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Research Report

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

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Running title: Universal Design for Learning in Anatomy Education

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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 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 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

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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 (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, 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

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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 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 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 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 Ahmad, 2017; Roces Montero et al.,

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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 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 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 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.

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)

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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, 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

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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, 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 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, 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 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, 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 and Brennan, 2019). Studies have shown

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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 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 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 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 towards successful learning and enhance academic performance, and is crucial for learning

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(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 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 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

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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

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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 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)(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.

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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 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). 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

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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”

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(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, radiological images, video recordings, simulations and quick response (QR) 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; Ben Awadh et al., 2020; Golenhofen et al., 2020; Lee et al., 2020; 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

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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 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: "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 and Drake, 2015; Park and 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

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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 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.

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 et al., 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

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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 and 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 and Caramelli, 2009; Schwartz, 2014). Therefore, allied health

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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 et al., 2014), and therefore struggle to motivate themselves to participate and understand (Latman and 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 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

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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 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

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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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FIGURE LEGENDS

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

Figure 2. A PRISMA-ScR flow diagram of the literature selection. Adapted from Tricco et al. (2018).

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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)

OT, Occupational Therapy; SLT, Speech and Language Therapy; UDL, Universal Design for Learning

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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]
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
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

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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	Singapore	Medicine	A, B	I

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		pathology				
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

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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

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[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.

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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)

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Table 4

Themes and Subthemes of strategies aligning with Universal Design for Learning

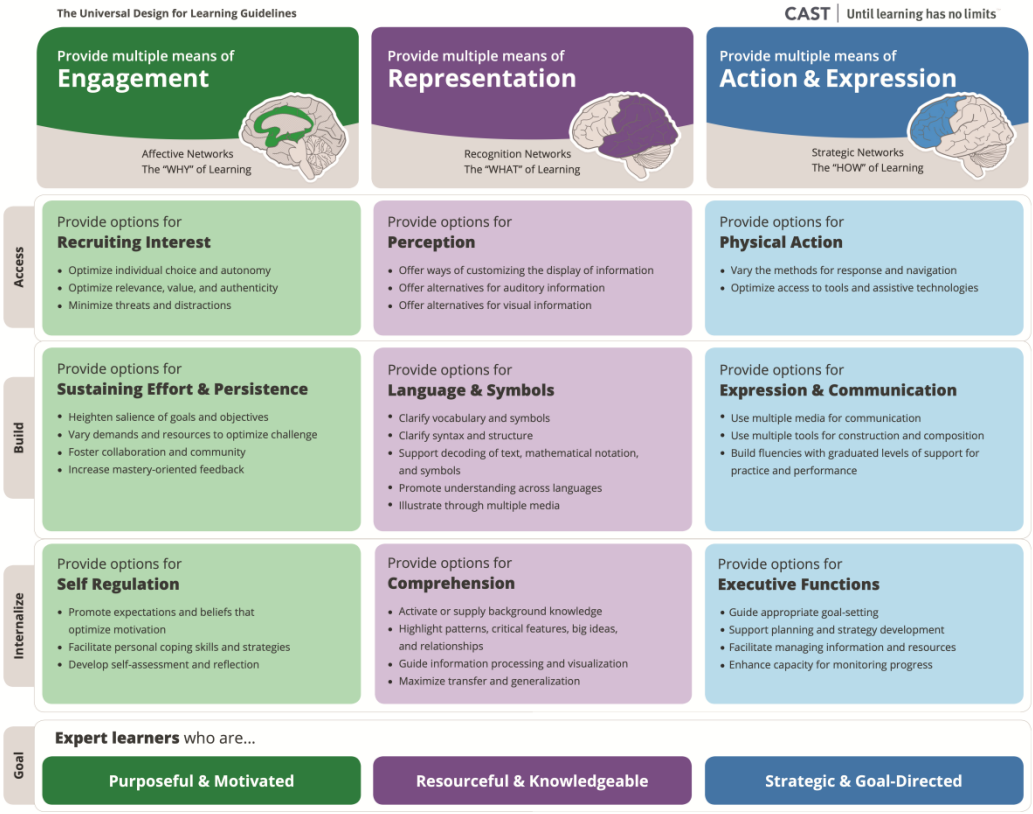
Theme	Subtheme	Studies in which themes appear[a]
Technology-Enhanced Teaching	E-learning	C, D, F, G, H, I, J, L, N, P, Q, R, U, V, X, Z, AA, AB
	Simulations	D, G, H, J, L, Q, R, U
	Mobile applications	F, G, H, I, N, R, V
	Recordings	C, K, L, N, AA, AC, AG
	Quick Response (QR) codes	V
Contextualization	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., 2020); 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, (Guimaraes 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 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., 2018); AA, (Ocak and Topal, 2015); AB, (Park and Howell, 2015); AC, (Pillay et al., 2019); AD, (Pratten et al., 2014); AE, (Rao Bhagavathula et al., 2021); AF, (Rezende et al., 2020); AG, (Yohannan et al., 2022).

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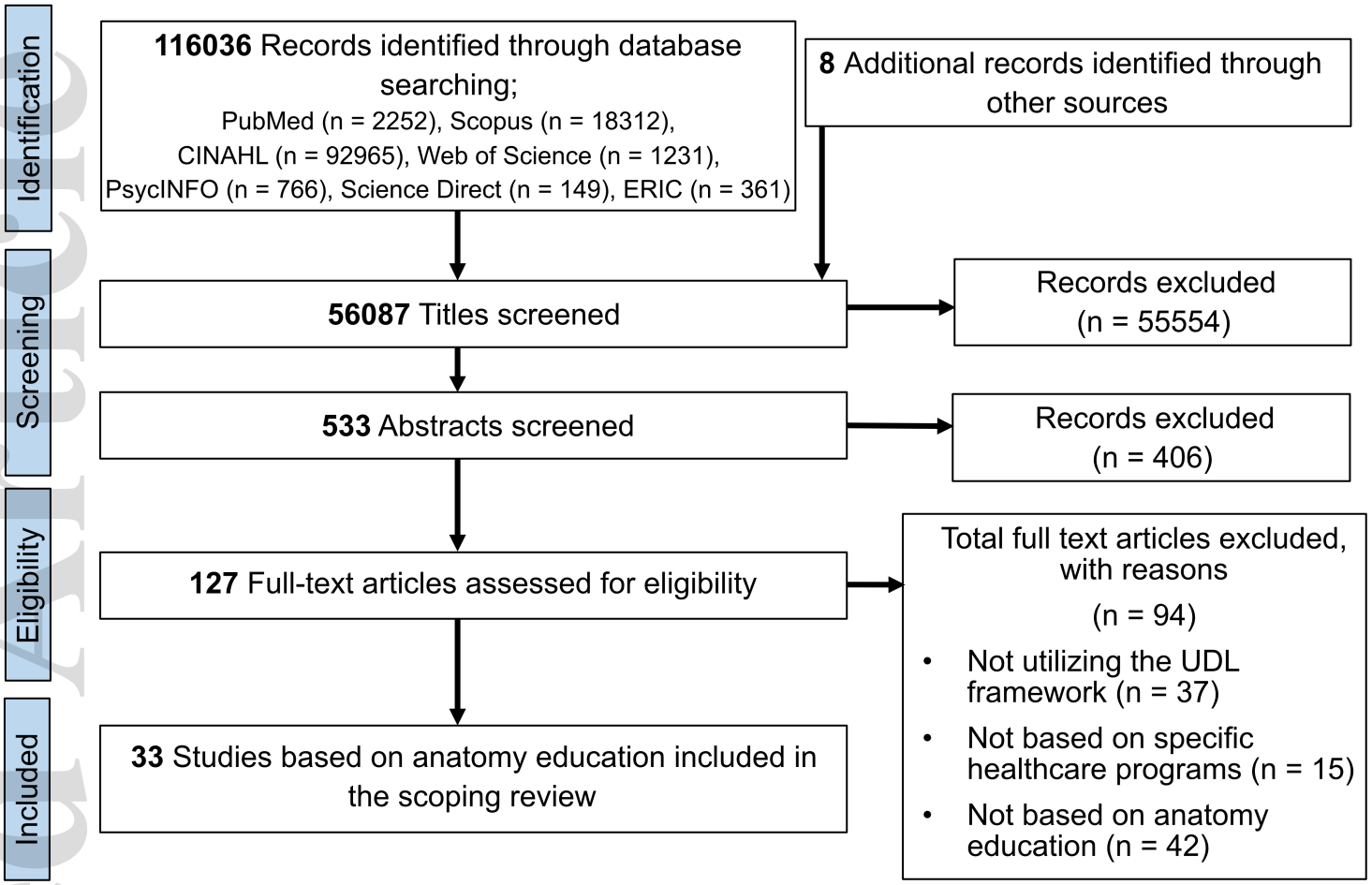
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