrypted in transit and at rest. Features such as version control, external sharing and audit logging are available. Microsoft Teams sites can also be archived after the research is completed. If you have questions about these services, please contact the UCC IT Helpdesk or click on the link on the left.
UCC Device Encryption Service	This service provides for the encryption of the internal hard disks of University laptops.
UCC Staff IT Services	List of all UCC staff IT services.
HEAnet FileSender	HEAnet FileSender is a way to share large files. It works through your web browser. Filesender also allows you send encrypted files to any email address in a safe manner, which is useful for sending audio files to a transcriber or between team members outside of UCC.
Azure Information Protection	Microsoft Azure Information Protection - AIP - enables you to protect documents on your computer before sharing them, and also enables you to protect emails in Outlook before sending them (PCs only). Click here for the Azure how to guide. Click here to download the software.

Appendix 14 Published Manuscripts

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RESEARCH REPORT

Anatomical Sciences Education | AMERICAN ASSOCIATION FOR ANATOMY | WILEY

Universal design for learning in anatomy education of healthcare students: A scoping review

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Abstract

There are concerns among healthcare practitioners about poor anatomical knowledge among recent healthcare graduates. Universal Design for Learning (UDL) is a framework developed to enhance students' experience of learning and help students to become motivated learners. This scoping review identified whether UDL has been utilized in third level healthcare education and if so, whether it had been used to enhance student motivation to study anatomy. Seven online databases were searched for studies reporting the use of UDL in the curricula of medical, dental, occupational therapy (OT) or speech and language therapy (SLT) programs. Studies were screened for eligibility with set inclusion criteria. Data were extracted and analyzed. Analysis revealed that UDL was not specifically mentioned in any of the studies thus there are no published studies on UDL being formally applied in healthcare education. However, the authors identified 33 publications that described teaching methods which aligned with UDL in anatomy curricula and a thematic analysis yielded four main themes relating to teaching strategies being employed. Universal design for learning was not mentioned specifically, indicating that educators may not be aware of the educational framework, although they appeared to be utilizing aspects of it in their teaching. The review revealed that there is a lack of research concerning the anatomy education of OT and SLT students. The role of UDL in enhancing motivation to learn anatomy in medical, dental, OT and SLT programs has yet to be explored.

KEYWORDS

health professions education, gross anatomy education, healthcare education, motivation, occupational therapy education, scoping review, speech and language therapy education, universal design for learning

INTRODUCTION

In recent years, the hours dedicated to teaching anatomy through dissection and didactic lectures to students of medicine and allied health professions, in the physical university environment, has reduced due to the advancement of technology and competition with teaching time from other disciplines (Papa & Vaccarezza, 2013; Wong et al., 2020). Additionally, there are concerns among medical and dental practitioners about poor anatomical knowledge among recent healthcare graduates (Durham et al., 2009; Fillmore et al., 2016; Hagan & Jaffe, 2018). Moreover, there appears to be a paucity of published research concerning the anatomical knowledge of occupational therapy (OT) and speech and language therapy (SLT) graduates. Anatomy is one of the fundamental subjects in healthcare curricula and is considered indispensable for safe and effective practice (Smith et al., 2016). It is not only healthcare professionals that notice the inadequate anatomical knowledge among graduates, students themselves also recognize this. Students in the early stages of their medical degree have described anatomy as boring and relate it to learning off reams of factual information which demands self-discipline rather than understanding the material (Bergman et al., 2013a). A recent study has indicated that 53% ($n = 87$) of students, who had already completed their undergraduate degree in OT and were pursuing further OT training either by completing a Masters or a Doctorate degrees, did not feel prepared or felt only somewhat prepared for the anatomy content of a mandatory module as they lacked confidence in their anatomical knowledge gained during their undergraduate OT program (Giles et al., 2021). Schofield (2018) found that occupational therapists with more than three years' experience were of the opinion that newly graduated therapists did not possess adequate anatomy knowledge, although there is a lack of empirical data to affirm this opinion. These findings highlight the need to enhance healthcare students' anatomy learning. To maximize student motivation and enhance anatomical knowledge, it is suggested that changes be made regarding the educators' approach to teaching anatomy to healthcare students (Ghosh, 2016; Singh et al., 2019). This has generated inquiries around ways in which educators can maximize learning for all their students and promote better understanding of anatomical knowledge. There are few studies investigating the inclusivity of teaching methods utilized in anatomy curricula. Meyer and Cui (2019) highlight how incorporating diversity and inclusivity to an anatomy and physiology module allowed students to flourish, make informed decisions and feel safe. Díaz-Navarro and Sánchez De La Parra-Pérez (2021) demonstrated how 3D-printed typhlological replicas could be used to teach the anatomy of the skull to visually impaired archaeology students and thus showed that it is possible to make anatomy curricula inclusive.

Universal design for learning

Universal Design for Learning (UDL) was developed by the Center of Applied Special Technology (CAST) in the United States in the early 1990s as a method to enhance student experience, remove barriers to learning and ensure that education is inclusive for all learners (CAST, 2021). It posits that a "typical" or "average" student does not exist, but instead that all students learn differently (CAST, 2021). Thus, UDL was constructed to incorporate more flexible approaches to teaching and assessment so that students of differing abilities are catered for (Gronneberg & Johnston, 2015). It is suggested that teachers should adhere to three UDL principles when designing learning, namely multiple means of engagement, multiple means of representation and multiple means of action and expression.

The principle of multiple means of engagement relates to ways in which students may become motivated learners by enhancing their opportunity to be autonomous, persistent and self-regulated (Meyer et al., 2014). Multiple means of representation focuses on methods which encourage students to become resourceful and knowledgeable (Meyer et al., 2014), while multiple means of action and expression highlight methods to help students to become more strategic and goal-directed (CAST, 2021). These three principles are divided into nine guidelines which are further broken-down into 31 checkpoints, which educators may use to enhance program design (Figure 1). The checkpoints allow for greater ease of understanding and use of the UDL framework by educators (CAST, 2021). Universal design for learning allows flexible assessment opportunities whereby the students can express their learning in the manner which is most appropriate for them (Rose & Gravel, 2010). Research indicates that first year undergraduate students utilize memorization and rote learning as a learning strategy; whereas it has been shown that rote learning is not an optimal approach in third level education (Ahmed & Ahmad, 2017; Roces Montero & Sierra y Arizmendiarrieta, 2017; Ishartono et al., 2019). Thus, the incorporation of UDL may help students develop new strategies to help them succeed in their journey through third level education.

A number of motivational theories overlap with the UDL principles including attribution theory (Weiner, 1985), social cognitive theory (Bandura, 1977), self-determination theory (Ryan & Deci, 2000) and goal orientated theories (Dweck & Leggett, 1988). A motivational theory which aligns with the first principle of UDL, namely multiple means of engagement and is relevant to the topic of this review is that proposed by Ryan and Deci (2000), namely self-determination theory. Self-determination theory suggests that learners are more inclined to develop intrinsic goals when they are provided with varying challenges and relevant feedback (Ryan & Deci, 2000). This aligns with the UDL checkpoints "vary demands and resources to optimize challenge" and "increase mastery-oriented feedback" (Figure 1). Furthermore, the study by Mattick and Knight (2007) suggests that designing a curriculum which activates and emphasizes prior knowledge to enhance the integration of information is a factor in promoting motivation among second year medical students. This approach aligns with the UDL checkpoints "activate or supply background knowledge" and "maximize transfer and generalization". Therefore, instead of drawing from numerous learning theories, it may be more efficient to examine anatomy education through the singular lens of UDL.

Regarding the globalization of UDL, there appears to be an imbalance as studies exploring the benefits and use of UDL are predominantly based in first world countries (Smith et al., 2019; Nieminen & Pesonen, 2020; Tomas et al., 2021). In contrast, limited research has been conducted in lower and middle income countries (Chiwandire, 2019; Dalton et al., 2019; McKenzie & Dalton, 2020). This highlights a future need to explore the implementation of UDL, specifically in healthcare education contexts in third world countries, to ensure that the global status is captured.

Anatomy curricula at present

Anatomy is considered a classical science, it continues to demonstrate considerable relevance in the training of third level students in health professions, as the anatomical knowledge these students obtain will be used throughout their practical careers (Ruzycki et al., 2019). However, the manner in which students' anatomy knowledge is being taught and assessed is changing. Rowland et al. (2011) reported that in 2005 there was a major shift in the method of anatomy

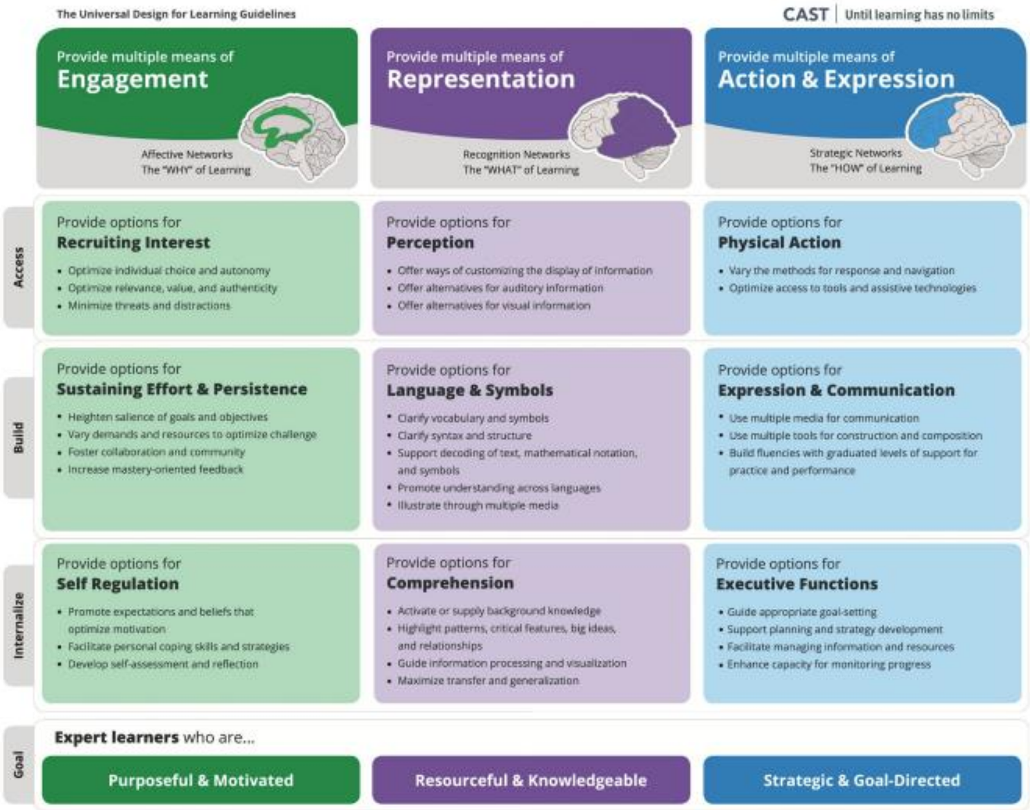

FIGURE 1 A schematic outlining the three Universal Design for Learning principles and their respective guidelines and checkpoints (CAST, 2021)

assessments which health professional students undertook. Prior to 2005, students were typically assessed by way of practical and oral examinations as opposed to the methods used since then, namely written examinations such as multiple-choice questionnaires (MCQs) and extended matching questions. Consequently, it was found that as assessment methods altered, so too did students' learning strategies. Students began to neglect the practical aspects of the anatomy content and instead focused on the theoretical information (Rowland et al., 2011). As a result of students neglecting the practical anatomy content, opportunity to make connections between their theoretical and practical knowledge was reduced and their ability to use background information to further their understanding inhibited (Yong, 2012). Perhaps the introduction of teaching strategies which utilize elements of UDL like activating background knowledge and highlighting patterns, critical features and relationships may help to combat such disconnections between theory and practice among anatomy healthcare students (CAST, 2021).

A recent study by Tayyem et al. (2019) reported that 46.6% ($n = 313$) of final year medical students felt that they had a poor grasp of anatomical knowledge. Furthermore, the authors highlighted the need to promote transfer of knowledge as only 111 (35.4%) students thought that the way anatomy was classically taught was adequate to understand radiological images, endoscopic views and laparoscopic views. Additionally, Tayyem et al. (2019) emphasized that although students thought that cadaveric teaching was the best method for teaching anatomy (79.6%), they were in fact being predominantly taught via lectures (92%). Similarly, the most common method of anatomical assessment among the students was MCQ examinations when only 36.7% of participating students actually chose this as their preferred method of assessment in anatomy (Tayyem et al., 2019). The discrepancies between what students prefer and what occurs in practice suggest that perhaps if multiple means of engagement, representation, action and expression were available to the students they may find the learning material more accessible and inclusive of their needs.

Vitorino et al. (2020) compared the academic performance of anatomy students taught with passive and active teaching methodologies. Active methodologies refer to when students are the active subject in the teaching-learning process and the educator is acting as a facilitator, guiding the students through the learning process while allowing them to generate their own ideas and understanding (Lee & Hannafin, 2016). The purpose of UDL is similarly to nurture learners to become autonomous, independent and self-directed (CAST, 2021). Although, this study found that students' academic performance was quantitatively better using passive rather than active methodologies (Vitorino et al., 2020), it should be highlighted that educational institutions typically utilize the traditional, passive, methods in their curricular design, whether in primary school or third level institutions (Lee & Hannafin, 2016). Thus, third level students may find it difficult to comprehend new teaching methods. It has been suggested that active methodologies should be gradually introduced to students at the beginning of their third level educational journey before they are effectively applied (Davis et al., 2014). Furthermore, Lee and Hannafin (2016) suggest that students may prefer passive methods because they struggle to identify the key concepts within the learning material. This indicates that the use of passive teaching methods in isolation may deny students the opportunity to develop academic and life skills like critical thinking and the ability to recognize important information and critical concepts; all of which are skills which UDL aims to develop among students (CAST, 2021).

Literature from the field of pedagogy does not identify any one teaching method as optimal, but instead suggests that the most appropriate method depends on the discipline, the student population and the learning material (Estai & Bunt, 2016). Universal design for learning, which provides students with multiple means of engagement, multiple means of representation and multiple means of action and expression (CAST, 2021) enables such flexibility. This allows learners to develop the skills to identify methods which are most suitable, inclusive, accessible and applicable to their individual needs. Learners of varying abilities are afforded the opportunity to thrive in the same environment as their peers, they do not have to be singled out nor do specific accommodations need to be made for them (CAST, 2021).

Universal design for learning in third level anatomy education

The UDL framework has been successfully incorporated into the curricula of various university programs (Al-Azawei et al., 2017; Dean et al., 2017; Nelson & Brennan, 2019). Studies have shown that UDL has positive effects on students' learning and their educational experience (Scanlon et al., 2018; Dalton et al., 2019). In 2019, Shikha and Mthombeni emphasized the need to incorporate UDL into the curriculum of family and consumer sciences to offer students access to education through varying learning experiences. Similarly, Snow (2018) demonstrated how to vitalize student assessments by taking inspiration from UDL. It has been reported that UDL allowed students to explore various teaching and learning methods (Katz & Sokal, 2016), and therefore have the opportunity to learn to work in an optimal manner (Hashey et al., 2020). Implementing UDL in a third level public health program demonstrated an increase in learning, student engagement, improved personal development and student experience (Shiely & McCarthy, 2019). Evidently there are published studies reporting the use of UDL in third level education, however, the extent of utilization of UDL in healthcare curricula generally and in anatomy education specifically remains largely unknown. Therefore, an examination of its implementation in third level anatomy education is timely. Furthermore, UDL takes into account the developmental stage of learners and allows students of different abilities to reach their individual potential (Schreffler et al., 2019). This is particularly important as most of the anatomy curriculum is typically covered in the first year of healthcare programs, when most students are adolescents (Sawyer et al., 2018).

A recent publication from University College Cork, Ireland (UCC) described the utilization of the UDL framework in the delivery of practical anatomy teaching to first year medical students (Balta et al., 2020). Balta and colleagues (2020) concluded that UDL is sufficiently flexible to be included into an established practical anatomy course as a part of a medical program and that the ease of implementing UDL provides educators with the educational rationale for doing so. The role of UDL in enhancing motivation to learn anatomy in medical, dental, OT or SLT programs has yet to be explored.

Universal design for learning and student motivation

In the educational field, motivation is described as an individual's ambition and aspiration to participate in a learning environment (Wei et al., 2015). Motivation is required for students to endeavor toward successful learning and enhance academic performance, and is crucial for learning (Budiman, 2016; Abdel Meguid et al., 2020). Universal design for learning has been shown to allow students autonomy over their actions and how they express themselves (CAST, 2021), as well as freedom and independence which promotes student participation and motivation (Cheon et al., 2020). Specifically, the UDL principle, multiple means of engagement, focuses on the way in which learners become engaged and remain motivated (Al-Azawei et al., 2017). Therefore, it has been proposed that having numerous methods of engagement will help to enhance and sustain motivation (Lowrey et al., 2017). Furthermore, motivation appears to be one of the key ingredients for successful learning (Chai et al., 2016; Raza et al., 2019). However, there remains a paucity of information on how educators may promote and sustain motivation among students studying to become healthcare professionals. The aim of this scoping review was to identify whether UDL has been utilized in the anatomy curricula of third level healthcare programs, specifically in medical, dental, SLT or OT education and if so, to identify what elements of UDL have been utilized and whether UDL enhances motivation of undergraduate healthcare students in learning anatomy.

MATERIALS AND METHODS

Scoping reviews are used to investigate and highlight evidence in a particular area of interest (Rumrill et al., 2010) and to define the gaps for future research (Arksey & O'Malley, 2005). Thus, scoping reviews are a useful tool to assess current knowledge in an area of study that is still emerging (Levac et al., 2010), which is the case for UDL in anatomy curricula in healthcare education. The process of selecting studies on the use of UDL in the anatomy curricula of selected third level healthcare programs aligned with the recommendations in the preferred reporting items for systematic reviews and meta-analyses extension for scoping reviews (PRISMA-ScR) checklist (Tricco et al., 2018) and followed the framework developed by Arksey and O'Malley (2005). The protocol for this scoping review was registered with the Open Science Framework (OSF).

Identification of research question

A preliminary search of the Cochrane Library (John Wiley & Sons, Ltd., Chichester, West Sussex, UK) and JBI Database of Systematic Reviews (JBI, Adelaide, Australia) were carried out to identify whether a scoping review on UDL in healthcare anatomy curricula had already been conducted. No such study was found. To explore relevant evidence in the literature, this review used an initial research question: "Has UDL been utilized in the curricula of third level healthcare students?". The search was then narrowed to answer the following questions:

1. "What are the elements of UDL which have been utilized in the anatomy education of third level healthcare students?"
2. "Does UDL enhance motivation of undergraduate third level healthcare students in learning anatomy?"

Identification of relevant studies

Searches were carried out using the following electronic databases: PubMed (US National Library of Medicine, National Institutes of Health, Bethesda, MD), Scopus (Elsevier B.V., Amsterdam, Netherlands), CINAHL (EBSCO Information Services, Ipswich, MA), PsycINFO (American Psychological Association, Washington, DC), Web of Science (Clarivate Analytics, Philadelphia, PA), ERIC (ProQuest, Ann Arbor, MI) and Science Direct (Elsevier B.V., Amsterdam, Netherlands). Studies published between January 1990 and August 2021 were included. Techniques for searching included the use of search tools such as Boolean operators and free text terms, where appropriate. The descriptive key search terms that were developed to guide the search and the number of studies identified are outlined: (("universal design for learning" AND "healthcare education") OR ("universal design for learning" AND "anatomy education") OR ("universal design for learning" AND "undergraduate" AND "medical") OR ("universal design for learning" AND "education" AND "health") OR ("universal design for learning" AND "occupational therap*" AND "education") OR ("universal design for learning" AND "medic*" AND "education") OR ("universal design for learning" AND "speech–language therap*" AND "education") OR ("universal design for learning" AND "dent*" AND "education") OR ("accessib*" AND "healthcare education" AND "anatomy") OR ("inclusi*" AND "intervention" AND "education" OR training" AND "allied health") OR ("collab*" AND "allied health" AND "education") OR ("inclusi*" AND "college student*" AND "healthcare education") OR (("accessib*" OR "inclusi*") AND ("healthcare education" OR "allied health") AND "education") OR ("universal design for learning" AND "speech-language patholog*" AND "education") OR (("inclusi*" OR "collab*") AND "motivation" AND "healthcare education") OR (("inclusi*" OR "collab*") AND "motivation" AND "anatomy education")). Please see the Supporting Information for details of the search strategy. A hand search was carried out on the reference list of each of the included studies, grey literature and unpublished literature, such as theses, dissertations and abstracts of conference proceedings. The search was limited to original studies which were written in English.

Study selection

The screening process was carried out in three stages; title screening, abstract screening, and full-text screening. Duplicates were identified and removed by the first author (A.M.K.D.) during the first stage of the review process. The first author (A.M.K.D.) carried out the initiation screen and presented her findings to the other authors (M.L., Y.M.N., E.H.). Publications were selected based on the inclusion criteria for title selection (Table 1) and the abstracts were collected. The abstracts were then screened according to the inclusion criteria for abstract selection (Table 1), namely whether the abstract provided evidence of UDL in the curricula of specific healthcare programs or the inclusion of teaching strategies which aligned with UDL in the curricula of specific healthcare programs. The full texts associated with these abstracts were screened according to the inclusion criteria for full-text selection (Table 1) by all authors (A.M.K.D., M.L., Y.M.N., E.H.). To help identify whether a study utilized a UDL strategy, the authors composed a number of questions which aligned with each UDL principle. For instance, "Did students engage with the activity?", "Were the students provided with an opportunity to interact with their peers?", "Was the module content expressed in numerous formats?", "Was the module content accessible to all students?", "Did the students demonstrate their understanding?" or "Did the students have the opportunity to express themselves?". Search results were exported to the bibliographic software programs EndNote, version 9, (Clarivate Analytics, Philadelphia, PA) and Microsoft Excel spreadsheet (Microsoft Corp., Redmond, WA). The final analysis included 33 publications for data extraction and charting. All authors discussed and concurred on the selection of titles, abstracts and full articles selected for inclusion in the scoping review. There were no disputes.

TABLE 1 Criteria for study selection

Inclusion criteria	Criteria
Inclusion criteria for title selection	Published between 1990 and 2021
	Published in English in peer-reviewed journals
	Title reflects that the study was carried out among third level students
Inclusion criteria for abstract selection	Abstract reflects that the study is an original article
	Abstract shows evidence of UDL being implemented
	Abstract shows evidence of a teaching method aligning with UDL being implemented
	Abstract reflects that the study was carried out among third level healthcare students
Inclusion criteria for full text selection	Full text indicates that the study was carried out among medical, dental, OT or SLT students
	Full text describes the utilization of UDL in anatomy education of healthcare students
	Full text includes a description of a teaching method which aligns with at least one UDL checkpoint
	Full text shows evidence of evaluation of the teaching method implemented
	Full text provides clear methodology on the measurement of the outcome(s)

Abbreviations: OT, occupational therapy; SLT, speech and language therapy; UDL, universal design for learning.

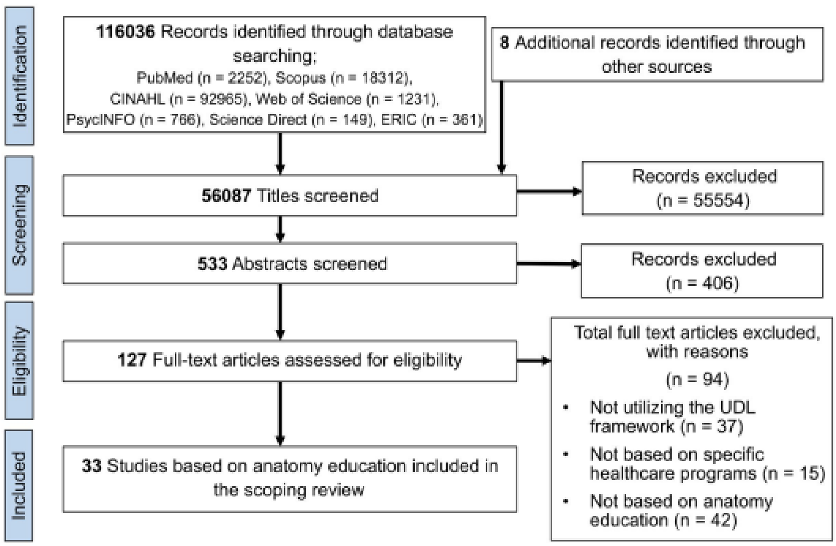

FIGURE 2 A preferred reporting items for systematic reviews and meta-analyses extension for scoping reviews (PRISMA-ScR) flow diagram of the literature selection. Adapted from Tricco et al. (2018)

Charting the data

A table was developed to collate the relevant information from the selected publications as follows: author(s), year of publication, title of study, geographical location, study population, sample size, study design, study objectives, data collection method, UDL checkpoint utilized and reported outcomes. Confirmability of the extracted data was supported by frequent debriefing sessions and collaboration between the first author and supervisor team.

Collating, summarizing, and reporting the results

Descriptive statistics were used to report the UDL checkpoints utilized in the selected studies. A thematic analysis (Braun & Clarke, 2006) was performed to identify the recurring elements of UDL which had been utilized in the anatomy education of third level healthcare students. Teaching methods which shared similar characteristics were organized thematically to provide a statement of the evidence.

RESULTS

Literature search

The searches resulted in a total of 116,044 publications identified through database searching (*n* = 116,036) and through other sources (*n* = 8) (Figure 2). Duplicates (*n* = 59,957) were removed. The titles of the remaining publications were screened according to the inclusion criteria (Table 1) and 55,554 publications were removed. The abstracts of the remaining 533 publications were screened according to the inclusion criteria. As a result, 406 publications were excluded as the abstracts revealed that the studies were not original research [book (*n* = 22), book chapter (*n* = 12), review article (*n* = 71), or opinion (*n* = 5)], they were not focused on third level education, they were not focused on the specific healthcare programs: medicine, dentistry, OT or SLT, they did not indicate the utilization of UDL or a strategy which aligned with the UDL framework or they could not provide evidence of quantitative or qualitative analysis. The full text for the remaining 127 publications were retrieved and screened according to the inclusion criteria (Table 1). The full text of the remaining 33 publications which fulfilled all the inclusion criteria were analyzed. The majority of the selected publications were based on studies conducted on medical students, although two involved dental students, one was conducted among OT students, and three included a mixture of medical and dental students. The process of data selection is illustrated (Figure 2).

Characteristics of the selected studies

The 33 selected studies were published between 2014 and 2021. The study characteristics are summarized (Table 2).

The utilization of universal design for learning in third level healthcare education

The scoping review identified that no published studies formally reported the utilization of UDL in the curricula of third level medical, dental, OT and SLT programs as none of the studies identified in the review mentioned the term UDL. However, 33 publications met the inclusion criteria as they presented enough evidence that the teaching methods described in the study aligned with the UDL principles.

The utilization of universal design for learning in third level anatomy education

None of the studies based on anatomy education in healthcare programs mentioned the term UDL. Of the identified 33 studies, only eight assessed student motivation. The remaining 25 studies investigated factors including: student attendance, student performance, teaching strategies and the learning environment. Although none of the selected studies specifically mentioned the term UDL, they met the scoping review inclusion criteria as they implemented at least one UDL checkpoint (Table 1). The checkpoint "develop self-assessment and reflection" was implemented the most often, appearing in 23 (69.7%) of the studies. "Support decoding of text, mathematical notation and symbols" was the only checkpoint that was not used in any of the 33 selected studies (Table 3). The checkpoints which fall under the engagement principle appeared most frequently: "foster collaboration and community" (54.5%), "optimize individual choice and autonomy" (42.4%), "optimize relevance, value and authenticity" (45.5%), "heighten salience of goals and objectives" (45.5%) and "increase mastery-oriented feedback" (45.5%) (Table 3). The most frequent occurring checkpoint from the "representation" principle was "maximize transfer and generalization" (51.5%) and the most frequent checkpoint from the "action and expression" principle was "enhance capacity for monitoring progress" (51.5%) (Table 3).

Universal design for learning to enhance motivation to study anatomy

The review also sought to identify whether UDL enhanced motivation of undergraduate healthcare students in learning anatomy, specifically students enrolled in medical, dental, OT and SLT programs. Although the 33 anatomy-based studies implemented strategies which are categorized under the UDL framework, only eight investigated the effect of UDL on student motivation to study anatomy (Anyanwu, 2013; Hu et al., 2016; Felszeghy et al., 2019; Mogali et al., 2019; Gnanasegaram et al., 2020; Mogali et al., 2020; Rezende et al., 2020; Rao Bhagavathula et al., 2022). Seven of the selected articles reported an increase in self-reported motivation and engagement among medical, dental and OT students. However, only three of the studies used a validated instrument to measure student motivation.

Results of thematic analysis

The thematic analysis yielded four main themes relating to teaching strategies which aligned with UDL: technology—enhanced teaching, contextualization, the learning environment, and active learning. Various technological tools, for example, e-learning programs,

TABLE 2 Study characteristic of selected anatomy based studies

Author	Year of publication	Title of study	Geographical location	Study population	Data collection method[a]	Study design[b]
Ben Awadh et al.	2022	Multimodal three-dimensional visualisation enhances novice learner interpretation of basic cross-sectional anatomy	UK	Medicine	A, D	I
Rao Bhagavathula et al.	2022	The integration of pre-laboratory assignments within neuroanatomy augment academic performance, increase engagement and enhance intrinsic motivation in students	USA	Occupational Therapy	A, B, H	L
Yohannan et al.	2022	"Air anatomy"—teaching complex spatial anatomy using simple hand gestures	India	Medicine	A	L
Dua et al.	2021	Development of a novel peer-sharing application to supplement learning from cadaveric dissection	USA	Medicine	A, B	J
Abdullah et al.	2020	Student-centred learning in the anatomy laboratory: Medical students' perspective	Ireland	Medicine	A, B	J
Gnanasegaram et al.	2020	Evaluating the effectiveness of learning ear anatomy using holographic models	Canada	Medicine	A, B, D	L
Golenhofen et al.	2020	The use of a mobile learning tool by medical students in undergraduate anatomy and its effects on assessment outcomes	Germany	Medicine	A, D	I
Lee et al.	2020	A web-based virtual microscopy platform for improving academic performance in histology and pathology laboratory courses: A pilot study	Taiwan	Medicine	A	K
Lorenzo-Alvarez et al.	2020	Game-based learning in virtual worlds: A multiuser online game for medical undergraduate radiology education within second life	Spain	Medicine	A, B, D	L
Mogali et al.	2020	Summative and formative style anatomy practical examinations: Do they have impact on students' performance and drive for learning?	Singapore	Medicine	A, B, D	K
Rezende et al.	2020	Comparison of team-based learning versus traditional lectures in neuroanatomy: Medical student knowledge and satisfaction	Brazil	Medicine	A, D	J
Felszeghy et al.	2019	Using online game-based platforms to improve student performance and engagement in histology teaching	Finland	Medicine & Dentistry	A, B	L
Guimaraes et al.	2019	The role of anatomy computer-assisted learning on spatial abilities of medical students	Portugal	Medicine	F	I
Hoffmann et al.	2019	Massage and Medicine: An interprofessional approach to learning musculoskeletal anatomy and enhancing personal wellness	USA	Medicine	A, B, D, E	L

TABLE 2 (Continued)

Author	Year of publication	Title of study	Geographical location	Study population	Data collection method[a]	Study design[b]
Mogali et al.	2019	Scan and Learn: Quick response code enabled museum for mobile learning of anatomy and pathology	Singapore	Medicine	A, B	I
Oakes et al.	2019	Using the jigsaw method to teach abdominal anatomy	Australia	Medicine	A, B	L
Pillay et al.	2019	Exploring opportunities for embedding graduate attributes in a first-year undergraduate anatomy course for allied health students	South Africa	Medicine	E, H	I
Nathaniel et al.	2018	Impact and educational outcomes of a small group self-directed teaching strategy in a clinical neuroscience curriculum	USA	Medicine	A, B	L
Kranz et al.	2017	Implementation of clinical references for undergraduates in anatomy	Germany	Medicine	A	L
Hu et al.	2016	Motivation in computer-assisted instruction	USA	Medicine	A, B, H	L
Ma et al.	2016	Personalised augmented reality for anatomy education	Germany	Medicine	A, C	I
Manyama et al.	2016	Improving gross anatomy learning using reciprocal peer teaching	Tanzania	Medicine	A, C, D	I
McBride and Drake	2015	Student perceptions of an interprofessional educational experience: The importance of goal articulation	USA	Medicine	A	I
McCluskey et al.	2015	Developing an e-tutorial of heart anatomy with real-time 3D cadaveric prosections and cardiac imaging techniques	UK	Medicine	A	J
Ocak and Topal	2015	Blended learning in anatomy education: a study investigating medical students' perceptions	Turkey	Medicine	B, G	J
Park and Howell	2015	Implementation of a flipped classroom educational model in a predoctoral dental course	USA	Dentistry	A, D	I
Murphy et al.	2014	Medical student knowledge regarding radiology before and after a radiological anatomy module: Implications for vertical integration and self-directed learning	Ireland	Medicine	A, D	I
Pratten et al.	2014	Group in-course assessment promotes cooperative learning and increases performance	UK	Medicine	D	I
Anyanwu	2013	Anatomy adventure: A board game for enhancing understanding of anatomy	Nigeria	Medicine & Dentistry	A	L

(Continues)

TABLE 2 (Continued)

Author	Year of publication	Title of study	Geographical location	Study population	Data collection method[a]	Study design[b]
Bacro et al.	2013	Lecture recording system in anatomy: Possible benefit to auditory learners	USA	Dentistry	A	L
Bergman et al. b	2013	Constructive, collaborative, contextual and self-directed learning in surface anatomy education	The Netherlands	Medicine	A, B	I
Inuwa et al.	2012	Implementing a modified team-based learning strategy in the first phase of an outcome-based curriculum—Challenges and prospects	Oman	Medicine	A, B	I
Jaffar	2012	YouTube: An emerging tool in anatomy education	United Arab Emirates	Medicine	A, B, E	I

[a] Data collection method: A, Questionnaire on student perception; B, Open-ended questions; C, Questionnaire on educator perception; D, Pre- and post-knowledge test; E, Focus group discussion; F, Pre- and post-skills test; G, Semi-structured interview; H, Post knowledge test.

[b] Study design: I, Cross-sectional study; J, Quasi-experimental study; K, Retrospective study; L, Randomized controlled trial.

radiological images, video recordings, simulations and quick response codes, have been used to enhance the teaching of anatomy (Jaffar, 2012; Bacro et al., 2013; McCluskey et al., 2015; Guimarães et al., 2019; Mogali et al., 2019; Golenhofen et al., 2020; Lee et al., 2020; Ben Awadh et al., 2022; Yohannan et al., 2022). Specifically, technology-enhanced teaching was utilized in 17 (52%) of the selected anatomy-based studies. This teaching method aligns with numerous UDL checkpoints, like "vary demands and resources to optimize challenge", "offer ways of customizing the display of information" and "vary the methods for response and navigation". Contextualization of anatomy is essential to sustain student engagement (Nicholson et al., 2016). In this regard, eight of the selected studies highlighted the relevance of anatomy to medical students' future careers (Murphy et al., 2014; Kranz et al., 2017; Pillay et al., 2019; Lorenzo-Alvarez et al., 2020). This strategy of contextualization aligns with the UDL checkpoints "optimize relevance, value, and authenticity", "heighten salience of goals and objectives" and "promote expectations and beliefs that optimize motivation". Although only one study created a specific learning environment for undergraduate medical students to practice, assess and consolidate their anatomy knowledge (Ocak & Topal, 2015), the inclusion of certain teaching methods, namely providing numerous learning materials for students at a time which was most convenient for them, helped to nurture a safe and inclusive learning environment. This teaching method utilized by Ocak and Topal (2015), aligned with several UDL checkpoints: "minimize threats and distractions", "vary demands and resources to optimize challenge", "develop self-assessment and reflection", "optimize access to tools and assistive technologies" and "facilitate managing information and resources". Furthermore, this specific learning environment ensured that all students had access to a safe and nurturing environment to study anatomy. Additionally, the gamification of anatomy learning material helped to create a relaxed learning environment for students (Anyanwu, 2013; Ma et al., 2016; Felszeghy et al., 2019).

The authors identified numerous examples of active learning from the selected anatomy-based studies. Specifically, 19 (58%) of the studies investigated the use of collaborative learning which aligned with the UDL checkpoint "foster collaboration and community". Collaborative learning was introduced via a variety of methods including small group learning, a flipped classroom or peer assessment (Inuwa et al., 2012; Bergman et al., 2013b; Pratten et al., 2014; McBride & Drake, 2015; Park & Howell, 2015; Manyama et al., 2016; Hoffmann et al., 2019; Oakes et al., 2019; Abdullah et al., 2020; Mogali et al., 2020).

Analysis of the reported outcomes from the selected studies highlights the positive effect of teaching strategies which align with the UDL framework on promoting student learning. The selected studies revealed that providing students with multiple methods for engagement with the learning material, representing the material in multiple formats or allowing students to express their knowledge in multiple ways has, in turn, heightened student motivation, participation and performance. Specifically, 14 (42%) of the selected anatomy-based studies utilizing elements of UDL reported improved

TABLE 3 Universal design for learning checkpoint utilized in the selected anatomy based studies

Universal design for learning checkpoint (n = 33)		Count n (%)
Multiple means of engagement	Optimize individual choice and autonomy	14 (42.4)
	Optimize relevance, value, and authenticity	15 (45.5)
	Minimize threats and distractions	4 (12.1)
	Heighten salience of goals and objectives	15 (45.5)
	Vary demands and resources to optimize challenge	12 (36.4)
	Foster collaboration and community	18 (54.5)
	Increase mastery-oriented feedback	15 (45.5)
	Promote expectations and beliefs that optimize motivation	11 (33.3)
	Facilitate personal coping skills and strategies	6 (18.2)
	Develop self-assessment and reflection	23 (69.7)
Multiple means of representation	Offer ways of customizing the display of information	11 (33.3)
	Offer alternatives for auditory information	8 (24.2)
	Offer alternatives for visual information	3 (9.1)
	Clarify vocabulary and symbols	2 (6.1)
	Clarify syntax and structure	1 (3)
	Support decoding of text, mathematical notation, and symbols	0 (0)
	Promote understanding across languages	1 (3)
	Illustrate through multiple media	5 (15.2)
	Activate or supply background knowledge	7 (21.2)
	Highlight patterns, critical features, big ideas and relationships	10 (30.3)
	Guide information processing and visualization	15 (45.5)
	Maximize transfer and generalization	17 (51.5)
Multiple means of action and expression	Vary the methods for response and navigation	13 (39.4)
	Optimize access to tools and assistive technologies	5 (15.2)
	Use multiple media for communication	4 (12.1)
	Use multiple tools for construction and composition	3 (9.1)
	Build Fluencies with graduated levels of support for practice and performance	3 (9.1)
	Guide appropriate goal setting	2 (6.1)
	Support planning and strategy development	5 (15.2)
	Facilitate managing information and resources	13 (39.4)
	Enhance capacity for monitoring progress	17 (51.5)

performance and understanding among the students. Seven (21%) studies reported an increase in motivation, and five (15%) reported an increase in confidence as a result of utilizing one or more UDL checkpoints. However, due to the lack of formal utilization and acknowledgement of UDL in the studies, such results cannot be attributed to UDL with absolute certainty. Thematic analysis is summarized (Table 4).

DISCUSSION

This scoping review revealed that the term UDL has not been utilized in third level healthcare education generally, nor specifically in the anatomy curricula of medical, dental, SLT and OT programs. Furthermore, the review revealed that UDL has not been specifically used to enhance motivation of undergraduate third level healthcare students to learn anatomy. Although the term UDL was not mentioned in the selected studies, the teaching methods described in the studies align with the UDL framework. However, it should be noted that each of the selected studies aligned with no more than half of the UDL checkpoints and in turn the benefits identified in the reported outcomes cannot be attributed entirely to the incorporation of UDL strategies. Nevertheless, the review has identified a gap in the literature in regard to the utilization of the UDL educational framework in the anatomy curricula of third level healthcare students.

TABLE 4 Themes and subthemes of strategies aligning with universal design for learning

Theme	Subtheme	Studies in which themes appear[a]
Technology-enhanced teaching	E-learning	C, D, F, G, H, I, J, L, N, P, Q, R, U, V, X, Z, AA, AB
	Simulations	D, G, H, J, L, Q, R, U
	Mobile applications	F, G, H, I, N, R, V
	Recordings	C, K, L, N, AA, AC, AG
	Quick Response (QR) codes	V
Contextualization	Career relevance	D, E, L, O, Q, S, T, Y
	Clinical relevance	B, D, E, G, I, J, K, M, N, Q, U, Y, AD, AE, AF
Learning environment	Gamification	B, G, R, Q, V
	Reflection	B, C, F, G, K, M, W, Y, AC, AD, AF
	Specific space	AA
Active learning	Flipped classroom	A, F, K, T, Z, AB
	Peer-assessment	E, M, S, T, Z, AB, AD
	Team based activities	A, B, D, E, F, G, K, M, S, V, W, X, Y, Z, AA, AB, AC, AD, AF

[a]Studies in which themes appear: A, (Abdullah et al., 2020); B, (Anyanwu, 2013); C, (Bacro et al., 2013); D, (Ben Awadh et al., 2022); E, (Bergman et al., 2013b); F, (Dua et al., 2021); G, (Felszeghy et al., 2019); H, (Gnanasegaram et al., 2020); I, (Golenhofen et al., 2020); J, (Guimarães et al., 2019); K, (Hoffmann et al., 2019); L, (Hu et al., 2016); M, (Inuwa et al., 2012); N, (Jaffar, 2012); O, (Kranz et al., 2017); P, (Lee et al., 2020); Q, (Lorenzo-Alvarez et al., 2020); R, (Ma et al., 2016); S, (Manyama et al., 2016); T, (McBride & Drake, 2015); U, (McCluskey et al., 2015); V, (Mogali et al., 2019); W, (Mogali et al., 2020); X, (Murphy et al., 2014); Y, (Nathaniel et al., 2018); Z, (Oakes et al., 2019); AA, (Ocak & Topal, 2015); AB, (Park & Howell, 2015); AC, (Pillay et al., 2019); AD, (Pratten et al., 2014); AE, (Rao Bhagavathula et al., 2022); AF, (Rezende et al., 2020); AG, (Yohannan et al., 2022).

Universal design for learning in third level healthcare education

UDL has much to offer teaching and learning in programs from many fields like information technology (Al-Azawei et al., 2017), microbiology (Kumar & Wideman, 2014) and geology (Feig et al., 2019). However, the advantage of UDL as a tool for teaching and learning in healthcare programs remains largely unexplored. Furthermore, none of the selected studies mentioned UDL, which suggests that the full potential of UDL has not been realized in the selected studies. It points to the likelihood that the authors of these studies were unaware of the framework and its potential benefits to student learning.

Universal design for learning in third level anatomy education

The studies identified in this review demonstrate that the teaching methods utilized, which aligned with the UDL framework, benefit the learning experience of medical, dental and OT students. These range from improved performance (Pratten et al., 2014; Manyama et al., 2016; Guimarães et al., 2019; Oakes et al., 2019; Lee et al., 2020; Mogali et al., 2020; Rao Bhagavathula et al., 2022) and understanding (Jaffar, 2012; Bergman et al., 2013b; Murphy et al., 2014; Nathaniel et al., 2018; Hoffmann et al., 2019) to enhanced participation (Inuwa et al., 2012; Pratten et al., 2014; Park & Howell, 2015) and confidence (Anyanwu, 2013; Manyama et al., 2016; Dua et al., 2021). The improvements and enhancements in teaching and learning reported in the selected studies can be attributed to the incorporation of technology, gamification, team-based activities, peer-assisted learning, an emphasis on the relevance of anatomy or the creation of a tailored anatomy learning environment. Moro et al. (2021), concluded from a review of the relevant literature that virtual and augmented reality are viable alternatives to traditional methods of teaching anatomy as they provide students with the opportunity to learn their anatomy material through various means, and thus concurs with the findings from this scoping review.

One of the aims of UDL is to promote accessibility and inclusivity among the student population. It cannot be stated for certain whether this was achieved in the selected studies as it was not investigated by the authors. It could be postulated though that the improved academic performance and understanding identified could be due to the learning material being more accessible to a larger variety of students. However, further research is required to confirm this. The scoping review also identified a paucity of studies that utilized the UDL framework in anatomy in allied health programs, specifically in OT and SLT programs as the majority of studies involved medical students only. This is surprising given the concerns among allied health professionals about the anatomy curricula of allied health programs which, in their opinion, requires attention and investigation during the preclinical years (Nayas et al., 2013; Singh et al., 2015; Wittich et al., 2017).

Evidently, there is scant research on how students enrolled in allied health programs are taught anatomy. For example, clinical therapy programs are considered new and young (Paden, 1970; Quiroga, 1995; Donnelly et al., 2013) when compared to the long-established professional medical and dental programs (Vieira & Caramelli, 2009; Schwartz, 2014). Therefore, allied health professions may not yet have the same established culture of research into curriculum development generally and of relevance here, anatomy education. This reiterates the need to research teaching methods which enhance, consolidate, and sustain students' motivation to learn anatomy in allied health professional programs. Unlike medical graduates, graduates of OT and SLT programs are not required to pursue further qualification once they have completed their undergraduate degree. Typically, students are taught the theoretical aspects of anatomy during their first year of study and must utilize this knowledge throughout their professional careers (Latman & Lanier, 2001; Janssen et al., 2014). It is imperative therefore that OT and SLT students gain the most from their first-year anatomy education. However, during their first year of study, usually before any clinical placements, students do not often grasp the relevance of anatomy (Smith et al., 2014), and therefore struggle to motivate themselves to participate and understand (Latman & Lanier, 2001; Smith et al., 2014; Barros et al., 2018). Additionally, first year students are typically adolescents and are in the midst of their transition to third level education (Sawyer et al., 2018).

Universal design for learning and motivation among undergraduate anatomy students

Eight of the selected studies assessed motivation among healthcare students, and five were carried out on undergraduate students, as opposed to graduate entry students. This is of importance as McKeown and Anderson (2016) highlighted how graduate entry and undergraduate students are motivated differently. They found that graduate entry business students were more motivated to study and participate when compared to an undergraduate cohort enrolled in a similar module (McKeown & Anderson, 2016). Furthermore, Wickramasinghe and Samarasekera (2011) reported that undergraduate medical students preferred a passive approach in comparison to graduate entry students. They concluded that this may be because graduate entry programs are typically more self-directed compared to undergraduate programs in which curricula are primarily based on lectures and tutorials (Wickramasinghe & Samarasekera, 2011). Self-directed learning has been shown to promote academic motivation (Ryan & Deci, 2000). Dynan et al. (2008) proposed that not all undergraduate students are prepared for self-directed learning when compared to graduate entry students, emphasizing the need to robustly investigate whether the UDL framework would enhance motivation among undergraduate healthcare students studying anatomy in the same way it has enhanced learning for undergraduate students from other programs (Al-Azawei et al., 2017; Dean et al., 2017; Nelson & Brennan, 2019).

Overall, this scoping review provides the rationale for further investigation into the utilization of UDL within the anatomy curricula of third level healthcare students. The results highlight the benefits of incorporating multiple means of engagement, multiple means of representation and multiple means of action and expression within the anatomy curriculum in order to promote participation, motivation, academic success and knowledge retention among healthcare students.

Limitations of the study

This review aimed to identify the utilization of UDL in the anatomy curriculum of healthcare programs. However, CAST developed the term UDL in the 1990s, therefore the review period was from January 1990 to August 2021 and literature prior to this were not included. Additionally, the review only included studies conducted with students enrolled in medical, dental, OT or SLT programs. Determining whether a study met the inclusion criteria was reliant on the authors' opinion, specifically in relation to its utilization of the UDL framework.

CONCLUSION

In this scoping review, the extent and nature of the use of the UDL framework in the anatomy curricula of healthcare programs was examined. Analysis indicated that although elements of UDL have been utilized in third level anatomy education, educators may not be aware of the framework as they did not explicitly use of the language of UDL. This suggests that if educators were more aware of the breadth and depth of the UDL framework, its full potential could be leveraged to enhance student learning. The results identified a lack of research concerning the anatomy education of OT and SLT students. Thus, whether or not the anatomy curriculum of these programs requires adjustments is yet to be determined. The role of UDL in enhancing motivation of third level healthcare students to learn anatomy in medical, dental, OT and SLT programs has also yet to be explored. Analysis of the selected studies from this scoping review suggest that providing students with multiple means of engagement is of crucial importance in healthcare education. This is in line with the UDL framework which was designed with the intention of molding and guiding students to become motivated and resourceful learners (CAST, 2021). The authors propose that the UDL framework is a pertinent framework to enhance student motivation to study anatomy through its utilization in healthcare programs.

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher's website.

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EDUCATION

CLINICAL ANATOMY WILEY

Awareness of Universal Design for Learning among anatomy educators in higher level institutions in the Republic of Ireland and United Kingdom

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Abstract

There is an increasing need to facilitate enhanced student engagement in anatomy education. Higher education students differ in academic preferences and abilities and so, not all teaching strategies suit all students. Therefore, it is suggested that curricula design and delivery adapt to sustain learner engagement. Enhanced learner engagement is a fundamental feature of Universal Design for Learning (UDL). The aim of this study is to determine if anatomy educators in the Republic of Ireland (ROI) and United Kingdom (UK) are aware of UDL and to assess if, and to what extent, it has been implemented in the design and delivery of anatomy curricula for healthcare students. An anonymous online questionnaire was administered to anatomy educators in higher level institutions in the ROI and UK. Inductive content analysis was used to identify the impact of UDL on student learning, engagement, and motivation, as perceived by the participants. The response rate was 23% (n = 61). Nineteen participants stated they knew of UDL. Of these, 15 had utilized UDL in their teaching of anatomy. Analysis indicated that the perception of UDL was mixed. However, the majority of responses relating to UDL were positive. The majority of the respondents were unaware of UDL but identified the frameworks' checkpoints within their curriculum, suggesting they have unknowingly incorporated elements of UDL in their curriculum design and delivery. There is a lack of information on the benefits of explicit utilization of UDL for engagement and motivation to learn anatomy in healthcare programs in the ROI and UK.

KEYWORDS
anatomy, curriculum design, universal design for learning

1 | INTRODUCTION

Anatomy is an essential pillar of healthcare programs and the foundation for safe and effective practice (Sugand et al., 2010). Healthcare

Mutahira Lone and Yvonne M. Nolan contributed equally to this work.

professionals have voiced their concern about poor anatomy knowledge among recent healthcare graduates (Bhangu et al., 2010; O' Keeffe et al., 2019) in particular their poor anatomical competency and lack of preparedness upon entering residency programs (Fillmore et al., 2016), suggesting that anatomy curriculum design requires reform. In the modern curriculum, there are constraints on the amount of time allocated to the formal teaching of anatomy within healthcare programs, and more specifically time dedicated to dissection (Harrison et al., 2019; Jeyakumar et al., 2020). In the Republic of Ireland (ROI) and United Kingdom (UK), anatomy is typically taught using an in-person didactic format complemented with practical laboratory sessions to consolidate student learning (Smith et al., 2021). Both of these teaching modalities have been identified as critical for students' anatomy learning experience (Farkas et al., 2016). Recent literature indicates that these traditional methods should not be used in isolation but rather alongside new innovative methods to enhance accessibility of learning material and to promote student engagement and interest in anatomy (Dempsey et al., 2022; Iwanaga, Loukas, et al., 2021; Lochner et al., 2016). For example, studies have identified that modern teaching strategies, such as gamification, virtual and augmented reality which align with multiple means of representation, result in similar levels of knowledge acquisition and collaborative activity as traditional methods (Moro et al., 2021; Rezende et al., 2020). However, these modern methods have the added bonus of stimulating student autonomy and increasing satisfaction among learners (Alfalah et al., 2019; Rezende et al., 2020) all of which aligns with the Universal Design for Learning (UDL) framework. Furthermore, research has highlighted that certain teaching strategies may not suit all students, as students differ in academic preferences and abilities (Hu et al., 2018; Quinn et al., 2018; Ruthberg et al., 2020). The learning styles and social and cultural background of the student population is continually changing as more learners are traveling and migrating to enter third level education (Nortvedt et al., 2020; Vos et al., 2016). Specifically, in 2017 international students comprised 12.5% of the entire third level student population in the ROI (Department of Education, 2018) and this number is increasing as 18.4% of all graduates in the ROI in 2019 were international students (CSO, 2022). Additionally, widening participation agendas promote the accessibility of third-level education (House of Commons, 2022). Thus, more students from diverse socio-economic backgrounds or with learning difficulties or disabilities are entering higher education both in the ROI and UK (GOV, 2022; HEA, 2022). Therefore, to sustain student interest and engagement in anatomy education, educators need to adapt their curriculum to the present student population and educational environment (Chan et al., 2021; Jeyakumar et al., 2020; Kahu & Nelson, 2018).

In March 2020, all higher level institutions in the ROI and UK were required to pivot to online teaching during the global COVID-19 pandemic (Franchi, 2020; Longhurst et al., 2020). Educators had to adapt quickly to ensure that students could continue to learn and engage with their material, albeit remotely (Evans et al., 2020). Anatomy educators became creative and innovative in their teaching methods (de Carvalho Filho et al., 2021; Dickinson & Gronseth, 2020; Evans et al., 2020; Harmon et al., 2021; Iwanaga, Loukas, et al., 2021; Yoo et al., 2021). For example, Harrell et al. (2021) incorporated online laboratory dissection videos, Flynn et al. (2021) introduced a 3-dimensional anatomical modeling program to medical students, and Zarcone and Saverino (2022) used Leica Acquire, a virtual microanatomy application, to teach pathological anatomy. Additionally, new teaching methods such as Augmented Reality (AR) (Iwanaga, Terada, et al., 2021) and asynchronous and synchronous lectures (Byrnes et al., 2021; Harrell et al., 2021) were utilized. Opportunities for students to demonstrate their understanding in multiple formats such as presentations (Flynn et al., 2021; Keet et al., 2021) and online breakout rooms (Al-Neklawy & Ismail, 2022) were also provided. As we emerge from the pandemic and return to on-campus teaching there is an increasing awareness of the benefits of student engagement to allow students to express their knowledge and understanding in a format which is most appropriate and accessible for them (Singh et al., 2021). These are fundamental features of UDL, a learning theory first articulated in the United States (US) in 1990.

Universal Design for Learning is an educational framework designed to ensure that all types of learners can participate, engage and thrive in the same learning environment (CAST, 2021a; Fornauf et al., 2021). The framework was developed by the Centre for Applied Special Technology (CAST) in the US as a guide for educators to design an accessible curriculum with the aim of changing the design of the learning environment rather than changing the learner (Bedrossian, 2018). The authors propose that anatomy students are encouraged to become life-long and resilient learners through an enhanced educational experience that meets their learning preferences. To help accomplish this, three guiding principles were articulated, namely multiple means of engagement, multiple means of representation and multiple means of action and expression. Each principle is divided into three guidelines and each guideline has a set of associated checkpoints (31 in total) which educators may use in the design and delivery of curriculum, in order to enhance accessibility for all students (CAST, 2021a) (Figure 1). The aim of UDL is to afford the opportunity to all students to optimize their learning capabilities while also fulfilling the learning outcomes. If there are certain learning outcomes that need to be met or assessed, then there may be limited opportunity for flexibility. The authors contend that promoting and increasing knowledge and understanding of anatomy enhances safety in anatomy practice (Smith et al., 2016), which is a core component of the skillset needed for a professional degree (Lewis et al., 2016; Simons et al., 2022). However, the incorporation of UDL in the design and development of assessments in vocational degree programs requires further research as there is currently little information available. CAST advocate that providing learners with multiple options to engage with the learning material will help learners achieve their potential (CAST, 2021a).

Since the inception of UDL in primary school settings, educators in Canada and the US have reported that students retained increased amounts of class content, that student communication skills were enhanced and that participation in classroom activities had increased (Katz, 2015; Lowrey et al., 2017). A meta-analysis carried out by Capp

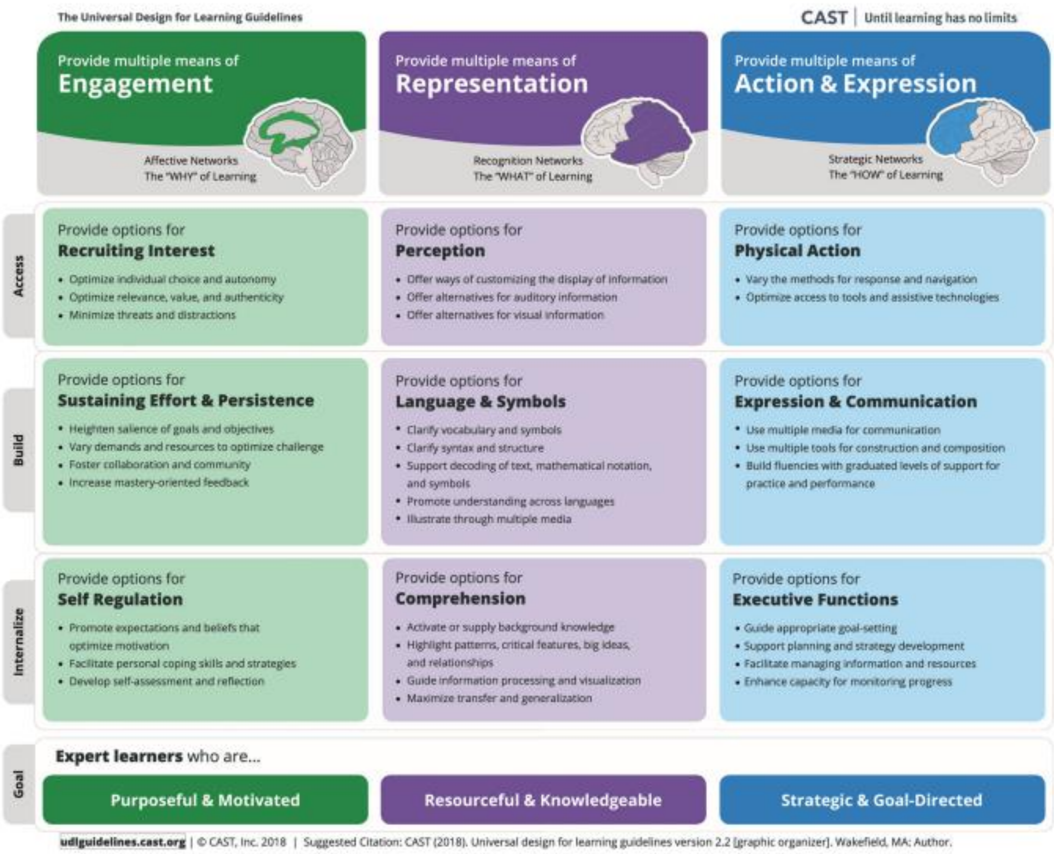

FIGURE 1 A schematic outlining the three Universal Design for Learning principles and their respective guidelines and checkpoints (CAST, 2021a)

(2017) reported that UDL is an effective teaching strategy for enhancing the learning experience of all students with and without disabilities in environments ranging from second level to third level education (Capp, 2017). However, it must be determined if these promising results and benefits, as a result of embedding UDL in the curriculum of primary and secondary education, would translate to students enrolled in higher level institutions.

Black et al. (2015) reported that presenting learning material in various formats, regularly providing students with constructive feedback and assessing students using diverse methods was beneficial to learning in a cohort of students enrolled in a higher level institution, in the US, all of which aligns with UDL checkpoints (CAST, 2021a). Murphy et al. (2020) suggested that because UDL has been implemented in an effective manner to aid students with disabilities in their transition to higher level institutions, then perhaps it could potentially be used to help students without disabilities in their transition to higher level institutions (Murphy et al., 2020). The UDL framework incorporates strategies like flexibility and accessibility which any student enrolled in higher level education, regardless of ability, will find beneficial (Griful-Freixenet et al., 2017).

The UDL educational framework offers potential for enhancing students' engagement in anatomy learning in higher level institutions (Dempsey et al., 2022). Many of the teaching strategies incorporated into anatomy education during the pandemic are aligned with the UDL framework, although none of the studies (Byrnes et al., 2021; Harmon et al., 2021; Harrell et al., 2021) specifically mention that UDL underpinned the change in approaches to teaching anatomy. Although there is a lack of published research about the explicit utilization of UDL in anatomy education in general (Dempsey et al., 2022), it is considered an effective tool to enhance student learning of anatomy with a recognized need for multiple means of engagement, representation, action and expression. Research by Balta et al. (2021) and Dempsey et al. (2022) shows that anatomy educators currently, and perhaps unknowingly, use various teaching methods and strategies when designing their curricula including the use of technology in its many forms (Bell et al., 2019; Ruthberg et al., 2020). Particularly, Ruthberg et al. (2020) incorporated mixed reality as an alternative to cadaveric dissection to utilize students' time more efficiently and, in turn, improve practical examination scores. They concluded that their mixed reality platform "HoloAnatomy" reduced the amount of time required for learning musculoskeletal anatomy without compromising student understanding, but they also acknowledged that not all students benefited from 3D resources and that individuals with less developed spatial abilities required more time viewing the 3D images (Ruthberg et al., 2020). This is an example of how implementing one teaching method in isolation will not cater for all students equally. Therefore, there is a need for a variety of teaching methods to ensure that content is accessible to all students. Bell et al. (2019) included the use of ultrasound in their curriculum to nurture an active learning environment for medical students studying the anatomy of the floor of the mouth, a teaching method which 97% of participating students (n = 31) agreed improved their learning. Furthermore, research has identified active learning as an essential element in creating a productive learning environment as it fosters student participation and engagement (Felder & Brent, 2009) all of which are aims of UDL (CAST, 2021a). The approach of Bell et al. (2019) to incorporate active learning to help students become independent thinkers, also aligns with the aim of UDL (CAST, 2021a). Universal Design for Learning caters for students with diverse learning needs, such as poor spatial recognition. This can be accomplished in anatomy curricula by including teaching strategies such as three-dimensional visualization software (Jamil et al., 2019; Lone et al., 2021) which allows students to view the learning material in different ways, which in turn helps with comprehension among learners.

More specifically, recent publications have reported the use of UDL in healthcare programs. Dickinson and Gronseth (2020) described the benefits and utility of the UDL framework for surgical education during the COVID-19 pandemic when face-to-face interaction was limited. Specifically, Dickinson and Gronseth (2020) used simulation, online resources, and mobile applications to aid the delivery of their curriculum to surgical residents in the US. Murphy et al. (2020) investigated, by means of an online survey, the implementation and knowledge of the tenets of UDL among occupational therapy educators in the US. They concluded that there is a need for more extensive use of UDL in preparation for teaching and continuing professional development as they propose its implementation would improve student learning and preparation for entering the discipline of occupational therapy (Murphy et al., 2020). Additionally, Murphy et al. (2020) highlighted throughout their study that, as the student population in higher level institutions and student preferences for learning are becoming more diverse, UDL will become the key to ensuring that all occupational therapy students can be ready for effective clinical practice. Studies analyzing healthcare education in higher level institutions indicate that when designing curricula, educators may incorporate methods which align with the UDL framework, without explicitly stating that UDL was utilized (Dempsey et al., 2022). Furthermore, anatomy educators may be utilizing the UDL framework but may not have measured or published the impact of its utilization in healthcare programs. For both reasons, an exploration of anatomy educators' knowledge and use of UDL is necessary and timely.

The aim of this study was to determine if anatomy educators in the ROI and UK were aware of the UDL framework and to assess if, and to what extent, they have been incorporating UDL in their curriculum design and delivery for healthcare students. Furthermore, the study explored if anatomy educators have identified or measured an impact on student learning, engagement, or motivation as a result of utilizing UDL; if there is an association between teaching experience and the incorporation of UDL; and finally, if educators have identified any barriers to implementing the UDL framework in their anatomy curricula.

2 | MATERIALS AND METHODS

2.1 | Study design

The authors developed and administered an anonymous online questionnaire to academic anatomy educators who were teaching in the anatomy departments of higher level institutions in the ROI and UK. A list of such higher level institutions was available on the Anatomical Society's website (Anatomical Society, 2021). The Anatomical Society seeks to promote and advance research and education in all aspects of anatomical science. The email addresses of anatomy educators from the above listed higher level institutions were accessed through each of the respective higher level institutions websites. The online questionnaire was distributed via email from the first author (A.M.K. D.) to potential participants. The questionnaire was accessible through the survey platform, Microsoft Forms (Microsoft Corp., Redmond, WA). Ethical approval was obtained from the Institutional Social Research Ethics Committee [Log 2021-082].

2.2 | Questionnaire design

The questionnaire was divided into two sections. Section one gathered demographic information such as academic position, methods of teaching and assessing anatomy and the healthcare programs on which educators taught anatomy. Section two focused on the respondents' knowledge, experience, and opinion of the UDL educational framework. The questions in section two were a mixture of both open and closed questions. Open-ended questions were included to allow participants to elaborate and expand on questions. The questionnaire was open to participants for 12 weeks from July 5, 2021 to October 1, 2021. Reminders were sent out fortnightly via email to all potential participants. Although the questionnaire was distributed during the COVID-19 pandemic, none of the questions specifically mention the pandemic.

2.3 | Data analysis

All data were exported to Microsoft Excel (Microsoft Corp., Redmond, WA) and frequency tables were created for categorical variables. Data

TABLE 1 Demographic information of participating anatomy educators

		Number of educators
Gender	Female	30 (49%)
	Male	30 (49%)
	Non-Binary	1 (2%)
Academic Position	Professor	13 (21%)
	Senior Lecturer	15 (25%)
	Lecturer	29 (48%)
	Tutor	1 (2%)
	Other	3 (5%)
Location	Ireland	9 (15%)
	Northern Ireland	1 (2%)
	England	39 (64%)
	Scotland	9 (15%)
	Wales	3 (5%)
Teaching Experience	Less than 1 year	1 (2%)
	1–3 years	7 (11%)
	4–6 years	11 (18%)
	7–10 years	13 (21%)
	11–15 years	9 (15%)
	16–20 years	6 (10%)
	More than 20 years	14 (23%)
Undergraduate Programs	Dentistry	14 (23%)
	Diagnostic Radiography	2 (3%)
	Medicine	47 (77%)
	Nursing	7 (11%)
	Occupational Therapy	5 (8%)
	Physiotherapy	7 (11%)
	Speech and Language Therapy	8 (13%)
	Therapeutic Radiography	2 (3%)
Graduate Entry Programs	Dentistry	3 (5%)
	Diagnostic Radiography	1 (2%)
	Medicine	19 (31%)
	Physiotherapy	1 (2%)
	Speech and Language Therapy	2 (3%)
	Therapeutic Radiography	1 (2%)
Teaching Methods	Plastic Models	54 (89%)
	Didactic	52 (85%)
	Imaging	52 (85%)
	Technology	52 (85%)
	Prosections	51 (84%)
	Osteology	46 (75%)
	Surface Anatomy	46 (75%)
	Dissection	45 (74%)
	Gamification	28 (46%)
	Team-based learning	28 (46%)
	Plastination	23 (38%)
	Kinesthetic	18 (30%)
	Peer-instructed Learning	18 (30%)
	Microscopes	16 (26%)

(Continues)

TABLE 1 (Continued)

		Number of educators
Assessment Methods	Multiple Choice Questionnaires	56 (92%)
	Short answer Questions	39 (64%)
	Essay	27 (44%)
	Objective Structured Clinical Examination	22 (36%)
	Extended Match Questions	21 (34%)
	Oral Examination	20 (33%)
	Group based Assessment	16 (26%)
	Student Self-assessment	15 (25%)

were entered manually into Statistical Package for Social Scientists (SPSS), version 22 (IBM Corp., Armonk, NY). Descriptive analyses were completed including the lambda coefficient to identify associations between teaching experience and the utilization of UDL. Inductive content analysis was used to explore anatomy educators' opinions of UDL through open-ended questions (Elo & Kyngäs, 2008; Kyngäs, 2020). Verbatim quotes that captured the concepts articulated by a number of participants were included.

3 | RESULTS

The overall response rate was 23% ($n = 61$). The majority of anatomy educators who participated in this study were at lecturer level ($n = 29$, 48%) and were located in England ($n = 39$, 64%). The teaching experience of the participants ranged from less than 1 year to over 20 years. The majority of anatomy educators who taught on undergraduate programs taught medical students. Similarly, the majority of anatomy educators who taught on graduate entry programs (to students who already had an undergraduate degree in another discipline) also taught medical students. A large variety of methods were utilized to teach anatomy. Plastic models were reported to be the most utilized method ($n = 54$, 89%), closely followed by imaging ($n = 52$, 85%), didactic teaching ($n = 52$, 85%), technology ($n = 52$, 85%) and prosections ($n = 51$, 84%). Teaching anatomy with microscopes was the least utilized method by anatomy educators ($n = 16$, 26%). Participating educators were asked to indicate the most commonly used assessment methods for anatomy. Multiple choice questionnaires (MCQ) were the most selected method of assessment among the respondents ($n = 56$, 92%), followed by short answer questions ($n = 39$, 64%). Student self-assessment was the least utilized method of assessment ($n = 15$, 25%). All information from section one of the questionnaire is summarized in Table 1.

3.1 | Awareness of UDL

Of the 61 respondents, only 19 (31%) stated that they had heard of the term UDL prior to completing the questionnaire. Of these 19 educators, 15 (79%) (and thus 25% of all respondents) had incorporated elements of UDL in their teaching of anatomy.

3.2 | Incorporation of UDL

Respondents were asked whether the design and delivery of their anatomy curriculum aligned with any of the UDL checkpoints. Every respondent identified at least one checkpoint from each of the three UDL principles in their curriculum. The most utilized checkpoint, from the multiple means of engagement principle, was "optimize relevance, value and authenticity" ($n = 50$) and the least utilized was "increase mastery-orientated feedback" ($n = 13$) (Figure 2A). The most utilized checkpoint from the multiple means of representation principle was "activate or supply background knowledge" ($n = 51$), followed closely by "illustrate through multiple media" ($n = 50$). The least utilized checkpoints from this principle were "support decoding of text, mathematical notation and symbols" ($n = 5$) and "promote understanding across languages" ($n = 8$) (Figure 2B). The most utilized checkpoint from the multiple means of action and expression principle was "use multiple media for communication" ($n = 54$) and the least utilized was "build fluencies with graduated levels of support for practice and performance" ($n = 14$) (Figure 2C).

Thirteen (21%) of the anatomy educators responded to the open-ended question "If you have utilized elements of UDL, can you give an example of how?". Eight of these 13 (62%) stated that they provide multiple means of representing the learning material. This is achieved by using several different formats including videos with closed captions, Microsoft PowerPoint slides with background information, digitally accessible documents, prosections, plastic models, and body painting. Five of these 13 (38%) respondents stated that they incorporate multiple means of engagement into their anatomy curricula by providing opportunities for the students to work together in pairs or small groups or by encouraging students to participate in self-directed learning. Two of these educators (15%) provided multiple means of action and expression by integrating a variety of assessment methods into the curriculum and by supporting the students to present their learning in a manner which best suits their learning style. For example, they encouraged students to palpate and draw surface anatomy and

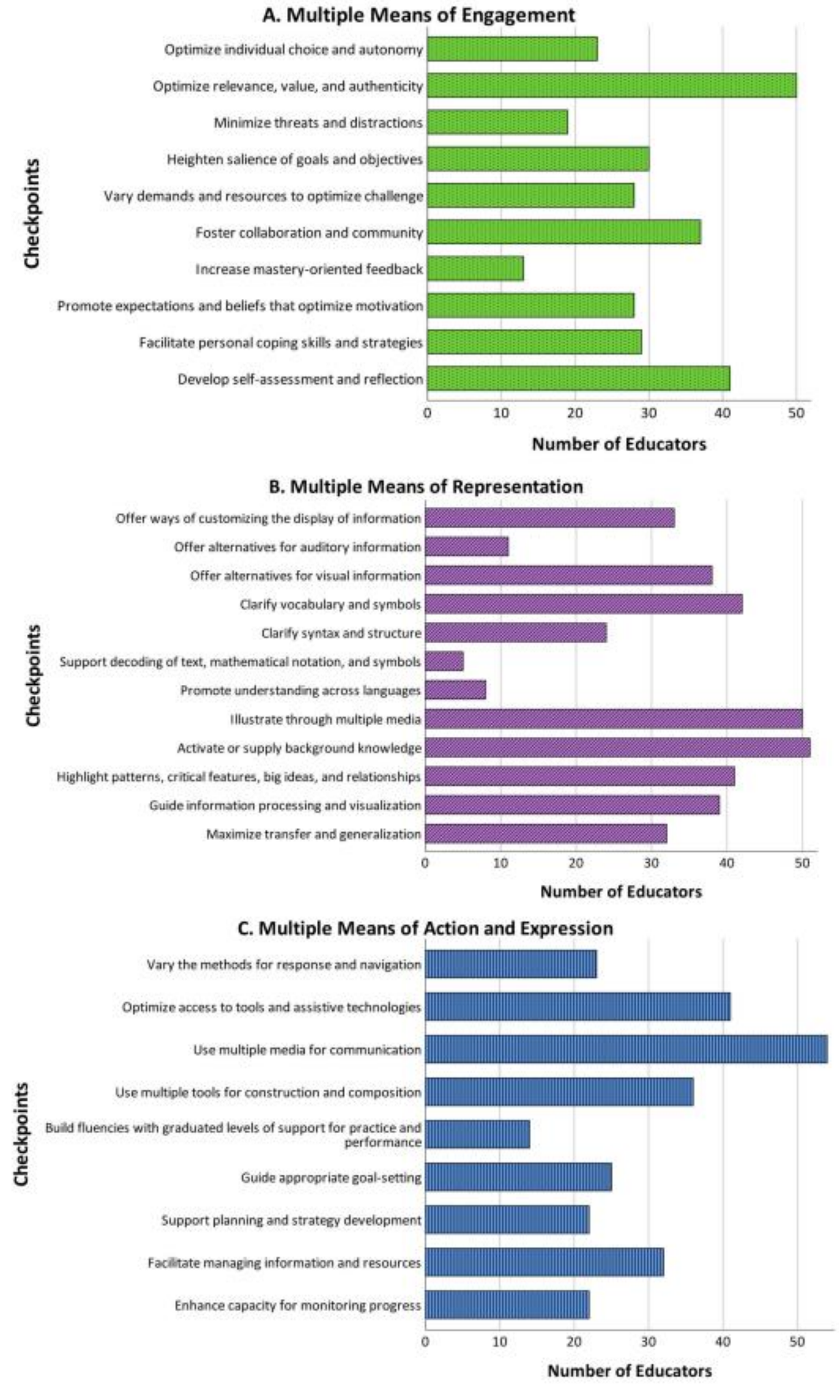

FIGURE 2 The number of anatomy educators whose anatomy curriculum aligned with each checkpoint of the (A) multiple means of engagement principle, (B) multiple means of representation principle, and (C) multiple means of action and expression principle

incorporate anatomy maps or applications when presenting their learning to their peers.

3.3 | Impact of UDL on student learning, engagement, or motivation

Inductive content analysis was used to identify the impact of UDL on student learning, engagement and motivation, as perceived by the participants. Of the 13 anatomy educators who responded to the open-ended question "From your experience, how do you think UDL benefits teaching and learning within an anatomy module?", the majority (n = 11, 85%) stated that UDL provides students with options for interacting with the learning material which in turn promotes engagement among students, empowers them to learn, creates a nurturing environment and makes it easier for students to access information. More specifically educators stated that UDL "*reduces the need for reasonable adjustment*," "*enables different cognitive processes to process information giving a richer learning experience and leading to deeper knowledge and longer-term retention. It offers flexibility and choice for learners but unless it is guided it can be overwhelming*," and "*improves engagement, appeals to wider variety of learners, helps students with self-assessment of progress and keeps instructors aware of individual learning needs of students*." Furthermore, another educator commented that "*the (anatomical) language itself can be challenging and so it is important to ensure that this is clearly explained and providing a UDL approach gives students the best opportunity to be able to understand and engage not only with the physical anatomy but also with the language*" and "*variety is key as some students will engage with some aspects of the teaching and not in others*."

Twelve respondents (20%) gave their opinion on whether the incorporation of UDL into curricula had an effect on student motivation to study anatomy. Two respondents did not think that the incorporation of UDL motivates students to learn anatomy. Three respondents said that they were not sure of the effect of UDL on motivation but that they were optimistic that it would have positive results. Specifically, one respondent said that they were "*not sure of the effect*" but that UDL has "*the potential for enhancing the student experience and in turn widening participation and motivation*." The remaining seven educators (58%) agreed that UDL has an effect on student motivation. Four of these educators did not elaborate on whether it was a positive or negative effect but of the other three, one stated that they have seen an increase in motivation among graduate entry students, another said that "*it (UDL) gives them (students) more freedom to learn in a way that is suitable for them and allows them to explore what works for them*" and the final respondent said "*it (UDL) has made the subject more 'fun' and less dry. Anatomy is not something to be learned and forgotten, it is meant to be applied to healthcare*."

The anatomy educators were asked "if you are not familiar with UDL, from the description of the framework, what potential, if any, do you see UDL having for teaching and learning in anatomy curricula?". Of the educators who were not familiar with UDL (69%), their opinion of the framework was mixed. Six (14%) of these respondents reported minimal or no potential of UDL application for teaching and learning in anatomy curricula. The remaining responses in relation to the potential of UDL were positive. For example, comments included "*lots of potential, especially for enhancing the student experience and being inclusive to different groups*," "*potential to give students a learning experience that best suits their individual needs within an intended outcome framework*," "*it would seem that UDL encapsulates those principles that are crucial for recognizing that individuals learn differently and facilitating such individual learning*," and "*I think there is definitely scope for us to think more about providing variety of learning experiences within anatomy teaching*". A word map was created to graphically represent the responses of participants to the open-ended question "what potential, if any, do you see UDL having for teaching and learning within anatomy curricula?" to emphasize the recurring opinions. The size of a particular word in the figure corresponds with how frequently it appeared in the responses of the educators (Figure 3). Word maps align with the UDL framework under the multiple means of representation principle. In particular, they align with Guideline 1, Checkpoint 1.1 "Offer ways of customizing the display of information" (CAST, 2021a). For some readers, an image illustrating the most common responses may aid interpretation of the results.

3.4 | Association between teaching experience and incorporation of UDL

A lambda coefficient statistical test was carried out to determine whether there was an association between respondents' teaching experience and their utilization of UDL. This resulted in a lambda score of 0.022 suggesting that there is no association between the number of years of teaching experience and the utilization of UDL among the responding anatomy educators.

3.5 | Barriers to implementing the UDL framework in anatomy curricula

A small number (7%) of the anatomy educators commented on the practicalities of implementing UDL in anatomy curricula. Specifically, there was reference to a staff shortage "*with an intake of over 400 students per year and very few staff, personalization is not an option*" and "*it (UDL) is hard to formally implement when there is a staff shortage*." Another educator said that UDL "*fits with best practice on teaching and learning but offers challenges in relation to assessment*."

4 | DISCUSSION

At the outset of the present study, the majority of the respondents were unaware of the UDL framework. However, once they gained some information about UDL and the associated principles and checkpoints, they realized that they had, seemingly unknowingly, been implementing elements of the framework in their curriculum design

FIGURE 3 A word map created from anatomy educators' responses to the question "What potential, if any, do you see UDL having for teaching and learning within anatomy curricula?"

and delivery. This suggests a need to inform educators of UDL and the potential benefits for teaching and learning of anatomy to healthcare students, especially when many of the respondents recognized the potential benefits of UDL in their responses to the open-ended questions. The present study did not investigate where educators, who were aware of the framework, had previously heard of UDL or if they received guidance on how to incorporate UDL into their curricula. Further research is needed to understand where and how educators are being made aware of the UDL framework, and whether supports are available to help guide them through the process of incorporating UDL into their anatomy curriculum design.

Fifteen of the respondents stated that they had been incorporating UDL into their anatomy curriculum and all 61 respondents identified at least one checkpoint from each of the UDL principles in their curriculum. This suggests that educators are already incorporating elements of the UDL framework, albeit potentially unknown to themselves. A scoping review analyzing the design and delivery of anatomy curricula in healthcare programs in higher level institutions revealed that when designing curricula, educators may incorporate methods which align with the UDL framework, without explicitly stating that UDL was utilized (Dempsey et al., 2022). However, there are still a number of checkpoints which very few respondents of this study identified in their curriculum design. For instance, only 21% of educators identified the checkpoint "increase mastery-orientated feedback," 31% identified the checkpoint "minimize threats and distractions" and 37% identified the checkpoint "optimize student choice and autonomy" (Figure 2A). Each of these checkpoints is categorized under the multiple means of engagement principle which helps foster self-directed and motivated learning. Various studies have shown that providing students with autonomy over their own learning is vital to sustain engagement and interest in the subject matter (Alsharari & Alshurideh, 2021; Goodman et al., 2021; Hensley et al., 2021). Similarly, it has been shown that providing students with immediate feedback allows students to engage with the learning process (Blondeel et al., 2022; Young et al., 2020). There is no mandatory number of UDL checkpoints which educators should implement (Rao et al., 2014), as some checkpoints are not appropriate for all subjects. For example, under the multiple means of representation principle, the checkpoint "support decoding of text, mathematical notation and symbols" is difficult to implement within anatomy curricula and therefore it was not surprising that only 8% of the respondents identified this checkpoint in their own curriculum design. Similarly, few respondents (13%) identified the checkpoint "promote understanding across languages" (Figure 2B). In comparison, a high number of respondents stated that their curriculum aligned with checkpoints such as "activate or supply background knowledge" (84%), "illustrate through multiple media" (82%) and "highlight patterns, critical features, big ideas and relationships" (67%) (Figure 2B), all of which are from the multiple means of representation principle and have been established as influencing successful student learning across various disciplines (Manthra Prathoshni et al., 2018; Vieira et al., 2019; List et al., 2021; Ulfa et al., 2021). Specifically in anatomy education, Zafar and Zacher (2020) concluded that representing anatomy material in various formats, such as complementing the use of cadavers with AR, increased enjoyment and engagement among dental students. In relation to the multiple means of action and expression principle, some of the least identified checkpoints were "support planning and strategy development" (38%), "enhance capacity for monitoring progress" (36%) and "vary the methods for response and navigation" (36%) (Figure 2C). However, studies have identified that varying the way students navigate and participate in the learning environment, and guiding student goal-setting helps nurture strategic and goal-directed anatomy learners (Donkin & Rasmussen, 2021; Eleazer & Scopa Kelso, 2018; Grønlien et al., 2021; Hernandez et al., 2020). Incorporating each of these guidelines would provide learners with the opportunity to express their knowledge in a manner which is most appropriate to them, and to track their progress, which in turn would allow them to identify areas where they may be struggling, or indeed excelling, all of which helps learners to become strategic and goal driven (CAST, 2021a). Edyburn and Edyburn (2021) describe the essential practices required to help any educator implement UDL in a manner which provides meaningful support for the diverse student population so that every learner can be successful. The authors emphasize that there is a requirement to understand the philosophy of UDL, but additionally that there is a need to bridge the gap between knowing about and implementing UDL. The authors propose the utilization of UDL for the design and delivery of anatomy curricula, as UDL encapsulates a number of pedagogical theories, such as self-determination theory (SDT) (Deci & Ryan, 2000; Hu & Zhang, 2017), generative learning theory (GLT) (Brod, 2021; Wittrock, 1974) and cognitive flexibility theory (CFT) (Spiro et al., 1991) into one framework. Universal Design for Learning also aligns with the FAIR principles postulated by Harden and Laidlaw (2016). Therefore, educators may look to one framework for guidance, when designing their curriculum delivery, rather than multiple different theories.

The present study illustrates the knowledge and perceived impact of UDL among anatomy educators in the ROI and UK. At the outset of this study, many of the respondents stated that they were not aware of the UDL framework, but at the end of the questionnaire they stated that they believed they were implementing elements of the framework in their curriculum design and delivery. These anatomy educators utilized various accessible and inclusive teaching methods and, in a number of cases, noticed improvements in student motivation and engagement as a result. The questionnaire provided educators with a very basic description of UDL. Perhaps with more detailed information they would be able to identify the areas in their curriculum that could be updated or modified. Teaching methods that align with the UDL framework have been reported to have a positive impact on learning among students with a variety of learning preferences across an array of programs in a higher level institution in the US (Black et al., 2015). The authors concluded that representing learning material in various formats, regularly providing students with constructive feedback, and assessing students using diverse methods was beneficial to student learning, all of which aligns with UDL checkpoints (CAST, 2021a). Murphy et al. (2020) suggested that since UDL has been effectively implemented in aiding the transition of students with disabilities to higher level institutions, then perhaps it could potentially be used to help students without disabilities in their transition to higher level institutions (Murphy et al., 2020). Furthermore, the UDL framework incorporates strategies like flexibility and accessibility to learning material which any higher level education student, regardless of ability would find beneficial (Griful-Freixenet et al., 2017).

The respondents' teaching experience ranged from less than 1 year to more than 20 years. There was no association between experience and the utilization of UDL, indicating that the educators' awareness of UDL and its implementation in anatomy curricula is not reliant on the extent of teaching experience.

Inductive content analysis was used to explore the participating anatomy educators' opinions of UDL. From this analysis it became clear that, according to the respondents, the main barrier of incorporating the UDL principles into anatomy curricula is a staff shortage. Staff shortage in anatomy programs has been documented (Kramer et al., 2020; Wilson et al., 2020). Thus, there may be a negative association with implementation of a new teaching framework to anatomy curricula due to the increased workload that typically accompanies curricular change. However, respondents may not yet be aware of recent publications guiding educators to incorporate UDL into their curriculum design and delivery (Cotán et al., 2021; Edyburn, 2021; Luke, 2021; Xie & Rice, 2021). Arguably, once anatomy educators are more knowledgeable about UDL, they will have an increased understanding of how easily they can tailor their curricula to accommodate all students, without the major workload they may have originally thought was required. Lee and Griffin (2021) highlight that not all educators will be comfortable implementing UDL in their curriculum design and delivery right away. Rather, they will require time to become confident with potentially new teaching strategies. Incorporation of UDL into assessment is highlighted as a barrier by one respondent who stated that UDL "*fits with best practice on teaching and learning but offers challenges in relation to assessment.*" This could be addressed by the suggestions compiled by CAST to help educators implement UDL strategies in the design and delivery of their assessments. They propose that educators consider which actions are relevant to the information being assessed and which actions can be supported or varied in order to obtain an accurate account of what each individual has learned (CAST, 2021b). The authors propose including a variety of question styles within an end-of-year assessment paper such as multiple choice questions (MCQs), extended match questions, short answer questions, labelling of diagrams, true or false questions, and essays. For continuous assessment, educators could allow the students to decide how they want to demonstrate their knowledge, either through essay, PowerPoint presentation, or pre-recorded video, while adhering to the learning outcomes of the module. Providing all the students with the same options removes the perception of unfairness, as they all have the same opportunity to choose which format they prefer to be examined in.

Specific examples of how anatomy educators may incorporate UDL into the design and delivery of their anatomy curricula include: highlight the relevance of the information, the clinical significance, if there are any notable anatomical variations; vary the level of demands posed to students, include both straight forward, simple questions and higher order questions. Incorporation of these examples of UDL would thus serve to challenge the high performing students to sustain engagement, while also catering for the weaker student so that they do not become overwhelmed and discouraged. Other suggestions of how UDL could be incorporated into anatomy education include: provide immediate feedback via self-assessed practice examinations or using game-based learning platforms like Kahoot! During lectures or tutorials; display information in a variety of formats including text, images, video, animations and voice over narration; allow students to choose, when appropriate, how to complete an assignment using PowerPoint presentation, video presentation or written essay.

The COVID-19 pandemic provided a unique opportunity for educators in higher level institutions to implement UDL more extensively in anatomy curricula, as educators had to adjust and adapt their curriculum design and delivery rapidly. The multiple ways in which anatomy can be taught both successfully and inclusively were highlighted when educators were forced to teach anatomy remotely (Byrnes et al., 2021; Goldman et al., 2021; Patra et al., 2021). Longhurst et al. (2020) investigated the adaptations made specifically to anatomy education in the ROI and UK in response to the COVID-19 pandemic. It was reported that the most commonly expressed concern among anatomy educators from the participating higher level institutions ($n = 14$) was in relation to the time investment required to develop new resources to replace traditional lectures and practical classes. This concern overlaps with the concerns expressed by the anatomy educators participating in this study with regards to incorporating UDL into their curriculum design. Furthermore, 36% of the respondents in the Longhurst et al. (2020) study highlighted that there was a reduction in student engagement since the start of the pandemic. Engagement is one of the main three principles of the UDL framework (CAST, 2021a). In Australia and New Zealand, Pather et al. (2020) concluded that flexibility and adaptability were essential for the continuity of anatomy education programs during the COVID 19 pandemic, both of which are aims of UDL. Perhaps if educators were more aware of UDL and the ways in which it can be incorporated into curriculum design and delivery, it may have eased some of the burden and stress among educators, in relation to teaching, during the COVID-19 pandemic.

The study is not without limitations. There was a 23% response rate and therefore the results cannot claim to be representative of all anatomy educators in ROI and the UK. However, the demographic of the respondents was quite varied, thus removing an opportunity for bias. Furthermore, only educators whose email address was accessible through their institutions website were contacted to participate. Although this study was carried out during the COVID-19 pandemic, the questionnaire did not specifically mention the pandemic. Therefore, it cannot be stated for certain whether the teaching strategies utilized by the respondents were always being used, or whether they were new strategies utilized in response to a global pandemic.

In conclusion, this study highlights that anatomy educators from higher level institutions in the ROI and UK are implementing teaching strategies which align with the UDL framework. However, the majority of respondents were not aware that a specific name can be used to collectively identify the teaching methods used. There is still a lack of information on the benefits of the explicit utilization of UDL in anatomy curricula of healthcare programs in higher level institutions. Furthermore, the authors conclude that it would be beneficial to introduce the UDL framework to anatomy educators in the ROI and UK. The potential positive impact of the explicit utilization of UDL on healthcare students' learning, engagement, motivation, and experience in higher level education is evident. The optimal method of distributing this information to educators requires consideration and research.

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