

**PERCEPTIONS OF ACADEMICS AND POSTGRADUATE STUDENTS TOWARDS THE
USE OF PLASTINATED SPECIMENS AND THEIR PUBLIC EXHIBITION**

By

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Submitted in fulfilment for the degree of

MASTER OF MEDICAL SCIENCE

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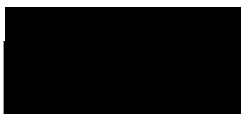
Discipline of Clinical Anatomy
School of Laboratory Medicine and Medical Sciences
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PREFACE

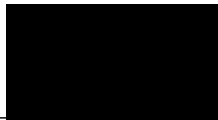
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The research described in this dissertation was carried out at the Discipline of Clinical Anatomy, School of Laboratory Medicine and Medical Sciences, College of Health Sciences, University of KwaZulu-Natal, Westville, Durban, South Africa under the supervision of Dr. Pamela Pillay and co-supervision of Dr. Brenda De Gama.



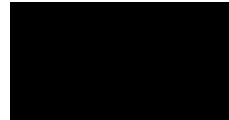
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DECLARATION

I, **Denvon Nathal Bailey**, declare that:

- i. The research reported in this dissertation, except where otherwise indicated is my original work.
- ii. This dissertation has not been submitted for any degree or examination at any other university.
- iii. This dissertation does not contain other person's data, pictures, graphs or other information, unless specifically acknowledged as being sourced from other persons.
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Date: 10 March 2021

DEDICATIONS

To my mother, Geraldine Bailey for her unconditional love, patience, encouragement and support, thank you for making me a man. Your tireless determination in the face of life's obstacles exemplifies the strength and endurance of the human body, spirit, and mind.

To my partner, Sinovuyo September, thank you for the motivation and for being understanding during this time.

To my entire family, friends and colleagues for their positive attitude, support and prayers throughout this journey.

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LIST OF ABBREVIATIONS

University of KwaZulu-Natal	UKZN
South Africa	SA
International Society for Plastination	ISP
International Federation of Association of Anatomists	IFAA
Federative International Committee of Ethics in Medical Humanities	FICEM
Three Dimensional	3D

ABSTRACT

Background – The global scarcity of cadavers and prosected specimens for teaching, learning and research has led to plastinated specimens (plastinates) becoming a valuable tool in bridging this gap. Over the last decade, plastinates have been incorporated into the teaching and learning of gross anatomy within anatomy departments as a supplementary tool to cadaveric dissection. A paucity of information exists regarding the views of academics and postgraduate students on the use of plastinates for anatomy teaching and learning. This study aimed to investigate the perceptions of academics and postgraduate students on the use of plastinates in anatomy education and public exhibitions.

Methods – Qualitative and quantitative methods of data extraction were employed using a questionnaire on a purposively sampled group of anatomy academics and postgraduate students at the Discipline of Clinical Anatomy, School of Laboratory Medicine and Medical Sciences, University of KwaZulu-Natal (UKZN) for data collection. Quantitative data from the questionnaire were analysed using descriptive statistics and the Mann-Whitney test ($p < 0.05$ considered statistically significant) to determine significant differences between sub-groups. To assess the perception on the use of plastinates for education and exhibitions, the quantitative responses of participants were grouped and then categorized into three categories i.e. good (10-7), average (6-4), and bad (0-3). Qualitative data from the questionnaire responses were analysed by the content analysis method to reflect emanating themes.

Results- Questionnaires were completed by 43 of 62 participants (response rate 69%) i.e. seven academics and 36 postgraduate students completed the questionnaire. Academics (57.1%) and postgraduate students (63.9%) had a good perception on plastinate use for education. Most academics (85.7%) and postgraduate students (94.4%) made use of plastinates for anatomy education. Various features of plastinates were highlighted, such as their ease of use, durability and ability to view structures clearly in three-dimensions (3D), which aids in understanding for students. However, ethical concerns were highlighted by academics (57.2%) and postgraduate students (55.6%) on the use of plastinates in public exhibitions.

Conclusion: Positive reactions of academics and postgraduate students were generally noted, plastinates were found to support anatomy teaching and learning. This reflects that plastinates may become vital for anatomy instruction in South Africa and their more inclusive use is recommended.

CHAPTER 1

Overview of Dissertation

This dissertation is written according to the College of Health Sciences Dissertation guidelines. It is organized as follows (i) Chapter 1 comprises the introduction, comprehensive literature review, aim and objectives; and overview of methodology; (ii) Chapter 2 is the manuscript that was prepared for submission to a journal; (iii) Chapter 3 is the synthesis of the entire dissertation.

1.1 BACKGROUND

Human anatomy is the scientific study of the structure of the human body (Pearce, 2009). It may be subdivided into gross anatomy which is the study of structures visible to the naked eyes and microanatomy that is the study of microscopic structures (Azu *et al.*, 2013). The dissection of cadavers is the traditional method of choice used in gross anatomical teaching in medicine and allied health sciences (Bianucci *et al.*, 2015; Bhandari *et al.*, 2016; Champney *et al.*, 2019). This is supplemented with the use of prosected specimens which are prepared human cadaveric specimens (Slotnick and Hilton, 2006). The preservation of these specimens for teaching purposes uses a technique, called embalming (Bajracharya and Magar, 2006; Saleh *et al.*, 2010). Embalming, introduced in the 18th century by Jan Swammerdam (1672), makes use of the chemical formalin (a formaldehyde solution) which is effective in slowing the decomposition process (Saeed *et al.*, 2001; Chu *et al.*, 2005). Currently, fixative solutions are toxic and some of them are carcinogenic, this includes formalin, which remains the “gold standard” for the preservation of biological tissues (de Paula *et al.*, 2018). Exposure to evaporation from these embalmed specimens has adverse health effects such as cytogenetic and immunological symptoms (Genium *et al.*, 1989; Janowsky *et al.*, 2000; Costa, 2013).

The health risks posed by the formalin fixed method of tissue preservation led to the development of the plastination technique, which was first introduced by the German anatomist Gunther von Hagens in 1977. He experimented with a variety of plastics to seek a method that would improve the quality of renal specimens in the laboratory (Pashaei, 2010). The technique of plastination has since gained worldwide acceptance as a method for preservation of biological specimens, full cadavers or prosected materials (Jones *et al.*, 2002; Barilan, 2006; Azu *et al.*, 2013). The preservation of anatomical plastinated specimens (known as plastinates) uses a technique wherein water and lipids in biological tissues are replaced by curable polymers that harden resulting in, odourless, dry and durable specimens (Pashaei, 2010; Riederer, 2014) known as plastination. Plastination provides an ideal tool for long-term preservation of carefully dissected specimens with numerous advantages and disadvantages, such as the ease with which plastinated specimens can be handled and stored compared to formalin-based preservation (Barilan, 2006; Riederer, 2014; Haque *et al.*, 2017). These specimens are of high quality

and have led to a significant expansion in the range of human anatomical specimens available for teaching, learning and research (Bianucci *et al.*, 2015).

The use of plastinates in medical education has also become an ideal teaching tool in anatomy, pathology, obstetrics, radiology and surgery (Fruhstorfer *et al.*, 2011). Currently, plastination has established itself as an indispensable tool for teaching resources, especially in the areas of neuroanatomy (Jones, 2002; Reidenberg and Laitman, 2002; Burns, 2007; Latorre *et al.*, 2007). While this is considered as an important contribution to education and research for the medical world (Jones and Whitaker, 2009), some uncertainty remains in relation to the value of plastinates for the comprehensive study of human anatomy (Fruhstorfer *et al.*, 2011).

Additionally, the public display of plastinates has become increasingly popular attracting controversy (Burns, 2007; Satyapal, 2012; Keating, 2014). Over the years, a total of over 200 plastinated bodies or body parts have been displayed in a spectacular and astonishing manner by traveling exhibitions in countries worldwide. The exhibitions of plastinated specimens are in stark contrast to the norms to which anatomists are accustomed and may be contrary to the ways that the donor would have expected their body to be used in teaching, and on occasion in research (Jones, 2014). However, it appears that many anatomists have not yet realized the revolutionary significance of plastination for anatomical research (Pashaei, 2010; Dhanwate and Gaikwad, 2015).

The focal point of the ethical debates arose from whether or not body donors were fully informed regarding the public display of their plastinated bodies and if they bequeathed their bodies for such a purpose (Bin *et al.*, 2016). It may also give the impression that the way bodies are displayed trivializes cadaveric dissection as a meagre spectacle, at the expense of medical education (Boyde, 2002; Bin *et al.*, 2016). Furthermore, anatomists view the display of dissected bodies and body parts to be appropriately restricted by law to designated educational areas and to those taking designated educational programmes. In contrast, some anatomists approved of the exhibitions for the general audience, recognizing the urge to satisfy the fundamental human curiosity to know what lies beneath our skin (Morris-Kay, 2002; Jones and Whitaker, 2009).

Knowledge of educational methodologies, resources and advances in technology becomes imperative for teachers of anatomy (Brenner *et al.*, 2003). With the decrease in the number of cadavers available for dissection, alternative methods of teaching and learning anatomy are utilised. The integration of different modalities and methodologies of training have been perceived to be advantageous for academics and students alike (Reidenberg and Laitman, 2002; McLachlan *et al.*, 2004; McLachlan and Patten, 2006). Plastination as a technique and its various methods and types have been widely documented in the literature (Jones, 2002; Ravi and Bhatt, 2011; Ameko *et al.*, 2013; Riederer, 2014; Sanjay *et al.*, 2017; Dibal *et al.*, 2018). The active research and growing interest in the study of fixative

compounds will aid to develop innovative non-hazardous agents to replace current toxic fixatives (especially formaldehyde) (Moelans *et al.*, 2011; de Paula *et al.*, 2018).

However, the use and the perceptions on the use of plastinates for anatomy education, based on the views of anatomy educators and postgraduate students, has been documented to a lesser extent. Thus, the aim of this study was to investigate the perceptions of academics and postgraduate students towards the use of plastinates for anatomy teaching and learning as well as to document their views on their use for public exhibitions.

1.2 REVIEW OF LITERATURE

1.2.1 Plastination: The process and techniques

“Plastination is derived from the Greek word plassein = to shape, to form” (Dundanakar et al., 2014)

For many years, the most widely used technique for preservation of human specimens for anatomy teaching has been formalin embalmed cadaveric specimens. The process of human cadaveric preservation uses diverse embalming liquid formulas to prepare open and wet solutions (Slater, 1981) and their evaporation from embalmed specimens exposes students, academics and technical staff to carcinogenic toxic vapors (Bajracharya and Magar 2006; Khouri, 2012). Formaldehyde containing fluids evaporate and exposure occurs by inhalation, or through the skin resulting in associated disorders which include leukemia, nasopharyngeal cancers (Hauptmann *et al.*, 2004), airway irritation and obstructive disorders, such as bronchial asthma (Binawara *et al.*, 2010), ocular irritations, corneal clouding, menstrual irregularities, spontaneous abortions and congenital malformations (Khaliq and Tripathi, 2009; Raja, 2012). Plastination differs in that it considerably reduces the risk of exposure to these highly volatile chemicals emitted from wet specimens (Latorre *et al.*, 2007; Azu *et al.*, 2013).

Plastination has proved to be an alternative tissue preservation technique which, unlike embalming, eliminates carcinogenic solutions used to preserve cadavers, organs and tissues (Turney, 2007). The plastination process involves dissected specimens that are frozen with water and fat which are then replaced by acetone (Barilan, 2006). The acetone (usually changed up to three times) replaces 80% of body fluids and the tissue is impregnated with reactive plastics, such as silicone rubber, polyester resin or epoxy resin in a special vacuum process (von Hagens and Whalley, 2000; Jones, 2002). Plastination then converts lifeless tissue into dry, authentic, odourless, colourful and resilient plastic specimens (Barilan, 2006). However, long-term exposure to acetone and other chemicals used in the initial process has been reported to cause allergic reactions and dermatitis (Genium *et al.*, 1989; Janowsky *et al.*, 2000). It may also lead to loss of brain weight, vomiting and unconsciousness (Dick *et al.*, 1989; Arts *et al.*, 2002).

Exposure to these risks can be reduced with the use of appropriate protective equipment such as gloves, masks and aprons etc. or by the prior fixation of the specimen in formalin prior to further processing as the formalin effectively neutralizes most of the pathogenic organisms (Riederer, 2014; Hayat *et al.*, 2018). Plastination offers odourless, non-hazardous, durable, maintenance-free tissue specimens, which are a fusion of science and art aimed at anatomy education. It is used as an alternate technique in providing specimens to teach anatomy since the preservation technique provides students with specimens that are dry, non-toxic and durable, without any color change in an odourless state (Ravi and Bhat, 2011; Bhandari *et al.*, 2016).

Plastination as a technique has variety in the methods and materials used. Numerous different resins and materials are used in the plastination technique for example, both Biodur S 10 and Biodur PEM 27 are used for plastination of body sections. The usage of S10 (silicone rubber) is sometimes limited to specimens of brain tissue, isolated or in situ and also specimens to be used by students for self-instruction (Pashaei, 2010; Dhanwate and Gaikwad, 2015). Biodur PEM 27 is the choice for all specimens requiring good visual appearance with clear surface detail (Pashaei, 2010). The use of silicone (S10) and polypropylene resins to impregnate tissues results in plastinates that show structures clearly, which is ideal for whole organ plastination (Pashaei, 2010; Dhanwate and Gaikwad, 2015) and use for teaching purposes (Dibal *et al.*, 2018).

Transparent body or organ slices are impregnated with epoxy resins (E12) and used for research purposes to study the structure of all body parts in 3D (Dibal *et al.*, 2018). In diagnostic imaging techniques, such as Computer Tomography (CT) or Magnetic Resonance Imaging (MRI), E12 plastinated sections have been used as a basis for the correct identification of anatomical structures in the same planes used in imaging techniques (Dhanwate and Gaikwad, 2015; Latorre *et al.*, 2019). Pashaei (2010) reported that two polymers have been widely used such as P35 and P40. The P35 polymer was introduced first and yielded firm semitransparent brain slices produced with polyester resins and used to differentiate fibres and nuclear areas (Pearce, 2009; Dibal *et al.*, 2018) of unparalleled beauty, clarity and definition of white and gray matter (Pashaei, 2010). The P40 polymer was introduced 10 years later and is used in a shorter and less cumbersome technique. However, the P40 polymer has a specific problem when used on brain tissue, orange spots may appear in the gray matter, however, when uniformly distributed throughout the gray matter, it may resemble the coloration of P35 slices (Henry, 1997, Pashaei, 2010).

Latorre *et al.* (2019) recently reported that the epoxy plastination techniques were developed to obtain thin transparent body slices with high anatomical detail. The transparency and the topography of the anatomical structures were well preserved (Sora and Matusz, 2012; Latorre *et al.*, 2019). Thus, thin epoxy slices are currently used for research purposes in both macroscopic and microscopic studies.

Furthermore, the sheet (slices) plastination technique is unique because it offers the possibility to produce a series of transparent slices (Figure 1.1).

Figure 1:1 Sheet (slice) plastinates are thin tissue slices illustrate anatomical structures clearly, in colour, either transparent or translucent (adopted from Hayat *et al.*, 2018)



Additionally, sheet plastinates retain structural details down to histological level, which increases their value not only for the teaching of anatomy, but also in some cases for basic investigation (Latorre *et al.*, 2007). Furthermore, this type of plastination allows for easier study of topographical detail in anatomy (Sora and Matusz, 2012). Hence, plastinates are further used to preserve fragile tissue samples e.g. intra-cerebral haematoma that can be preserved perfectly and made available to students for future study use (Prasad *et al.*, 2015).

1.2.2 Use of plastinates in teaching and learning

Plastination is a widely used technique in several countries around the world viz. New Zealand, India, United States, United Kingdom, Italy, Switzerland and Malaysia due its advantages. Literature reveals that plastinates make it easier to view smaller anatomical structures that might not be seen in other models (Jones, 2002, Fruhstorfer *et al.*, 2011). Furthermore, plastinates are stored and handled more easily than formalin-based preserved specimens (Barilan, 2006; Haque *et al.*, 2017).

Plastinates can be placed alongside plastic or wax models, cadavers, prosections, textbooks, computer models and living human subjects for teaching human anatomy (Burns, 2007). The natural looking

specimens are extensively used as an instrument for education in anatomy, radiology, pathology, and surgery in the medical and veterinary disciplines (Riederer, 2014; Bianucci *et al.*, 2015; Latorre *et al.*, 2016). The preservation of anatomical specimens through plastination in a physical state similar to that of the living condition also allows for electron and light microscopic studies (Jones and Whitaker, 2009; Sanjay *et al.*, 2017). The transparent quality of plastinates reveals high anatomical detail and the topography of the anatomical structures is well preserved, further showing microscopic structures (Riederer, 2014). Furthermore, thin plastinated slices can further be processed and used to generate tissue sections for three-dimensional (3D) computerized images of structures (Sora *et al.*, 2007). Plastinated organs or body slices can further be interrelated with CT and MRI scans for reference and radiological education (Jones and Whitaker, 2009).

Plastinates are also ideal for teaching anatomy, pathology, obstetrics, radiology, and surgery (Fruhstorfer *et al.*, 2011; Hayat *et al.*, 2018). It allows students to have hands-on experience in this field without smell and exposure to the carcinogenic chemicals. A significant advantage is that minute details in human anatomical structures are illustrated through plastinates which might be indiscernible in other models (Jones, 2002). Furthermore, researchers found that plastinates are relatively cheaper than conventional formalin-based preservation in the long-term (Valliyate *et al.*, 2012).

The depth and spatial orientation of structures of intricate anatomical regions e.g. brain/nervous system are seen clearly in 3D which aids understanding of anatomical relationships between structures in anatomical science (Riederer, 2014; Klaus *et al.*, 2018). A study from Nigeria documented that 75% of medical students viewed plastination as a benefit to anatomy learning (Azu *et al.*, 2013). Furthermore, 45% of anatomy educators in the same study agreed that plastinates could replace cadavers while 5% disagreed, and 50% agreed with the provision that plastinates should be used alongside other resources for teaching (Azu *et al.*, 2013). According to 76.7% of the medical students in a Canadian study, the use of plastinates as a supplemental learning resource compared to textbooks and images alone was preferred (McRae *et al.*, 2015). Furthermore, all respondents in the study reflected a desire to have plastinated placentas available for learning opportunities in future (McRae *et al.*, 2015).

A study in **the United Kingdom** at Cambridge University sought to investigate the benefits of using plastinates in combination with wet dissection in teaching gross anatomy, where they have found the student level of satisfaction with the combined use of cadaveric dissections and plastinates was high (Latorre *et al.*, 2016). Although the level of satisfaction of second-year students (98.4%) and first-year students (95.5%) was relatively similar, a significant difference of $p < 0.05$ was found (Latorre *et al.*, 2016). Furthermore, medical students in the same study felt that plastinates allowed them to see details that were often more difficult to identify in their dissections (Latorre *et al.*, 2016).

In a study from the Hind Institute of Medical Sciences, India, 95.4% - 99.0% of the students rated plastinates as useful for the understanding of anatomical relations, they indicated that plastinates were easy to hold and found them to be useful for understanding complicated structures (Bhandari *et al.*, 2016). However, this contrasted with a study conducted at the University of Kuala Lumpur Royal College of Medicine Perak, Malaysia, whereby it was reported that 59.4% of medical students did not view plastinates as easier to hold compared to wet specimens (Haque *et al.*, 2017). Although most of the medical students in the above-mentioned study found plastinates as not easy to handle, the majority (65.0%) of the students preferred the dissection experience, together with plastinates more than the dissection experience alone (Haque *et al.*, 2017).

Researchers at the Hind Institute of Medical Sciences, India found that the majority of medical students in their study indicated preference for use of plastinates instead of traditional anatomical models for anatomy study. The most common rationale for preference towards plastinates over plastic models, was that plastinates represented actual anatomical structures (Sanjay *et al.*, 2017). In addition, students in the same study stated that plastinates could demonstrate related anatomical structures in 3D, which provided a clearer view and easier identification of the structures (Sanjay *et al.*, 2017). However, the study conducted in Malaysia found that many of the medical students (77.6%) indicated that plastinates did not improve their knowledge of anatomy in a clinical context, or palpation skills (Haque *et al.*, 2017). This was in contrast to an earlier study from the University of Hawaii, Hawaii, where plastinates were developed to demonstrate common sports injuries for injury evaluation courses and underlying concepts for clinically diagnosing sports-related injuries (Tamura *et al.*, 2014). The study found that the majority of participants agreed (70, 94.6%) that the plastinates were helpful in improving palpation skills. Subsequently, the palpability of the real structures was one of the reasons for supporting plastinates, because the plastinates offered clear visibility of the structures that enabled students to practice accurate palpation of the bones, tendons, ligaments, and muscles (Tamura *et al.*, 2014).

In a study conducted at the University of Cape Town, South Africa, approximately half of the medical students had heard of plastination (51%) and the large majority (80%) supported the use of plastinates in anatomy practicals (van der Berg, 2017). However, more than half (51%) of medical students at UCT were against the exclusive use of plastinates for exam revision, they preferred the inclusion of wet specimens (van der Berg, 2017). It was further reported that academics and medical students encouraged the continued use of plastinates in conjunction with wet specimens in anatomy teaching and learning (van der Berg, 2017).

Additionally, it was noted at an International Plastination Conference held at University of Kwazulu-Natal in the KwaZulu-Natal province, South Africa, that plastinates may be at the student's disposal, thus promoting self-learning methods in anatomy for students (Sisobo, L, UKZN Newsletter, 2017).

The conference further confirmed that there has been a critical shortage of cadavers for teaching, learning and research, therefore plastinates produced from the plastination technique have become an essential tool to increase the resources available for demonstration and teaching in anatomical sciences education (Sisobo, L, UKZN Newsletter, 2017). Many investigations have centred around whether incorporation of plastinates into the curriculum shows improvement in teaching and research. Previous researchers have conducted various studies to evaluate whether the use of plastinates improved the quality of teaching and learning of anatomy. The studies were conducted over a wide range of fields and departments of human anatomy, medicine, veterinary anatomy, veterinary surgery, gynecology, pathology, and research (Latorre *et al.*, 2007, 2016; Fruhstorfer *et al.*, 2011; Bhandari *et al.*, 2016; Hayat *et al.*, 2018). The literature reflects that educators and students have both positive and mixed views on the use of plastinates in anatomy teaching and learning (James *et al.*, 2019; Sora *et al.*, 2019).

Similar to any other process, plastination has its limitations in not only its various techniques but also in its use. Long-term exposure to hydroxy-terminated poly(dimethylsiloxane) and ethyl silicate used for silicone impregnation has been reported to cause allergic reactions and dermatitis, respectively (Janowsky *et al.*, 2000). Furthermore, the rigid quality of plastinates makes them difficult to handle in practical anatomy teaching courses (Riederer, 2014) as underlying structures cannot be viewed. There were several limitations (Table 1) associated with the use of plastinates *viz.* the chemicals used in the plastination process pose health hazards if not properly handled and the development of a plastination laboratory needs a large amount of initial investment (Bin *et al.*, 2016; Hayat *et al.*, 2018).

Table 1: The limitations of plastination techniques and plastinate use in anatomy education

Authors (Year)	Country	Limitations
Dick <i>et al.</i> (1989) Genium <i>et al.</i> (1989) Janowsky <i>et al.</i> (2000) Smith and Holladay, (2001) Klaus <i>et al.</i> (2018)	USA	Acetone causes respiratory and dermal irritation in low concentration. High acetone concentration (> 12000 ppm) can cause severe symptoms such as vomiting and unconsciousness. Long-term exposure to hydroxy-terminated poly(dimethylsiloxane) and ethyl silicate used for silicone impregnation has been reported to cause allergic reactions and dermatitis, respectively. Exposure to viable pathogens is greater during the early processing of samples and poses a risk to operators. Poor durability and quality, unpleasant odorous, cannot be used for exploring relationships in various planes, poor representations of human tissues (due to the presence of silicone) compared to wet specimens.
Brown <i>et al.</i> (1990)	USA	Risk factors from pathogens and chemicals can be reduced by use of protective equipment e.g. gloves, masks and aprons etc. or by fixation of specimens in formalin.
Yokota <i>et al.</i> (1997)	Japan	Dibutyltin dilaurate used for sheet plastination causes allergic reaction and asthma if fumes are inhaled by operators.

Arts <i>et al.</i> (2002)	Netherlands	Long-term exposure to acetone in mice at concentrations > 19000 ppm has been shown to produce a reversible decrease in absolute brain weight of cadavers.
Ravi and Bhatt, (2011)	India	The plastination process is a time-consuming and sensitive technique which requires skilled professionals.
Costa <i>et al.</i> (2012)	Brazil	Long-term exposure to acetone, like most organic solvents, causes visual impairment and loss of visual contrast sensitivity.
Ameko <i>et al.</i> (2013)	Ghana	Plastinated specimens are relatively stubborn, therefore it becomes difficult to reflect the specimen and demonstrate the deeper anatomical features. This inflexibility poses a major obstacle for scientists using plastinates for clinical practices e.g. ultrasonography and endoscopy.
Riederer, (2014)	Switzerland	Plastinated brain tissue, an indispensable tool for neuroanatomy teaching, becomes extra rigid, fragile and breaks relatively easily when handled crudely.
Bin <i>et al.</i> (2016) Hayat <i>et al.</i> (2018)	Italy	A plastination laboratory requires a large investment, which creates a major challenge during the initial development of the laboratory.

Furthermore, the plastination process is a time-consuming and precise technique that requires qualified operators (Ravi and Bhat, 2011). The type of synthetic material used in the impregnation process of the cadaver dictates whether the plastinate is either flexible or firm, transparent or opaque (Bianucci *et al.*, 2015). The same polymers which make the plastinated specimens durable, also may make them brittle and they may break when handled crudely (Ameko *et al.*, 2013). The process also needs special and expensive equipment, handling and mounting of heavy plastinates which are important factors that are sometimes associated with limitations (Pashaei, 2010; Bin *et al.*, 2016; Hayat *et al.*, 2018). However, the use of a modified protocol of the plastination technique to produce thousands of plastinates at lower cost compared to use of standard materials and equipment demonstrates that plastination can be made possible for developing countries (Zheng *et al.*, 2000).

1.2.2 Perceptions on the use of plastinates in teaching and learning

Cadaveric dissection and prosected cadaveric specimens are the most appropriate resources for anatomy education and exposure to dissection develops important cognitive skills (Slotnick and Hilton, 2006). These tools provide students with an important 3D view of the human body, a sense and feel of how different anatomical features relate to each other and an appreciation of depth, fragility, manual dexterity and anatomical variation within the human body (Willan and Humpherson, 1999; Aziz *et al.*, 2002; McLachlan *et al.*, 2004; Older, 2004; Tamura *et al.*, 2014).

Limited or no access to cadavers due to shortages has resulted in a change in teaching and learning at institutions in North America and Europe that have dramatically reduced time in the dissection hall or replaced dissection with prosections, plastic models, multimedia learning packages and plastinated specimens to aid anatomy teaching and learning (Reidenberg and Laitman, 2002; McLachlan *et al.*, 2004; McLachlan and Patten, 2006). Several academics have accepted plastinates as superior to synthetic models, on account of their ability to reflect anatomical variations (Latorre *et al.*, 2007). Literature indicates that academics, postgraduate students and undergraduate students generally have a positive to average opinion on the use of plastinated specimens for anatomy education, in conjunction with cadaveric dissection (Azu *et al.*, 2013; Latorre *et al.*, 2007; 2016; Klaus *et al.*, 2018). The exclusive use of plastinates has shown positive results, higher scores and student satisfaction, while instruction time has been reduced (Baker *et al.*, 2013; Lopez *et al.*, 2018).

A recent review of published journal articles found that approximately 4 000 publications involving plastination in research exist. The data showed that plastination has enormous potential in all fields of academia including training, teaching, research and public culture (Sora *et al.*, 2019). In a recent study in the United Kingdom, medical students perceived plastinated cross-sections to be an important asset to describe and study complex anatomical interactions, such as the foot and ankle joint (James *et al.*, 2019).

Despite many studies reporting the benefits of plastinates, only 8% and 39% of anatomy instructors or academics have reported utilizing plastinates for teaching anatomy in Nigeria and United States, respectively (Azu *et al.*, 2013; Klaus *et al.*, 2018). Lack of funding to develop a plastination facility and qualified personnel were reasons cited for non-use of plastinated specimens (Azu *et al.*, 2013). The strong preference for cadaveric dissection by anatomy educators was due to several years of experience with dissection, therefore it was considered the best method to teach anatomy (Klaus *et al.*, 2018), which might point to a preference for traditional methods of instruction such as dissection, prosected specimens and plastic models. However, after the introduction of technological advancements many educators indicated that insufficient evidence exists in the literature to indicate dissection as being the most effective method of teaching gross anatomy (Pawlina and Lachman, 2004; Sugand *et al.*, 2010).

1.2.3 Perceptions on the use of plastinates in public display

The major advances in different plastination techniques have led to a significant expansion in the range of human anatomic specimens available for teaching, learning and research (Bianucci *et al.*, 2015). However, the use of these plastinated human remains in public display exhibitions has become increasingly popular and has attracted enormous controversy as well (Burns, 2007; Satyapal, 2012;

Keating, 2014; Jones, 2016a). Although several studies indicated positive perceptions on the use of plastinates in teaching and learning anatomy, many indicated ethical and moral concerns regarding their use in public exhibitions (Latorre *et al.*, 2007; Satyapal, 2012; McRae *et al.*, 2015).

The International Federation of Associations of Anatomists (IFAA) condemns the improper exploitation of human remains, prohibits disgraceful and undignified treatment of human remains, and regards charging an admission fee at exhibitions for financial benefit to shareholders, as unethical (Bleich, 2007). Conversely, von Hagens contends that plastination transforms a “useless corpse” into a useful and instructive specimen that can be utilized to inform the public about their body’s structure, thus enabling them to engage in better health practices (Bianucci *et al.*, 2015).

However, Bin *et al.* (2016) stated that the immortality secured through plastination of the corpse comes at the cost of their identity. One plastinate, in particular “The Smoker” stands upright with a blackened lung and cigarette in hand, supposedly enlightening the public on the evils of smoking (Hibbs, 2007). However, according to Jones (2016b), the nature of these exhibitions turns the display of human remains into a source of financial gain, thus obscuring the balance between being educational and entertainment. Furthermore, Bleich (2007), stated that “aesthetic indulgence solely from visual observation purely for recreational or entertainment intentions is nothing more than a macabre practice lacking religious or cultural complexity associated with dealing with human remains”. The plastination technique has also allowed whole bodies to be displayed in various positions as if standing or seated, engaging in sports and numerous other realistic activities, including sexual intercourse with ‘life-like’ facial expressions (Bleich, 2007; Jones, 2016b).

The dichotomy between anatomy and art is different for different specimens. The muscles of ‘The Runner’ are partially detached and fly out behind him, giving the appearance of movement at speed; “he communicates human exuberance, not anatomical accuracy” (Morriss-Kay, 2002). The cadaver is malformed, manipulated, tissues dyed to the colour of living flesh and fabricated into animated poses resulting in a synthetic depiction of perfected nature (King *et al.*, 2014). One plastinate has been arranged in a way that shows a flayed corpse clasping his own skin in hand, to suggest that he is offering it to the viewer (Barilan, 2006) as seen in Figure 2.

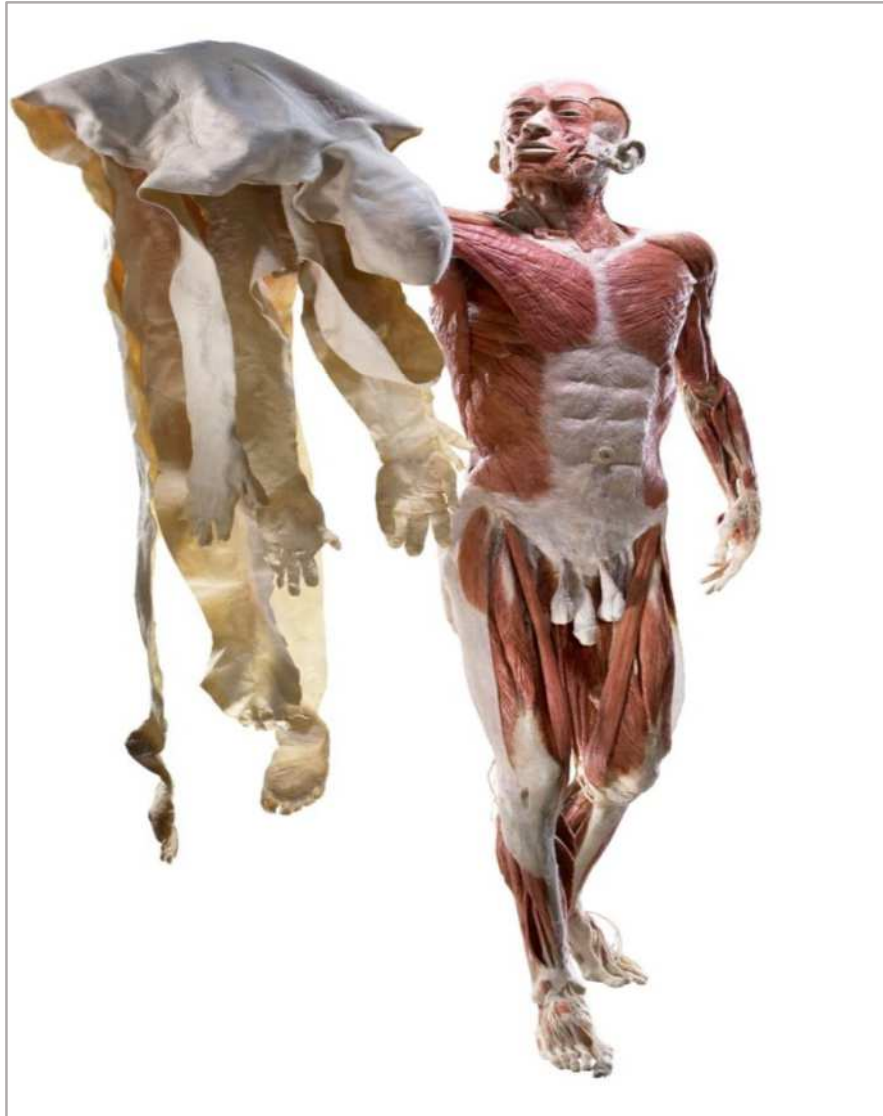


Figure 1.2: The "Skin Man." BODY WORLDS, Institute for Plastination, Heidelberg, Germany, www.bodyworlds.com. (Adopted from Keating, 2014)

Bianucci *et al.* (2015) stated that the exposure to plastinates might be of some use to the general public as a reminder to be health conscious. However, the knowledge of the human body gained by adults and particularly children is negligible, which might interfere with their understanding of death (Bianucci *et al.*, 2015). Raikos *et al.* (2012) reported a lack of empirical evidence on children's views (under the age of 10 years) on the *Bodyworlds* exhibitions. However, empirical data are available for young people aged 18–35-years, which demonstrates their comprehension of the concepts of death and its consequences and the violation of human dignity (Bianucci *et al.*, 2015).

Furthermore, Bianucci *et al.* (2015), stated that juveniles have a limited understanding of death, and the inadequate knowledge of death is often built upon vague reasoning. Researchers also found that most

children under the age of 10 years did not fully comprehend that death is a permanent, universal, and non-fictitious state (Bianucci *et al.*, 2015). Caution has been expressed regarding the illusion of movement of posed bodies, designed to be interpreted as ‘arrested motion, or potential motion’ misinterpreted as literal by younger viewers (Desmond, 2008). Keating (2014) stated that the success of *Bodyworlds* encouraged copycat exhibitions, including “Our Body: The Universe Within,” “Mysteries of the Human Body,” “BODIES...The Exhibition,” “Bodies Revealed” and “Body Exploration,” which individually have been met with their own successes and controversies. Similar concern by researchers has been expressed with respect to these extraordinary exhibitions that have become increasingly successful and profitable through the public display of plastinates (Jones, 2016a, b; Champney, 2016). The *Bodyworlds* and other exhibitions have over the past decade attracted millions of viewers in 65 cities all over the globe and have grossed millions of dollars worldwide profiting enormously from the public display of plastinated skinless human corpses (Bleich, 2007; Satyapal, 2012; Keating, 2014). von Hagens asserts that a large portion of the money made from these controversial exhibitions supports further work of his International Federation of Plastination (Moore and Brown, 2007). In contrast, the Federative International Committee of Ethics in Medical Humanities (FICEM) of IFAA expressed concerns that the principal purpose of these exhibitions may be sensationalism and voyeurism with the human body considered as an object of commercial benefit or morbid curiosity, compromising the dignity of the deceased (FICEM, 2012).

Satyapal (2012), emphatically stated that if *Bodyworlds* should come to South Africa, it should be opposed. Nevertheless, the exhibition did take place for the first time in Africa during 2012 at Cape Town’s Waterfront, advertised to ‘give the lay public an intimate and anatomical view of the human body previously reserved only for the medical fraternity whose educational demands birthed the technology’ (Bateman, 2012). Numerous modern-day exhibits have been interrupted by protestors who sought to call attention to the post-life humiliation of these plastinated bodies. Protestors poured red paint on the exhibition floor, covering them with blankets, even taking a hammer to the preserved corpses (Goeller, 2007; Keating, 2014). The German Anatomical Association expressed concerns that the commercialization of human remains was ethically questionable (Satyapal, 2012). Recently, in the United States a new phenomenon has arisen, the emergence of private willed body donation companies ‘body brokers’ (Champney *et al.*, 2019). Private enterprises are centred on a for-profit business model and promote their services through advertising in newspapers, nursing facilities, hospices, and funeral homes, although a few exceptions do exist (Champney, 2016). These companies attract a disproportionate number of destitute donors by offering to cover the entire funeral costs for the family and/or cremation. Body brokers accept the bodies which are dissected and distributed to United States and international clients for medical education or research purposes including postgraduate surgical training courses (Shiffman and Levinson, 2018).

The term “anatomical theatre” was usually used to refer particularly to the amphitheaters of medical instruction in the fifteenth to nineteenth centuries (Keating, 2014). Keating (2014) stated that the term Anatomy theatre in exhibitions should more broadly encapsulate the scope of the performance of human dissection to minimize ambiguity between education and entertainment (Keating, 2014). Bleich (2007) stated that the acceptance of the commercial exploitation of human remains by the public at large is one instance that indicates that the age we live in is dissolute and immoral. The use of plastinates in public display exhibitions has much in common with an educational rationale, however, exhibits lack in a research notion with renaissance allusions (Dhai, 2011). The author further stated that the contemporary genre of the use of plastinates in this manner are far removed from any traditional anatomical approach and generally lack a teaching focus and the pedagogy of teaching and learning focused sessions accustomed to in an educational setting (Dhai, 2011).

The arguably most controversial plastinate is that of an expectant female, separated and curtained-off in a section away from other plastinates in the exhibition suggesting secret knowledge or pornography but also might be due to the display of vivid criminality (Keating, 2014). In addition, male and female plastinated cadavers are posed in such a way as if intertwined in eternal sexual intercourse raising concerns of voyeurism and pornography (Barilan, 2006). Regardless of the existence of informed consent, the assumption of the donor’s sexual preference shows disregard for the donor’s sexual identity. If the body belonged to a homosexual individual, the possibility that he might have objected to eternal heterosexual “mummification” undoubtedly does exist (Satyapal, 2012).

These theatrical poses of plastinates in exhibitions raise ethical concerns regarding consent to be posed in such a manner (Bianucci *et al.*, 2015). King *et al.*, 2014) stated that plastinates are ambiguous and they cannot easily be inserted into established categories using standard cultural binary categories of interior or exterior, real or fake, dead or alive, self or other. However, von Hagens argues that these aesthetic poses are essential to dissipate revulsion and ‘promote emotional awareness with protecting the sanctity of the individual’ (Keating, 2014). This presentation significantly contrasts with more contemporary efforts of anatomists and anatomy as a discipline to humanize dissection and student relationships with the bodies they are dissecting (Hildebrandt, 2010; Jones, 2016a). Furthermore, a paucity exists of information on the views of the anatomists preparing these extraordinary plastinates for public display exhibitions (Riederer, 2014).

The plastination process makes fundamental alterations to the composition of the bodies by reducing the amount of original human tissue to a fraction of the whole, therefore, plastinates are essentially composed mostly of plastic (von Hagens and Whalley, 2000; Jones 2002; King *et al.*, 2014). The lifespan of the plastinated corpse is estimated to be anywhere from a hundred years to infinity and virtually indestructible, which is of materialistic value for von Hagens, by ensuring the longevity of the

plastinates, which is better for business (Keating, 2014; King *et al.*, 2014). Although, the plastination technique has been in existence for more than four decades, as an efficient way to circumvent the natural decay of the human body after death, the longevity of plastinates is still debatable as they may last indefinitely. Interestingly, many donors seem to intend just that, to become a non-perishable plastinate because they associate this post-mortal fate with notions of an eternal existence or even immortality (FICEM, 2012).

1.2.4 Legal and Ethical views related to the use of plastinates

1.2.4.1. Legal views related to the use of plastinates

The appearance of functional bequest programs in the mid- to late 20th century has allowed a shift from the use of unclaimed bodies, regarded as a poor ethical choice today, to the use of donated bodies (Kahn *et al.*, 2017). These bequest programs have permitted people to donate their remains to medical schools for use in medical education through willed body programs (Richardson, 2001; Garment *et al.*, 2007). The use of human remains without consent for any purpose is illegal and morally unacceptable, as it transgresses sacrosanct boundaries that have been respected over millennia (Satyapal, 2012). Even with informed consent, a legal vacuum exists within legislation that governs the use of human tissue, which allows anatomical specimens to be permitted to cross international borders (Satyapal, 2012). Since, the Anatomy Act of 1832, British legislation governing the dissection of cadavers has continued to emphasize the importance of consent given by the individual prior to death (Jones and Whitaker, 2009). The Legislation in Australia, New Zealand and South Africa revolves around the Victoria (British) Human Tissue Act 2006. The Act makes provision for registered schools of anatomy and tissue banks, and prohibits commercial trading in human tissue, while allowing for the recovery of reasonable costs associated with the processing and storage of tissue (Jones and Whitaker, 2009).

Different people and cultures vary considerably in their *default formal duties*, the innate moral judgment deep-seated conviction that humans do not treat each other as raw material or as mere products for consumption (Barilan, 2004; 2006). Donors must be fully informed on the use of their remains in order to ensure transparency and those who survive the donor must know that the person made a free and informed decision (Barilan, 2004; 2006). von Hagens' former partner, Dr. Sui Hongjin, established his own exhibitions in 2005. "Bodies: The Exhibition", previously known as Bodyworks, was staged in New York, which resulted in further public uproar from human rights organizations as specimens might have been deceased Chinese prisoners and unclaimed bodies (Satyapal, 2012). The Chinese medical system has no legal or ethical limitations on the use of bodies of executed prisoners for medical purposes (Parmly, 2001; Hildebrandt, 2010). This use of the executed bodies is regulated by laws, such as the one approved in 1984; Article 3 of China's Provisional Regulations on the Use of Executed Prisoner's

Corpses or Organs states that a corpse may be used for medical purposes if unclaimed or if the family refuses or is unable to bury the remains; the prisoner voluntarily donates the body for use by medical facilities; or the immediate family consents to its use after death (Parmly, 2001; Hildebrandt, 2010). Executions are frequent in China, about 6,000 people were sentenced to death in 2004 and 3,400 were executed (Hildebrandt, 2010). “BODIES: The Exhibition” has since openly admitted to the use of unclaimed bodies of executed prisoners from the Chinese Bureau of Police (Klaus *et al.*, 2018).

Currently, most African countries continue to rely on the use of unclaimed bodies for anatomy education through dissection programs (Habicht *et al.*, 2018). In the South African context, during a period spanning four decades (1956-1996), 77.8 % of all bodies used for dissection at one medical school in South Africa sourced unclaimed bodies from government mortuaries (Labuschagne and Mathey, 2000). In 2005, South Africa revised the Human Tissue Act in response to public concerns regarding informed consent and the use of human remains, intended to restore public confidence in the collection and use of human tissue and organs for both research and public display purposes (Satyapal, 2012). In South Africa, the Anatomy Act No. 3 of 1911 and the National Health Act 61 of 2003, authorized inspectors of anatomy to regulate human tissue procurement, storage, use, and disposal (Slabbert, 2014; Pillay *et al.*, 2017; Soobramoney *et al.*, 2017). However, researchers have found that the act appeared deficient with regards to appropriate consent (Slabbert, 2014; Pillay *et al.*, 2017; Soobramoney *et al.*, 2017).

1.2.4.2 Ethical views related to the use of plastinates

The scientific study of the dead human body, its organs, and separated parts introduces a wide array of questions that have developed into increasingly critical ethical discussions as the visibility of dead bodies has escalated among the public (Jones, 2016a). Concerns over the use of unclaimed bodies, bodies of mentally challenged people and executed prisoners by public exhibitions have also been raised by human rights activists (Bleich, 2007). The use of deceased bodies in medical education and research has expanded, resulting in an affiliated upsurge in the need for willed bodies and an increase in the need to supply bodies (Champney *et al.*, 2019). Similarly, the establishment of for-profit organizations over the past decade has also influenced this upsurge in the need for bodies as they operate purely on the business model unlike museums and non-profit organizations (Champney *et al.*, 2019).

The process of plastination itself elicits ethical issues since the plastinates in exhibitions differ from the remains of the recently deceased or even the embalmed cadaver typically found in the anatomy dissection hall (Jones, 2014). Even under the assumption of following the donor’s wishes, multiple factors need to be considered in determining what may be appropriate or inappropriate in public exhibitions (Jones, 2014). Major ethical lapses have occurred as illustrated in the Bristol Royal Infirmary Inquiry, the Royal Liverpool Children’s Inquiry and the Walker (Satyapal, 2012). The

exploitation of human remains without obtaining consent resulted in legislative changes i.e. Human Tissue Act of 2006 (Satyapal, 2012). In London, in November of 2002, von Hagens conducted a public autopsy of a recently deceased human body in a crude improvised anatomical theatre (Barilan, 2006). This controversial and illegal exploit was performed at The Old Truman Brewery in front of several hundred paying audience members who were enticed by von Hagens passing organs amongst them in these twenty-first century autopsies (Bouchard, 2010; Keating, 2014).

As reflected in the literature reviewed, these complex ethical debates are centred around informed consent, the respectful disposal of human cadavers and the ambiguity that exhibitions have created between science (specifically anatomical science) and art, public education and financial gain, immortality and death (Moore and Brown, 2007). The techniques at the disposal of anatomists have the possibility for the display of human remains in unusual manners, imposing a reassessment of the ethical foundations of body donation (Jones, 2016a). Nevertheless, these exhibitions also entertain the public in the method of a “circus or freak show” that offers a flabbergasting and fascinating spectacle of plastinated human remains and ultimately death on display in exchange for a fee (Burns, 2007). The ongoing ethical debates by IFAA and other anatomical societies around the world have focused mainly on informed consent for the public display of human remains. Anatomists’ views on the use of plastinated specimens in public exhibitions have not been widely documented, which contrasts with contemporary anatomy teaching, using criteria far removed from the norms of conventional anatomy and anatomists *viz.*: the way death is on display and human dignity (Jones and Whitaker, 2009). In most countries around the world, the continued success of body donation programs depends on the ethical and institutional control of the body’s utilization to conserve trust and a positive relationship with potential donors and the community (Cornwall, 2011).

The University of KwaZulu-Natal (UKZN) has one of the several working plastination units in South Africa. Plastinates are used in human and veterinary study of anatomy. The Department of Clinical Anatomy offers plastination as part of the curriculum for postgraduate students who are taught plastination as part of the advanced methodology module. A gap exists in the literature on anatomists’ perceptions and use of plastinates for teaching and learning. The present study addresses the need for a better understanding of the use and perceptions of academics and postgraduate students in South Africa, so far lacking in scientific literature.

This study through the use of questionnaires aimed to elicit data on the perceptions of academics and postgraduate students at the School of Laboratory Medicine and Medical Science (LMMS), UKZN, Durban, South Africa toward the use of plastinates for anatomy teaching and learning as well as to document their views on the use of plastinates for public exhibitions. Data were analyzed, interpreted and documented. The results of this study will contribute to the expanding knowledge on the uses of

plastination among anatomists and hopefully stimulate ongoing debates regarding their ethical standing on exhibitions that publicly display human remains. Thus, possibly influencing the discussion and debate on regulations and legislation for the public display of human remains in South Africa.

1.3 Aim and Objectives of this investigation

Study aim/s:

The study aimed to examine the perceptions of academics and postgraduate students on the use of plastinates for anatomy education and for public display exhibitions.

Research objectives:

- To document academics' and postgraduate students' perceptions on the use of plastinates for teaching and learning.
- To document perceptions on the use of plastinates in public display exhibitions and investigate any religious, legal, or ethical concerns.

1.4 Methods and Materials

This study utilized questionnaires to gather data, which were analyzed and interpreted, to determine the perceptions of clinical anatomists and postgraduate students at UKZN toward the use of plastination in education and exhibitions. This research study employed both the qualitative and quantitative methodological approach. An electronic five-page questionnaire was created using Google Drive software and disseminated electronically via email/social platforms (e.g. Research Gate). Data were subjected to statistical analysis, Mann-Whitney test was employed and $p < 0.05$ was considered statistically significant.

Sample Size:

Questionnaires were distributed to 62 members of the Discipline of Clinical Anatomy, College of Health Sciences, University of KwaZulu-Natal (UKZN). A small sample size of 43 participants was recruited due to the small number of academics and postgraduate students in the Discipline of Clinical Anatomy at UKZN. Sample size was calculated using the method described in <http://www.openepi.com/>. Informed consent was received from academics and postgraduate students. Gatekeeper permission was obtained from the Dean and Head of School of the School of Laboratory Medicine and Medical Sciences. Ethical clearance was obtained from the Biomedical Research Ethics Committee of the UKZN (BE/45718). The period allocated for the targeted participants to answer the

questionnaire was two months with regular reminders sent every second week. The anatomists were South African anatomists ranging from academics (including technicians) to postgraduate students.

Inclusion criteria: The study was limited to persons who teach anatomy for academics including technicians and postgraduate students who have completed a minimum of an undergraduate degree in anatomy.

Exclusion criteria: The study excluded all undergraduate students and academics who were co-authors in the study.

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CHAPTER 2

This chapter is written in the form of a manuscript entitled “Use of plastinated specimens for anatomical education and public exhibitions” that has been submitted to the Anatomical Sciences Education Journal (ASE-21-0004).

USE OF PLASTINATED SPECIMENS FOR ANATOMICAL EDUCATION AND PUBLIC EXHIBITIONS

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ABSTRACT

The use of plastinates has been documented in various fields, however, literature is limited with regards to anatomists' perceptions on the use of plastinates for anatomy education. This study investigated the perceptions of staff members and postgraduate students on the use of plastinates in anatomy education and exhibitions. Through the use of a five-page questionnaire which consisted of closed and open-ended questions on a purposively sampled group of anatomy staff and postgraduate students, data was collected. Data were analyzed using descriptive statistics and the content analysis method, respectively. The Mann-Whitney test was used ($p < 0.05$ considered statistically significant) to determine significant differences between sub-groups. A response rate of 69% from 7 academics and 36 postgraduate students was obtained to assess their perceptions on the use of plastinates. Academics (57.1%) and postgraduate students (63.9%) had good perception on plastinate use for anatomy education. A higher percentage of postgraduate students (94.4%) indicated use of plastinates for anatomy education compared to academics (85.7%). Plastinates were found to support anatomy education among the respondents (95.3%). Respondents also found plastinates easy to use and helpful in the visualization of 3D structures. However, ethical concerns were raised by some academics and postgraduate students on use of plastinates in public exhibitions. This study recommends exploration of more inclusive use of plastinates in higher learning institutions especially in South Africa due to experienced cadaver shortages in order to supplement anatomy teaching and learning.

Keywords- Anatomy, Dissection, Cadaver, Teaching, Learning, Plastination, Plastinated specimens

Introduction

Cadaveric dissection has been regarded as the benchmark for anatomy education since the seventeenth century, providing an important three-dimensional (3D) view, and an appreciation of depth, fragility, and variability within the human body (Hildebrandt, 2010). Although cadaveric dissection is fundamental in anatomical education, a previous meta-analysis indicated that cadaver dissection does not necessarily result in better student performance (Aziz *et al.*, 2002). The volatility of chemicals from wet specimens subject academics and students to numerous health hazards, *viz.* allergic reactions, asthma, respiratory and dermal irritations (Dick *et al.*, 1989; Yokota *et al.*, 1997). Globally, medical schools have embraced alternative modalities of instruction through the use of medical imaging (including ultrasound), plastic models, multimedia learning, virtual anatomy, and plastinated specimens due to reduced dissection hours (Reidenberg and Laitman, 2002; Fruhstorfer *et al.*, 2011; Estai and Bunt, 2016). It is also ideal for teaching anatomy, pathology, obstetrics, radiology, and surgery; allowing for hands-on experience without smell and exposure to the carcinogenic chemicals (Fruhstorfer *et al.*, 2011; Hayat *et al.*, 2018).

Plastinated specimens (plastinates) have proved useful as an undergraduate and postgraduate teaching tool, also progressively emerging as a notably advantageous research tool in institutions that experience cadaver shortages (Jones and Whitaker, 2009; Bateman, 2012; Dibal *et al.*, 2018). The plastination technique has been used in many affiliated areas of education in clinical medicine, anatomy and health sciences, biology, pathology, art and more recently, as an object of commerce and entertainment in exhibitions (Jones and Whitaker, 2009; Sugathy and Francis, 2012; Bin *et al.*, 2016).

Plastination has enormous potential in all fields of academia including training, teaching, research and public culture (Sora *et al.*, 2019). It may also be used as a tool to transform public perceptions on the human body (Jones, 2016a). The technique of plastination for the preservation of human tissue (used for the production of plastinated specimens) is of direct interest to anatomists and biomedical scientists for teaching purposes (Jones, 2016a). Use of plastinates is a relatively new approach to teach anatomy, the preservation technique of plastination provides students with specimens that are dry, non-toxic and durable, without any color change in an odorless state (Ravi and Bhat, 2011). It has also been exceptionally effective for teaching neuroanatomy since the specimens can be grasped (Riederer, 2014; Dibal *et al.*, 2018). The brain slices demarcate grey and white matter distinctly to differentiate between fibers and areas of nuclei in the brain (Weiglein, 1997; Burns, 2007; Riederer, 2014; Dibal *et al.*, 2018). Another significant advantage is that minute details in human anatomical structures are illustrated through plastinates that might be indiscernible in other models (Jones, 2002) (Table 2).

Table 2: The advantages of plastinate use in anatomy education

Authors (Year)	Country	Advantages
Jones, (2002) Jones and Whitaker, (2009) Sora and Matusz (2012)	New Zealand	Illustrate minute details in human anatomical structures that might be indiscernible in other models. Plastinated organs or body slices can be interrelated with Computer Tomography (CT) and Medical Resonance Imaging (MRI) scans for reference and radiological education. Sheet plastination allows for easier study of topographical anatomy in detail.
Burns (2007)	Canada	Exceptionally effective for teaching neuroanatomy as grey and white matter present distinctly.
Turney (2007) Fruhstorfer <i>et al.</i> (2011)	United Kingdom	Eliminate exposure to carcinogenic solutions that are used to preserve cadavers, organs, and tissues. The smell of formalin makes it difficult for some students to study thus losing interest, whereas the plastination process eliminates this challenge. Plastination offers relatively more detailed features as all structures are fully preserved in their near-natural state.
Kocevski <i>et al.</i> (2010)	Macedonia	Preservation of parasites present in flesh e.g. larvae in putrid flesh can be preserved for demonstration.
Riederer, (2014)	Switzerland	Utilized for unmediated teaching in lecture rooms or in smaller groups and not limited to the dissection hall.
Ottone <i>et al.</i> (2015)	Chile	Plastinated specimens can be preserved for up to 40 years, which is 10 times more than conventional formalin-based preservation.
Kumaraswamy <i>et al.</i> (2011) Prasad <i>et al.</i> (2015) Sanjay <i>et al.</i> (2017)	India	Plastination completely preserves accurate specimens without vulgar smell or toxic fumes of embalming solutions. Fragile tissue sample preservation e.g. intra-cerebral hematoma can be preserved perfectly and made available for future use. Plastinates retain dilated conformation which permits the use in the gastrointestinal anatomy and endoscopic technique.
Bin <i>et al.</i> (2016)	Italy	Construction of 3D models of computable anatomical structures from ultra-thin plastinated dissections of organs.
Barilan, (2006) Haque <i>et al.</i> (2017)	Malaysia	Plastinates are stored and handled easier compared to than formalin-based preserved specimens.
Villiyate <i>et al.</i> (2012) Klaus <i>et al.</i> (2018)	USA	Cost to produce plastinates is relatively cheaper than conventional formalin-based preservation in the long-term. Allows for direct contact and 3D perception of intricate anatomical regions and clarifies the relationship between anatomical structures for students e.g. brain/nervous system and pelvis/perineum and its internal organs.

However, several studies have suggested disadvantages to their use viz. (i) they represent human tissue poorly in texture and spatial orientation (Fruhstorfer *et al.*, 2011; Ravi and Bhat, 2011; Dhanwate and Gaikwad, 2015); (ii) the fixed state of plastinates does not allow for demonstration of complex mechanical features of joints (Riederer, 2014; Klaus *et al.*, 2018); (iii) the rigidity of the plastinated material makes it difficult for the learner to visualize deeper structures (Collins, 2008; Fruhstorfer *et al.*, 2011). Korf *et al.* (2008) argued that the retention of anatomical concepts in long-term memory may

be compromised by restricting learning to one sensual experience of learning when using the plastinates alone. Additionally, there were health and safety concerns associated with the large amounts of flammable chemicals used in the preparation of plastinates (Janowsky *et al.*, 2000; Smith and Holladay, 2001; Costa *et al.*, 2012; Estai and Bunt, 2016).

Although cadaveric dissection was the superior and the preferred method for anatomy teaching and learning in comparison to plastinates (Nnodim *et al.*, 1996; Hildebrandt, 2010; Klaus *et al.*, 2018). Over the years, numerous studies have reported on the use of plastinates for teaching and learning from different fields of study with positive and mixed views (Table 3). Fruhstorfer *et al.* (2011), found that learning could be compromised due to the lack of tactile and emotional experience from the exclusive use of plastinates.

Table 3: Outcomes on views of the use of plastinates in anatomy education

Authors	Year	Participants	Views on plastination	Outcome
Latorre <i>et al.</i>	2007 2016	Academics Students	Used for anatomy teaching and learning resource, deemed useful. High level of satisfaction, higher second-year students (98.4%) than for first-year students (95.5%) found significant ($p < 0.05$).	Positive
Fruhstorfer <i>et al.</i>	2011	Students	Exclusive use of plastinates, rated as valuable resource for learning. However, learning experience perceived to be compromised due to limitations of tactile and emotional experience.	Mixed
Azu <i>et al.</i>	2012 2013	Students Academics	Valuable resource and benefit to student learning, used as a teaching tool. However, approximately 8.0% of academics used plastinates for anatomy teaching.	Positive Mixed
Baker <i>et al.</i> Lopez <i>et al.</i>	2013 2018	Students	Exclusive use of plastinates, high scores, while hours of instruction were reduced by 40% of the national mean, student satisfaction increased.	Positive
McRae <i>et al.</i>	2015	Postgraduates	Valuable educational resources compared to images alone. Students preferred plastinates as a supplemental learning resource.	Positive
Bhandari <i>et al.</i>	2016	Students	Complicated structures could be seen more clearly, easy to handle, useful for understanding. However, the students objected that the understanding of relations of the organs could not be made in the plastinated organ.	Mixed
Klaus <i>et al.</i>	2018	Academics	Currently used by academics (39%) for medical anatomy education and is a good supplement to, but not a replacement dissection.	Mixed
Akamatsu. <i>et al.</i>	2019	Postgraduates	Useful method to enhance anatomy learning for graduate students in slice plastination to enhance comprehension and diagnostic skills in imaging.	Positive
ABD-Elmagid	2019	Students	Plastinates were useful for developing clinical skills and learning clinical gross-anatomy, some prefer it more than traditional prosection.	Positive

Jones (2016) described the first public exhibitions as beginning in Tokyo in 1995 to 1997, which were followed by those in Mannheim in Germany in 1997 to 1998 and occurred later in other European countries. These were followed by an extensive Anatomy Art catalogue (von Hagens and Whalley, 2000), which precluded the first UK and American public exhibitions in 2002 and 2003 and 2004 and 2005, respectively (Jones, 2016).

While these exhibitions were associated with many positive aspects and attitudes toward the technique and its development, there were always negative aspects within the confines of an academic institution (Pashaei, 2010). These public display exhibitions draw a stark dichotomy between the scientific and artistic elements (Moore and Brown, 2007; Jones and Whitaker, 2009). Many of the dominant themes that emerge from the literature centre around the ambiguous ontological status of plastinates and ethical concerns, viz. informed consent, legal and ethical assessments (King *et al.*, 2014; Champney, 2016; Jones, 2016). These exhibits have created a blurred line between education and entertainment known as “edutainment” (Jones and Whitaker, 2009; Satyapal, 2012; Bin *et al.*, 2016).

Limited or no access to cadavers due to shortages has resulted in a change in teaching and learning at institutions in North America and Europe that have dramatically reduced time in the dissection hall or replaced dissection with prosections, plastic models, multimedia learning packages and plastinated specimens to aid anatomy teaching and learning (Reidenberg and Laitman, 2002; McLachlan *et al.*, 2004; McLachlan and Patten, 2006). A similar pattern of cadaveric shortages, high student numbers, and change in curricula are seen in South Africa (SA) especially at the University of KwaZulu-Natal (UKZN). UKZN is privileged in that it is one of the Universities in SA to have a functional plastination unit established in 1986 at the Westville campus and has been used to aid the learning of anatomy for medical and health science students.

The limited access to cadavers due to shortages has resulted in the incorporation of plastinates in teaching and learning at Clinical Anatomy UKZN, South Africa. Plastination is integrated into a laboratory techniques module offered by UKZN to undergraduate (third year Bachelor of Medical Science) and postgraduate (Honours) anatomy students. Teaching and learning primarily occurs via dissection however, too many students are allocated around a cadaver, therefore, it is supplemented by prosections, plastic models, multimedia learning packages (such as Primal Pictures and Aclands) and plastinates aligning to modalities used by others (Pawlina and Lachman, 2004; Sugand *et al.*, 2010). Hence, this study sought to investigate the perceptions of academics and postgraduate students from this University on their use of plastinates in anatomy education and their views on the public display of plastinates in exhibitions. In this study, it is hypothesised that the use of plastinates are useful in the teaching and learning of anatomy.

Materials and Methods

The study received ethical approval from the Biomedical Research Ethics Committee of the UKZN (BE457/18). Participation in the study was voluntary and informed consent was obtained from all participants. Through the use of a five-page questionnaire which consisted of closed and open-ended questions on a purposively sampled group of anatomy staff and postgraduate students, data was collected.

The questionnaire was administered to a convenient sample of 62 academics and postgraduate students from the Department of Clinical Anatomy at UKZN, School of Laboratory Medicine and Medical Science. The questionnaire investigated the perceptions of participants on plastinates with regard to the use thereof in teaching and learning and public display in exhibitions. This resulted in seven anatomy staff which included academics and technicians who were included in this study while two academics were excluded as co-authors in the study. A total of 36 postgraduate students who had completed a three-year anatomy undergraduate degree, were included in the study resulting in a small sample size of participants in this study.

Descriptive statistics were used to analyse quantitative data from the questionnaires using the IBM Statistical Package for Social Sciences (SPSS) software (version 25.0) and the Mann-Whitney test ($p < 0.05$ considered statistically significant) to determine significant differences between sub-groups. To assess the perception on use of plastinates for education and exhibitions, the quantitative responses of participants were grouped into three categories i.e. good (10-7), average (6-4), and bad (0-3). Percentages were calculated from the total number of participants (n=43) in the study.

Qualitative data from the questionnaire responses were analyzed by the content analysis method to reflect emanating themes (Pope and Mays, 2006). Comments from the questionnaire were also assessed for ethical themes, the subthemes for this category were determined from the literature (Jones, 2002; Tanassi, 2007; Riederer, 2014). Following discussion, the principal investigator and co-authors found no major disagreements in the final coding framework and themes applied to all qualitative data.

Results

Study Participants

A total of 43 participants (69%) responded to the questionnaire consisting of $\frac{7}{43}$ (16.3%) academics and $\frac{36}{43}$ (83.7%) postgraduate students (Table 4).

Table 4: Sociodemographic characteristics of participants

Demographic Characteristic		Number of respondents (n)	Percentage (%)
Age	20-25	31	72.1
	25-30	8	18.6
	30-50	4	9.3
Occupation	Postgraduate Honours	13	30.2
	Postgraduate Masters	20	46.5
	Postgraduate PhD	3	7.0
	Academics	7	16.3
Gender	Female	32	74.4
	Male	11	25.6
Population affinity	Black African	22	51.2
	Colored	1	2.3
	Indian	19	44.2
	White	1	2.3

Academic vs student perception on the use of plastinates for teaching and learning

All the academics and students reflected familiarity with the plastination technique and agreed that plastinates add educational value to anatomy e.g. *“It allows students to have a more accurate and realistic view of the anatomy”*. Furthermore, plastinates were shown to be valuable when access to dissection and prosected specimens is limited or not possible. *“Sometimes the anatomy department runs short of new specimens due to a lack of body donors, so plastinated specimens are of great value since they are preserved and always available”*

The odorless quality of the plastinates for anatomy teaching and learning and its long-term preservation was also seen as valuable based on statements such as *“Plastinated specimens last for a long time and they do not give off the same smell as the specimens that are submerged to formalin”*. Postgraduate students reflected that the use of plastinates consumed less time in an odorless environment compared to cadaveric dissection. *“By making use of plastinated specimens, it allows students to observe and learn the structure without having the constant need to interact with embalmed specimens which are tedious and time consuming to work with”*. However, some participants noted that the fixed nature of plastinates does not allow for further dissection e.g. *“Many plastinated sections need to be used as the structures in the specimens cannot be moved around to study underlying structures”*.

A total of 85.7% ($\frac{6}{7}$) of the academics reflected use of plastinated specimens for anatomy teaching with 71.4% ($\frac{5}{7}$) agreeing that the use of plastinated specimens supported the teaching of anatomy, while 28.6% ($\frac{2}{7}$) disagreed. Furthermore, all the academics ($\frac{7}{7}$, 100%) viewed plastinates as a valuable resource in anatomy teaching. The overall perception of academics towards the use of plastinates for anatomy

education was detected as good 57.1% ($\frac{4}{7}$) and average 42.9% ($\frac{3}{7}$). Participants indicated frequent use of plastinates in scheduled lectures, tutorials, assessments, and practical hours in the dissection hall as reflected by *"Plastinated specimens are used for teaching during practical or lectures and assessments"*.

The vast majority of 94.4% ($\frac{34}{36}$) of the postgraduate students used plastinates in informal practical hours and self-study. *"Specimens are also available in the museum for student engagement, students can view plastinates and use displays for self-study"*. Although 5.6% ($\frac{2}{36}$) of postgraduates did not make use of plastinates for anatomy learning, they had also indicated that plastinates support their learning. *"A plastinated specimen would provide much more info as compared to textbook images or models, especially if cadavers are not readily available"*. The perception of postgraduate students towards the use of plastinates for anatomy education was good 63.9% ($\frac{23}{36}$), average 30.6% ($\frac{14}{36}$) and bad 5.6% ($\frac{2}{36}$).

"Plastinated specimens are based on real anatomy and showcase structures that students need to see for optimum knowledge". Postgraduate students showed an appreciation for plastinates as it aided their understanding of 3D depth perception, visualization of intricate anatomical structures, together with dissection and prosected specimens. *"It helps students view anatomy in a 3D view, which textbooks don't allow"*. It is also an aid to visualize difficult-to-dissect structures such as the bronchial tree of the lungs. *"Plastinates show tissue that wouldn't normally be seen in dissection (bronchi) ..." aid students to observe the human anatomy in true form which will aid in their studies and understanding of human anatomy"*

"Plastinated specimens are more defined and can assist students to get a better understanding of anatomy as opposed to them working with prosected cadaveric specimens"

Participants' gender was analyzed using the Mann-Whitney test to determine if gender had any influence on their perception towards the use of plastinates for education and exhibitions. The perception of female participants was found to be good 56.3% ($\frac{18}{32}$), average 40.6% ($\frac{13}{32}$) and bad 3.1% ($\frac{1}{32}$), whereas, the male participants' perception was detected as good 63.6% ($\frac{7}{11}$), average 27.3% ($\frac{3}{11}$) and bad 9.1% ($\frac{1}{11}$). There was no statistically significant difference between the median perception of females and males ($p = 0.711$) on the use of plastinates for education.

There was also no significant difference found between median perception of academics and postgraduates on the use of plastinates for anatomy education ($p = 0.774$) or public display ($p = 0.128$) at exhibitions.

Perception on Public Display exhibits

On the acceptability of financial gain, 85.7 % ($\frac{6}{7}$) of the academics and 61.1% ($\frac{22}{36}$) of the postgraduates disagreed with financial gain (profit) by public display exhibitions. The public display of plastinated human remains was considered ethical by 42.8% ($\frac{3}{7}$) academics. *“The exhibitions are educational but also artistic and exotic pieces are highly appreciated in art”* and 44.4% ($\frac{16}{36}$) of postgraduate students. *“If people consent to have their bodies being positioned in an exotic manner it should be done”*

More than half 57.2% ($\frac{4}{7}$) of academics and 55.6% ($\frac{20}{36}$) postgraduates noted this as unethical. *“The positions that the humans are displayed in are unethical and honestly unnecessary”*. The ethical concerns on the source of bodies and informed consent were central among the themes surrounding public display of plastinates in exhibitions. The exhibitions with exotic displays were seen as disrespectful and offensive to participants’ religion and culture.

When asked if they would consider donating their bodies to an exhibition, majority of the participants (90.7%, $\frac{39}{43}$) were against donation to public display exhibitions. *“I find the positions voyeuristic and uncomfortable”* *“There is no educational benefit and is purely perverse”*.

A small number of participants 9.3% ($\frac{4}{43}$) were pro-donation to public display exhibitions.

Participants indicated the presence of informed consent as central in the debates around public display and were more inclined toward the use of plastinates for education and research purposes.

“I believe it is sending a vulgar message across and it makes me upset as those bodies could have been used to educate students in medical sciences as there is a shortage of bodies”

Discussion

A few studies in the African continent have shed light on the use of plastination for teaching and learning viz. Nigeria (Azu *et al.*, 2012, 2013; Oyewopo *et al.*, 2018), Ghana (Ameko *et al.*, 2012, 2013) and South Africa (van der Berg, 2017). However, studies focusing on the use of the plastinated specimens in teaching and learning from both academics and postgraduate students and their use public exhibitions are limited especially in South Africa hence the contribution sought to be made by this study.

Similar to other studies, academics and postgraduate students were found to be familiar with the process of plastination and had experience using this supplemental tool (Azu *et al.*, 2013; Klaus *et al.*, 2018).

However, in Nigeria low usage of plastinates by anatomy educators (8%) was documented (Azu *et al.*, 2013). Academics at this Institution attributed the non-use of plastinates for anatomical education to lack of a functional plastination unit due to funding challenges and lack of expertise (Azu *et al.*, 2013). In the United States, less than half of their participants (39%) made use of plastinated specimens for teaching anatomy since some anatomy instructors considered plastinates to be useless, citing a preference to cadaveric dissection while others noted high costs of setting up a laboratory and lack of qualified staff to manage facilities (Klaus *et al.*, 2018). They did not see the perceived need for use of plastinates in teaching anatomy at this Institution (Klaus *et al.*, 2018).

The literature indicates that students often struggle with 3D perception of the relation between structures and thus the ability to differentiate between structures (Tamura *et al.*, 2014; Haque *et al.*, 2017). The current study highlighted several positive views *viz.* valuable resource; promotion of self-study; availability of specimens even through shortages and 3D visualization of difficult areas. This is comparable to various other reports from several countries around the world, that found that academics, undergraduate and postgraduate students judged plastinates as a valuable resource that benefits anatomy education in countries such as the United Kingdom, Canada, India, Malaysia, the United States, and Brazil (Fruhstorfer *et al.*, 2011; McRae *et al.*, 2015; Bhandari *et al.*, 2016; Haque *et al.*, 2017; Klaus *et al.*, 2018; Akamatsu *et al.*, 2019). Students often struggle with 3D perception of the relationship between structures and the ability to differentiate between structures (Tamura *et al.*, 2014; Haque *et al.*, 2017) due to learning restricted to two-dimensional static diagrams in textbooks, plastic models, still and on-screen images (Friedl *et al.*, 2002; Mitchell and Stephens, 2004; Battulga *et al.*, 2012).

Additionally, the use of plastinates required less time in an odorless environment compared to cadaveric dissection which was a similar view at the Institute of Clinical Education, Warwick Medical School, in the United Kingdom where medical students frequently acknowledged cadaveric dissection as a time-consuming activity (Fruhstorfer *et al.*, 2011). Fruhstorfer *et al.* (2011) documented that undergraduate medical students were reluctant to exclusively use plastinates for their anatomy study for the reasons that follow: student awareness of delicacy and monetary value of the specimens, they were apprehensive about touching plastinates, thus learning was limited to a visual experience. The limitation of plastinates in the current study included the rigid nature of the specimens.

Ethical concerns of plastinate use for exhibitions

There were mixed views regarding the display of plastinates. With comments such as “*The exhibitions are educational but also artistic and exotic pieces are highly appreciated in art*” while another stated, “*There is no educational benefit and is purely perverse*”. This might point to life experience and the ability of academics to be more objective toward the educational and cultural aspects associated with public display in for-profit exhibitions. The viewpoints regarding postures and poses were controversial and the majority felt it was unethical. This was consistent with a previous report by Klaus et al. (2018) on institutions in the United States which reported that 14% of survey participants who were all academics, had ethical comments or concerns. Some considered the use of human remains for public display exhibitions as exploiting donors and unethical (Jones, 2002; Tanassi, 2007; Riederer, 2014; Satyapal, 2012). However, comments within this current study did indicate consent as a key criterion: if a person consented then it should be allowed and is ethical.

Hayat et al. (2018) stated that the number of body donations to public display exhibitions is an indication of how these exhibits fascinate the public and that this fascination can be used to educate and encourage society to be more health-conscious. This could have an adverse effect on body donation in African countries where religious and cultural beliefs impact on the decision to donate (Gangata *et al.*, 2010). Interestingly, a small number of participants in the current study (9.3%) decided in favor of body donation to public display exhibitions.

Conclusion

Plastinates were appreciated by academics and postgraduate students as a valuable resource for teaching and learning in this study, confirming the importance of utilizing different methods in anatomy education. Knowledge of academic and student teaching and learning preferences in the different modalities of instruction and study will enable the creation of specific study models and strategies for anatomy education. In turn, this will ease the demand for donated bodies for anatomy teaching and learning. Further studies in this area should be conducted to include undergraduate anatomy students, medical students and other health-sciences students to improve knowledge on this topic. This might assist to transform and broaden knowledge on benefits and limitations of plastinates. The study recommends more inclusive use of plastinated specimens in the teaching and learning of anatomy in South African higher learning institutions. Plastinates should be included as we modernize the way in which anatomy is taught worldwide, and how it is perceived and projected to students and researchers.

Limitations

The small sample size is a limitation however it does add value to the contribution of anatomy teaching and learning. A larger sample size and a cohort of undergraduate medical and allied health students should be considered for future studies.

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CHAPTER 3

3.0. SYNTHESIS

The knowledge of educational methodologies, resources and advances in technology is imperative for educators of anatomy (Brenner *et al.*, 2003). The integration of different modalities and methodologies of training has been perceived to be advantageous for academics and students alike (Reidenberg and Laitman, 2002; McLachlan *et al.*, 2004; McLachlan and Patten, 2006). With the decrease in the number of cadavers available for dissection, alternative methods of teaching and learning anatomy are utilised.

Limited or no access to cadavers due to shortages has resulted in a change in teaching and learning at institutions in North America and Europe that have dramatically reduced time in the dissection hall or replaced dissection with prosections, plastic models, multimedia learning packages and plastinates to aid anatomy teaching and learning (Reidenberg and Laitman, 2002; McLachlan *et al.*, 2004; McLachlan and Patten, 2006). The plastination technique and its role in the production of plastinates offers to ease this demand for donated bodies as a supplemental instruction tool for anatomy teaching.

Plastinates have especially been valuable in institutions that experience body donor shortages globally some have completely moved away from dissection to the exclusive use plastinates for teaching and learning (Fruhstorfer *et al.*, 2011; Ghosh, 2017; Baker *et al.*, 2013; Lopez *et al.*, 2018). This is consistent with many other institutions that officially deemed conventional cadaveric dissection obsolete in lieu of model substitutes and technology (Guttmann *et al.*, 2004; McLachlan *et al.*, 2004; Sugand *et al.*, 2010).

This dissertation sought to address the need for a better understanding of the perceptions and use of plastinates by academics and postgraduate students, which is so far lacking in the scientific literature. Further, it sought to determine the perceptions of the same with regards to the use of plastinates in public exhibitions. The majority of academics and postgraduates indicated that they used plastinated specimens for anatomy teaching. However, a small minority of academics and postgraduates indicated non-use. Overall most of the participants agreed that the use of plastinated specimens supported teaching of anatomy. Participants viewed plastinates as a valuable resource that allowed a detailed view of authentic anatomy, and aided visualization of the course and relation of neurovascular structures in anatomy teaching and learning.

According to this study, participants had positive perceptions on the use of plastinates for anatomy teaching and learning. However, both academics and postgraduates, in this study largely had a bad perception on the use of plastinates for public display exhibitions. Many academics and postgraduates disagreed with financial gain (profit) by public exhibitions. However, this did not result in any statistically significant difference between the perceptions of academics and postgraduate students on plastinate use for anatomical education or exhibitions.

Not only did academics and postgraduate students consider plastinates to support anatomy teaching and learning, but postgraduate students also viewed plastinates as an aid to improve their understanding, supplemented by wet cadaveric dissection and prosected specimens. This is consistent with previous studies which found that anatomy educators and students had positive reactions to the use of plastinates for anatomy teaching and learning, supplemented by cadaveric dissection (Sanjay *et al.*, 2017; Klaus *et al.*, 2018).

Future education and training of medical, medical science, veterinary and postgraduate students will still heavily rely on body donations from the public. As the world is experiencing an ongoing and vicious spread of Covid-19, and with over a third of the world's population currently under some form of lockdown (Franchi, 2020). The disappearance of practical teaching, face-to-face contact and direct interactions as a result of Covid-19, has resulted in the learning environment now being far less than optimal, the loss of both educators and students may potentially hinder students' development as anatomists (Franchi, 2020).

Plastinates have proved useful as a pre- and postgraduate teaching tool progressively emerging as a notably advantageous research tool in institutions that experience cadaver shortages (Jones and Whitaker, 2009; Bateman, 2012, Dibal *et al.*, 2018). However, Fruhstorfer *et al.* (2011) documented that students were reluctant to exclusively use plastinates for their anatomy study for the reasons that follow: student awareness of delicacy and monetary value of the specimens, they were apprehensive about touching plastinates, thus learning was limited to a visual experience.

This study recommends a more inclusive use of plastinated specimens in the teaching and learning of anatomy especially in South African higher learning institutions. Plastinates should be included as the way in which anatomy is taught worldwide gets modernized, together with how it is perceived and projected to students and researchers.

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APPENDIX

Appendix 1 – Ethics Approval



01 October 2019

Mr D Bailey (214559919)
School of Laboratory Medicine and Medical Sciences
College of Health Sciences
214559919@stu.ukzn.ac.za

Dear Mr Bailey

Protocol: The use of plastinated specimens for anatomy teaching and learning at UKZN: Perceptions of Academics and postgraduate students.
Degree: MMedSC
BREC Ref No: BE457/18

RECERTIFICATION APPLICATION APPROVAL NOTICE

Approved: 17 October 2019
Expiration of Ethical Approval: 16 October 2020

I wish to advise you that your application for Recertification received on 09 September 2019 for the above protocol has been **noted and approved** by a sub-committee of the Biomedical Research Ethics Committee (BREC) for another approval period. The start and end dates of this period are indicated above.

If any modifications or adverse events occur in the project before your next scheduled review, you must submit them to BREC for review. Except in emergency situations, no change to the protocol may be implemented until you have received written BREC approval for the change.

The committee will be notified of the above approval at its next meeting to be held on 12 November 2019.

Yours sincerely

Prof V Rambiritch
Chair: Biomedical Research Ethics Committee

Supervisor: Sobramoniesw@ukzn.ac.za Debaraj@ukzn.ac.za
Co Supervisor: Suryapavith@ukzn.ac.za Postgrad admin: studhr@ukzn.ac.za

Appendix 2 – Informed consent form

MASTERS RESEARCH

TITLE : *The use of plastinated specimens for Anatomy teaching and learning at UKZN: Perceptions of Academics and Postgraduate Students*

CONSENT

I, _____ have been informed about the study entitled *Perceptions of South African anatomists on the use of plastinated specimens for teaching and learning and their public display*.

I understand the purpose and procedures of the study.

I have been given an opportunity to answer questions about the study and have had answers to my satisfaction.

I declare that my participation in this study is entirely voluntary and that I may withdraw at any time without affecting any treatment or care that I would usually be entitled to.

If I have any further questions/concerns or queries related to the study I understand that I may contact the researcher at: Email: 214559919@stu.ukzn.ac.za
Cell: ___060 942 9843___

If I have any questions or concerns about my rights as a study participant, or if I am concerned about an aspect of the study or the researchers then I may contact:

BIOMEDICAL RESEARCH ETHICS ADMINISTRATION

Research Office, Westville Campus
Govan Mbeki Building
Private Bag X 54001
Durban
4000
KwaZulu-Natal, SOUTH AFRICA
Tel: 27 31 2604769 - Fax: 27 31 2604609
Email: BREC@ukzn.ac.za

Signature of Participant

Date

Appendix 3 – Questionnaire

Title: Perceptions of South African anatomists on the use of plastinated specimens for teaching, learning, and their public display.

Section 1 of 3:

Demographics

1.1) Title

- ☐ Professor
- ☐ Dr
- ☐ Mr
- ☐ Mrs
- ☐ Ms
- ☐ Other (please specify) _____

1.2) Gender _____

- ☐ Female
- ☐ Male

1.3) Name _____

1.4) Surname _____

1.5) Gender _____

- ☐ Other (please specify) _____

1.6) Age _____

- ☐ 20-25
- ☐ 25-30
- ☐ 30-40
- ☐ 40-50
- ☐ 50-60
- ☐ 60-70

1.7) Population affinity

- ☐ Black African
- ☐ Coloured
- ☐ Indian/Asian
- ☐ White
- ☐ Other (please specify) _____

1.8) Highest Qualification

- ☐ Honours degree
- ☐ Masters degree
- ☐ PhD
- ☐ Post Doctorate
- ☐ Other (please specify) _____

1.9) Institution

- ☐ Durban University of Technology
- ☐ Nelson Mandela Metropolitan University

- ☐ Sefako Magatho Health Sciences University
- ☐ University of Cape Town
- ☐ University of Free State
- ☐ University of Johannesburg
- ☐ University of Kwazulu-Natal
- ☐ University of Limpopo
- ☐ University of Pretoria
- ☐ University of Stellenbosch
- ☐ University of Witwatersrand

1.10) Occupation

- ☐ Academic
- ☐ Technician
- ☐ PG Honours
- ☐ PG Masters
- ☐ PG PhD
- ☐ Post Doc
- ☐ Other (please specify) _____

1.11) Religious affiliation

- ☐ Christian
- ☐ Traditional African religion
- ☐ Muslim
- ☐ Hindu
- ☐ Jewish
- ☐ Atheist and agnostic
- ☐ Other (please specify) _____

Section 2 of 3:

Use of plastinated specimens for Teaching and Learning and Research

2.1) Are you familiar with what plastinated specimens are?

- ☐ Yes
- ☐ No

2.2) Do you know if your institution has a plastination unit?

- ☐ Yes
- ☐ No

2.3) Does your Institution make use of plastinated specimens for teaching and learning purposes?

- ☐ Yes
- ☐ No

2.3.1) if yes, please elaborate on its use (optional) _____

Appendix 3 – Questionnaire

2.4) Does your Institution display plastinated specimens in your departmental museum?

- ☐ Yes
- ☐ No

2.5) Is the public allowed to visit your departmental museum?

- ☐ Yes
- ☐ No

2.5.1) If yes, please give more information on this visitation procedure?

2.6) In your opinion does the use of plastinated specimens support the teaching and learning of human anatomy?

- ☐ Yes
- ☐ No

2.7) Do you think that the display of plastinated human remains has an educational value for students?

- ☐ Yes
- ☐ No

2.7.1) Please give a reason for your choice: _____

Section 3 of 3:

Views on public display

3.1) Have you attended any exhibitions which display plastinated human material?

- ☐ Yes
- ☐ No

3.1.1) If yes, please indicate name of exhibition and country you have seen it in?

3.2) What was your view of exhibitions prior to visiting a show?

3.3) What was your view after visiting the exhibition?

3.4) In your opinion, do you think such exhibitions are:

- ☐ Educational
- ☐ Voyeuristic
- ☐ Artistic

☐ Other: _____

3.5) If you did not attend, was it due to any of the following reasons?

- ☐ Personal
- ☐ Religious
- ☐ Cultural
- ☐ Financial
- ☐ Other: _____

3.6) If you had the opportunity, to visit an exhibition, would you do so?

- ☐ Yes
- ☐ No

3.6.1) Please give a reason: _____

3.7) Do you know if the Bodyworlds exhibition or equivalent exhibitions are promoted by your department?

- ☐ Yes
- ☐ No

3.8) What is your opinion regarding the “exotic” positions of plastinated bodies in exhibitions?

3.9) In your opinion, is the display of plastinates to the public, ethically and morally correct?

- ☐ Yes
- ☐ No
- ☐ Please elaborate: _____

3.10) In your opinion, is there appropriate dignity displayed in the way human remains are depicted?

3.11) Would you donate your body to be plastinated and used as part of an exhibition?

- ☐ Yes
- ☐ No
- ☐ Please elaborate: _____

3.12) Children over the age of two years old are permitted to enter these exhibitions, what is your opinion regarding this practice?

Appendix 3 – Questionnaire

3.13) Do you think the public display of plastinated human remains has educational value for children?

- ☐ Strongly disagree
- ☐ Disagree
- ☐ Neutral
- ☐ Agree
- ☐ Strongly agree

3.14) Do you think such exhibitions violate human dignity and the integrity of a person?

- ☐ Yes
- ☐ No

3.14.1) Please comment on your answer (optional) _____

3.15) Do you have any ethical reservations related to the exhibition of plastinated specimens?

3.15.1) Please elaborate _____

3.16) Do you think financial gain (profit) from exhibitions is acceptable?

3.17) In your opinion what should be the ethical criteria for having exhibits of plastinated specimens?

3.18) What is your opinion regarding plastination used for teaching and learning versus exhibits of plastinated specimens for profit?

Appendix 4 – Raw Data

1	Consent	1.1) Title	1.2) Gender	1.3) Name	1.4) Surname	1.5) Age	1.6) Population	1.7) Highest Qualific	1.8) Institution	1.9) Occupation	1.10) Religious	2.1) Are	2.2) Do	2.3)
2	Yes	Mr	Male	Anonymous	Anonymous	20 - 25	Indian	Honours degree	University of Kwazulu-Natal	PG Honours	Christian	Yes	Yes	Yes
3	Yes	Mrs	Female	Anonymous	Anonymous	20 - 25	Indian	Honours degree	University of Kwazulu-Natal	PG Masters	Muslim	Yes	Yes	Yes
4	Yes	Mr	Male	Anonymous	Anonymous	20 - 25	Black African	Honours degree	University of Kwazulu-Natal	PG Honours	Traditional Afri	Yes	Yes	Yes
5	Yes	Mrs	Female	Anonymous	Anonymous	30 - 40	Indian	Masters degree	University of Kwazulu-Natal	PG PhD	Hindu	Yes	Yes	Yes
6	Yes	Mr	Male	Anonymous	Anonymous	20 - 25	Black African	Honours degree	University of Kwazulu-Natal	PG Honours	Christian	Yes	No	Yes
7	Yes	Ms	Female	Anonymous	Anonymous	20 - 25	Indian	Masters degree	University of Kwazulu-Natal	PG Masters	Christian	Yes	Yes	Yes
8	Yes	Ms	Female	Anonymous	Anonymous	30 - 40	Black African	Masters degree	University of Kwazulu-Natal	PG PhD	Muslim	Yes	No	No
9	Yes	Ms	Female	Anonymous	Anonymous	20 - 25	White	Honours degree	University of Orange Free St	PG Honours	Christian	Yes	No	Yes
10	Yes	Mr	Male	Anonymous	Anonymous	20 - 25	Black African	Honours degree	University of Kwazulu-Natal	PG Masters	Christian	Yes	Yes	Yes
11	Yes	Ms	Female	Anonymous	Anonymous	20 - 25	Black African	Honours degree	University of Kwazulu-Natal	PG Honours	Christian	Yes	Yes	Yes
12	Yes	Ms	Female	Anonymous	Anonymous	20 - 25	Black African	Honours degree	University of Kwazulu-Natal	PG Masters	Christian	Yes	Yes	Yes
13	Yes	Ms	Female	Anonymous	Anonymous	20 - 25	Indian	Honours degree	University of Kwazulu-Natal	PG Masters	Muslim	Yes	Yes	Yes
14	Yes	Mrs	Female	Anonymous	Anonymous	25 - 30	Coloured	Honours degree	University of Kwazulu-Natal	PG Masters	Christian	Yes	Yes	Yes
15	Yes	Ms	Female	Anonymous	Anonymous	20 - 25	Black African	Honours degree	University of Kwazulu-Natal	PG Honours	Christian	Yes	Yes	Yes
16	Yes	Mr	Male	Anonymous	Anonymous	20 - 25	Indian	Honours degree	University of Kwazulu-Natal	PG Masters	Christian	Yes	Yes	Yes
17	Yes	Ms	Female	Anonymous	Anonymous	20 - 25	Black African	Honours degree	University of Kwazulu-Natal	PG Honours	Christian	Yes	No	Yes
18	Yes	Ms	Female	Anonymous	Anonymous	20 - 25	Black African	Honours degree	University of Kwazulu-Natal	PG Honours	Christian	Yes	Yes	Yes
19	Yes	Ms	Female	Anonymous	Anonymous	20 - 25	Black African	Honours degree	University of Kwazulu-Natal	PG Honours	Christian	Yes	Yes	Yes
20	Yes	Dr	Male	Anonymous	Anonymous	30 - 40	Black African	Masters degree	University of Kwazulu-Natal	PG PhD	Christian	Yes	Yes	Yes
21	Yes	Ms	Female	Anonymous	Anonymous	20 - 25	Black African	Honours degree	University of Kwazulu-Natal	PG Honours	Christian	Yes	Yes	Yes
22	Yes	Ms	Female	Anonymous	Anonymous	20 - 25	Indian	Honours degree	University of Kwazulu-Natal	PG Honours	Muslim	Yes	Yes	Yes
23	Yes	Mr	Male	Anonymous	Anonymous	20 - 25	Black African	Honours degree	University of Kwazulu-Natal	PG Masters	Christian	Yes	Yes	Yes
24	Yes	Ms	Female	Anonymous	Anonymous	25 - 30	Black African	Masters degree	University of Kwazulu-Natal	Academic	Christian and Tr	Yes	Yes	No
25	Yes	Dr	Female	Anonymous	Anonymous	40 - 50	Indian	PhD	University of Kwazulu-Natal	Academic	Christian	Yes	Yes	Yes
26	Yes	Ms	Female	Anonymous	Anonymous	25 - 30	Black African	Honours degree	University of Kwazulu-Natal	Academic	christian	Yes	No	Yes
27	Yes	Ms	Female	Anonymous	Anonymous	25 - 30	Indian	Masters degree	University of Orange Free St	Academic	Christian	Yes	Yes	Yes
28	Yes	Ms	Female	Anonymous	Anonymous	25 - 30	Indian	Masters degree	University of Orange Free St	Academic	Hindu	Yes	Yes	Yes
29	Yes	Ms	Female	Anonymous	Anonymous	20 - 25	Indian	Honours degree	University of Kwazulu-Natal	PG Honours	Hindu	Yes	Yes	Yes
30	Yes	Ms	Female	Anonymous	Anonymous	20 - 25	Indian	Honours degree	University of Kwazulu-Natal	PG Honours	Christian	Yes	Yes	Yes
31	Yes	Ms	Female	Anonymous	Anonymous	20 - 25	Indian	Honours degree	University of Kwazulu-Natal	PG Honours	Christian	Yes	Yes	Yes
32	Yes	Ms	Female	Anonymous	Anonymous	25 - 30	Indian	Masters degree	University of Johannesburg	Academic	Hindu	Yes	Yes	Yes
33	Yes	Ms	Female	Anonymous	Anonymous	20 - 25	Indian	Masters degree	University of Kwazulu-Natal	PG Masters	Hindu	Yes	Yes	Yes
34	Yes	Ms	Female	Anonymous	Anonymous	20 - 25	Black African	Honours degree	University of Kwazulu-Natal	PG Masters	Christian	Yes	Yes	Yes
35	Yes	Mr	Male	Anonymous	Anonymous	25 - 30	Black African	Honours degree	University of Kwazulu-Natal	Technician	Christian	Yes	Yes	Yes
36	Yes	Ms	Female	Anonymous	Anonymous	20 - 25	Indian	Honours degree	University of Kwazulu-Natal	PG Masters	Hindu	Yes	Yes	Yes
37	Yes	Ms	Female	Anonymous	Anonymous	20 - 25	Black African	Honours degree	University of Kwazulu-Natal	PG Masters	Christian	Yes	Yes	Yes
38	Yes	Ms	Female	Anonymous	Anonymous	25 - 30	Black African	Honours degree	University of Kwazulu-Natal	PG Masters	Christian	Yes	Yes	Yes
39	Yes	Ms	Female	Anonymous	Anonymous	20 - 25	Black African	Honours degree	University of Kwazulu-Natal	PG Masters	Christian	Yes	Yes	No
40	Yes	Mr	Male	Anonymous	Anonymous	20 - 25	Indian	Honours degree	University of Kwazulu-Natal	PG Masters	Christian	Yes	Yes	Yes
41	Yes	Mr	Male	Anonymous	Anonymous	20 - 25	Indian	Honours degree	University of Kwazulu-Natal	PG Honours	Hindu	Yes	No	Yes
42	Yes	Ms	Female	Anonymous	Anonymous	20 - 25	Indian	Honours degree	University of Kwazulu-Natal	PG Honours	Hindu	Yes	Yes	Yes
43	Yes	Ms	Female	Anonymous	Anonymous	20 - 25	Black African	Honours degree	University of Kwazulu-Natal	PG Honours	Christian	Yes	Yes	Yes
44	Yes	Ms	Male	Anonymous	Anonymous	20 - 25	Black African	Honours degree	University of Kwazulu-Natal	PG Honours	Traditional Afri	Yes	Yes	Yes

Appendix 4 – Raw Data

	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC
1	2.3.1) If yes, please elaborate	2.4) D2.5)	No	Yes	Yes	(2.7) (2.7.1) Please give a reason for your choice	3.1) Have	3.4) In your opinion	3.5) If you disagree	3.6) If you agree	3.6.1) Please give a reason	3.7) Do you	3.8) What is your opinion	3.9) In your
2	Plastinated specimens are used during	Yes	No	Yes	Yes	Plastination allows for the preservation of	No	Artistic	Financial	Yes	To firsthand experience	No	These such positions should	No
3	It was used for practicals and sometimes	Yes	No	Yes	Yes	The students can view these neatly dissected	No	Artistic	Personal	No		No	It's artistic but I don't think	Yes
4	Some are showcased in the Anatomy museum	Yes	No	Yes	Yes	You get to see the various structures of the	No	Artistic	Financial	No	I don't think there would be	No	As long as all the legal stuff	Yes
5	Students use plastinated specimens to	Yes	No	Yes	Yes	If plastinated correctly, specimens last for	No	Voyeuristic	Personal	No	The positions that the human	No	Perverse and unnecessary	No
6		Yes	No	Yes	Yes	From the plastinated specimens we get to	No	Educational	Financial	Yes	I'd love to see the different	No	They are wrong...extreme	No
7		No	No	Yes	Yes	It allows for students to study human specimens	No	Educational		Yes		No	Not relevant to anatomy	Yes
8		No	No	Yes	Yes	this will assist student in their understanding	No	Voyeuristic	Personal	No	it's not acceptable to me	No	the exhibition may even	No
9		Yes	No	Yes	Yes	Plastinated specimens help keep the anatomy	No	Educational	Personal	No	I would not like to support	No	I believe it is sending a	No
10	Plastinated specimens are much easier	Yes	No	Yes	Yes	It does have an educational value in a way	No	Artistic	Financial	Yes	It would be for the first time	No	Age restriction must be	No
11	They bring them out during class to	Yes	No	Yes	Yes	They make things more clear. Textbooks	No	Artistic	Financial	Yes	I think it sounds fascinating	Yes	I love it, makes Anatomy	No
12		Yes	No	Yes	Yes	Students can see what they are learning	No	Voyeuristic	Financial	Yes	Just to see what it is about	No	Unethical.	No
13	Plastinated specimens are available to	Yes	No	Yes	Yes	Plastinated specimens are based on real	No	Artistic	Financial	Yes	I would take the opportunity	Yes	I do not support it	No
14		Yes	No	Yes	Yes	It provides a 3D view of the anatomical	No	Educational	Personal	Yes		No	if the person was informed	Yes
15	We learn the anatomical structures from	Yes	No	Yes	Yes	It helps students understand the structure	No	Educational	Financial	Yes	I would like to see the anatomy	No	They should not be done	Yes
16	Lectures/practicals/museum display	Yes	No	Yes	Yes	Helps students to put a picture to what	No	Educational	Financial	Yes	It is very educational and	Yes	It's a violation of an individual	No
17	during practicals for better understanding	Yes	No	Yes	Yes	it gives them better understanding on	No	Artistic	Personal	Yes		No	it not right, as it imposes	Yes
18	to show tissue that wouldn't normally	Yes	No	Yes	Yes	they allow for detail study and preservation	No	Artistic	Personal	Yes	id love to see the how the	No	i strongly condemn such	Yes
19		Yes	No	Yes	Yes	it provides a practical learning experience	No	Educational	Financial	Yes	its very interesting	No	its fascinating and gives	Yes
20	Some plastinated specimens are used	Yes	No	Yes	Yes	It is just like learning with real human	No	Educational		Yes	To see the human body	No	Nothing about it	Yes
21	they are displayed in the museum and	Yes	No	Yes	Yes	plastinated specimens last for a long time	No	Voyeuristic		Yes	would love to see how it	No	its wrong	Yes
22	student studying purposes	Yes	No	Yes	Yes	It provides better visualisation	No	Educational		Yes	Educational purposes	No	they may be quite vulgar	No
23		Yes	No	Yes	Yes	they are clearer and easily identified	No	Voyeuristic		Yes	For experience	No	I think its important for	Yes
24		Yes	No	Yes	Yes	They can use specimen as reference of	No	Educational, Artistic		No	If I consented to, I have	Yes	If consented to, I have	Yes
25	Limited use teaching and assessment	Yes	No	Yes	Yes		Yes	Artistic		Yes		No	It is crude, especially for	Yes and
26	Used during practical sessions (sometimes)	Yes	No	Yes	Yes	Students may want to know what they	No		Personal	Yes	I might learn new things	No	Neutral, I don't know the	I don't know
27	Plastinated specimens are used during	Yes	Yes	No	Yes	Plastinated human remains allow student	No	Educational	Financial	Yes	I find it educational and	No	I think its interesting and	No
28		Yes	Yes	No	Yes	Students have access to accurate specimen	No	Artistic	Financial	Yes		No	With the perception of	Yes
29	Display anatomical structures, hands	Yes	No	Yes	Yes	They are afforded a better overall understanding	No			Yes	I feel it would be interesting	No	I feel neutral. I am neither	No
30	Used for teaching and examination purposes	Yes	No	Yes	Yes	Access to specimens at any time for learning	No	Educational		Yes	It is a good educational	No	Every part of the human	Yes
31	My institution makes use of plastinated	No	No	Yes	Yes	It allows students to have a more accurate	No	Artistic	Financial	Yes		No	I'm not sure, I haven't	No
32	Practical sessions and assessments	Yes	No	Yes	Yes	There is a cadaver storage, therefore plastinated	No	Educational		Yes	It is educational and also	No	If people consent to having	Yes
33	and freely accessible to students to	Yes	No	Yes	Yes	specimens to be preserved, over a long	No	Educational	Financial	Yes	allows the opportunity to	No	positions of plastinated	Yes
34	specimens in the anatomy museum	Yes	No	Yes	Yes	an imitation or drawing, It gives better	No	Artistic	Personal	No	would have done to you.	No	It is inappropriate	No
35	teaching during practical or lectures	Yes	Yes	Yes	Yes	self study	No	Educational	Financial	Yes	plastinated specimen in	No	Not acceptable	No
36	Utilized for practical learning	Yes	No	Yes	Yes	view, which textbooks don't allow	No	Artistic		Yes	great appreciation for the	Yes	Unnecessary	No
37	specimens in the anatomy museum	Yes	No	Yes	Yes	an imitation or drawing, It gives better	No	Artistic	Personal	No	would have done to you.	No	It is inappropriate	No
38		Yes	No	Yes	Yes	students	No	Educational	Financial	Yes	whole lot of information	No	never been to one before	Yes
39		Yes	No	Yes	Yes	and odourless therefore students can	No	Educational	Personal	Yes		No	deceased.	Yes
40		Yes	No	Yes	Yes	By making use of plastinated specimens	No	Artistic	Personal	No		No	I personally feel that it's	No
41		Yes	No	Yes	Yes	Plastinated specimens aid in learning	No	Educational		Yes		No	Inappropriate and disrespectful	Yes
42		Yes	No	Yes	Yes	Students can easily refer to plastinated	No	Educational	Financial	Yes		No	It doesn't really matter. At	Yes
43	Specimens are used for cadaveric dissection	Yes	No	Yes	No	the specimens are only vital for learning	No	Voyeuristic	Personal	No	the exhibitions are meant	No	although the specimens	No
44	The University of KwaZulu Natal uses	Yes	Yes	Yes	Yes	Sometimes the anatomy department runs	No	Educational	Financial	Yes	I would want to attend just	No	I personally have no problem	No

Appendix 4 – Raw Data

	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO
1	3.9.1) Please elaborate: 3.10)	3.11)	3.11)	3.11.1) Please elaborate: 3.12)	Children over the age 3.13)	Do you think th 3.14)	3.14)	3.14.1) Please elaborate: 3.15)	3.15.1) Please elaborate: 3.16)	3.17)	In your opinion what shou	
2	It depends on the type of	No	No	I would not donate my bo	Exposure to these display	Neutral	Yes	I do not think that the pers	No		No	The type of display should be s
3	I feel that it is fine for only	No	No	I would want to be buried	I feel this is wrong becaus	Neutral	Yes	The types of displays	No		No	Minimum age requirement, disp
4	I only say yes if the condi	No	No	The reason for this is as	If their parents feel they a	Neutral	No	For me, Human dignity ar	No		Yes	Unless it is purely for teaching
5	There is no benefit to view	No	No	It would be disrespectful t	This is utterly disturbing.	Strongly disagree	Yes	Did the person know what	Yes	It is unethical to use animals	No	It should purely be for education
6	It is ethically correct beca	No	No	It is against my religion	it is wrong, children shoul	Disagree	Yes	The sexual positions disp	Yes		No	People who donates their bodie
7	If the donors gave inform	Yes	No	I would not want my body	I feel like little children sh	Agree	No	No, it has been consenter	No		Yes	The donors must have given inf
8	Because the major object	No	No	because it will not contrib	I do not think its a good ic	Strongly disagree	Yes	Yea	No		No	Plastinated specimens should i
9	I would not like to have m	Yes	No	I do not want my loved on	Children's brains are very	Disagree	No	If the person knew what t	Yes	I don't think such exhibits shc	No	It should be solely for education
10	Because most people whi	No	No	I would want my body to t	Absolutely unethical and	Strongly disagree	Yes	Firstly, these bodies are f	No	Plastinated specimen do aid i	No	The criteria should consider divi
11	I think it is a nice way for	Yes	No	I would love to, but my far	I love that idea, although I	Strongly Agree	No	If they gave consent to th	Yes	I think we as black Africans fr	Yes	I think the people donating their
12	Only anatomists will be a	No	No	Just personal preference.	Unethical and ridiculous.	Strongly disagree	Yes	I don't think people who d	Yes	It should only be for institutio	No	Specific consent from the dono
13	I don't support display of s	Yes	No	Religious purposes	It shouldn't be allowed.	Neutral	Yes	Unethical and unnecessa	No	I don't support public display	Yes	A procedure should be followed
14	It is correct if the right pr	No	No	Personal reasons	I feel that the age restricti	Neutral	No	The donors provided prior	No		No	Donors need to be informed in
15	It is donated by the indivi	Yes	No	It's against my culture an	They are being exposed to	Strongly disagree	No	It's educational	Yes	I don't think private parts shou	Yes	Private parts should not be exh
16	Plastinations should be u	Yes	Yes	Yes if it is for science an	If they do not understand	Strongly disagree	No	Unless stated by the exhi	No		No	Participants need to be inform
17	if it for the right purposes	No	No	having seen what has bee	it may be good and it may	Neutral	Yes	If the person was not well	No		No	to make the person well inform
18	if only the deceased was	No	No	for religious purposes	i think there age permitte	Disagree	Yes	these plastinations remain	No	n/a	No	people should be told what ex
19	as long as the deceased	Yes	No	personally, I would not wa	think the minimum age s	Disagree	No	they do not violate human	Yes	I am not sure whether, when t	No	the deceased or his/her family i
20	Once the bodies have bee	Yes	Yes	I can donate my body for	Such explicit displays sh	Disagree	No	Once a body is given for	No	there's nothing ethically wron	Yes	appropriate consent from donor
21	the ones that ive seen in	Yes	No	i would donated my body	oh no no no the age restri	Strongly disagree	No	if they are exhibited prop	No	my culture has no say about	Yes	have them correctly placed. in
22	they may not understand	No	No	religious reasons	it may affect them psych	Disagree	Yes		Yes	yes, maybe excit	no	should be for those involved in t
23	Educational purposes, no	Yes	No	its against my belief	I don't think it is apropiat	Neutral	Yes		the pers	No	no	no
24	If I consented to	With i	Yes	I love art	The parents cedide to exp	Neutral	No		Yes	I'm supportive to such exhibit	Yes, if one is running a business they n	
25	Can be both. If for educati	Yes, (No		Definitely No, Must have an age restriction over 16	Agree	No	No		Yes,		Not too	No
26	It depends on the specim	Yes	No	Cultural reasons	They are too young to eve	Disagree	Neutral					I think e. The most importanat thing shou
27	There are laws protecting	Yes	No	I would only consider don	I think its a great idea as	Strongly Agree	No	If the exhibits were donate	No	I do not have any ethical rese	No	The exhibits are treated and ha
28	Yes and No. For educatio	Yes	No	For religious reasons my	In this instance I fully dis	Strongly disagree	No	If the person donating is fi	No		Yes	The individual donating their bo
29	The way disrespect the id	Yes	No	Personal	I feel that it is poor ethical	Disagree	Yes		Neutral		Yes, if t	Medical and health care related
30	It is not for harm but rathe	Yes	No	Personal reasons	Learning can be for all ag	Agree	No		No		No	No photograph/ Non-profit
31	I think that individuals don	Yes	No	However, I would consider	I think it is entirely up to t	Strongly disagree	Yes	I am not sure of the ethic	Yes	I personally believe plastinate	Yes	I think if there is a written conse
32	Plastinates provide stud	Yes	No	I have the intention to don	It is an educational tool fo	Agree	No	Each donor has the right I	No		No	Informed consent. The family of
33	consent was and is given	Yes	Yes	an understanding of the	the knowledge and	Agree	No	the donor has been	No	responsibility of the	Yes	the purpose and intent of the ex
34	demeaning to humanity	No	No	My body is sacred	little children to such a	Strongly disagree	Yes	body should be	Yes	wrong and unethical	No	studies that deals with the hum
35	purposes not for profit	No	No	religious reason	displays children age	Agree	Yes	purpose	No	fully informed if the there	No	no monetary gain
36	morally if consent was	No	No	people who attend the	age may be beneficial	Disagree	Yes	only way the exhibit	Yes	consent	Yes	Consent of deceased
37	demeaning to humanity	No	No	My body is sacred	little children to such a	Strongly disagree	Yes	body should be	Yes	wrong and unethical	No	studies that deals with the hum
38	little graphical to	Yes	No	prefer to be buried	learn at an early age	Strongly Agree	No	gives people know about	No		Yes	so that people would be aware
39	For educational purposes	Yes	No	dies,he or she must be	by themselves if they	Disagree	Yes	respected,they don't	No		No	cause in most time they are for
40	Plastinates should be use	Yes	No	As an organ donor there v	There should be an accep	Strongly disagree	No	Dignity is something that	No		Yes	Informed consent of the donor s
41	So long as consent is gra	Yes	No	I wouldn't want MY body t	Inappropriate	Disagree	No	So long as exhibitions po	Yes	The way in which the specim	No	Consent should be mandatory a
42	Provided that permission i	No	No	It is a personal choice.	An individual should decid	Neutral	No	Consent had to have beer	Yes		Yes	Only individuals over the age of
43	religion and most cultures	No	No	i do no find it respectful to	I am totally against this n	Strongly disagree	Yes	The exhibits are displaye	Yes	i think that not all bodies use	No	these exhibits should have deta
44	Due to differences in belie	Yes	No	My belief system requires	To its fine as long as the	Neutral	No	If the exhibition followed a	No	I have no issues with them as	Yes	The plastinated specimens shou

Appendix 5 – Statistics

	@1.9Occupation	@1.10Religiousaffiliation	@2.1	@2.2	@2.3	@2.3.1Ifyespleaseelaborate	@2.4Isyourinstitution	@2.5Isthepublic	@2.6Inyourpinion	@2.7Coyo	VAR00001	perc_cat	Usage
1	Academic	Hindu	Yes	Yes	Yes		Yes	Yes	No	Yes	6.00	2.00	1.00
2	Academic	Hindu	Yes	Yes	Yes	Practical sessions and assessments	Yes	No	Yes	Yes	7.00	3.00	1.00
3	Academic	Christian	Yes	No	Yes	Used during practical sessions (sometimes)	Yes	No	Yes	Yes	6.00	2.00	1.00
4	Academic	Christian and Tradi...	Yes	Yes	No		Yes	No	Yes	Yes	5.00	2.00	2.00
5	Academic	Christian	Yes	Yes	Yes	Plastinated specimens are used during practicals for all allied health sci...	Yes	Yes	No	Yes	7.00	3.00	1.00
6	Academic	Christian	Yes	Yes	Yes	Plastinated specimen are used to teaching during practical or lectures a...	Yes	Yes	Yes	Yes	8.00	3.00	1.00
7	Academic	Christian	Yes	Yes	Yes	Limited use teaching and assessments	Yes	No	Yes	Yes	7.00	3.00	1.00
8	PG Honours	Christian	Yes	Yes	Yes	Plastinated specimens are used during practical demonstrations to stud...	Yes	No	Yes	Yes	8.00	3.00	1.00
9	PG Masters	Muslim	Yes	Yes	Yes	It was used for practicals and sometimes lectures and tutorials.	Yes	No	Yes	Yes	8.00	3.00	1.00
10	PG Honours	Traditional African ...	Yes	Yes	Yes	Some are showcased in the Anat museum and others are used for dem...	Yes	No	Yes	Yes	8.00	3.00	1.00
11	PG PhD	Hindu	Yes	Yes	Yes	Students use plastinated specimens to study from in the DH, there are ...	Yes	No	Yes	Yes	8.00	3.00	1.00
12	PG Honours	Christian	Yes	No	Yes		Yes	No	Yes	Yes	3.00	1.00	2.00
13	PG Masters	Christian	Yes	Yes	Yes		No	No	Yes	Yes	5.00	2.00	2.00
14	PG PhD	Muslim	Yes	No	No		No	No	Yes	Yes	3.00	1.00	2.00
15	PG Honours	Christian	Yes	No	Yes		Yes	No	Yes	Yes	5.00	2.00	2.00
16	PG Masters	Christian	Yes	Yes	Yes	H Plastinated specimens are much easier to use and handle and its ret...	Yes	No	Yes	Yes	7.00	3.00	1.00
17	PG Honours	Christian	Yes	Yes	Yes	They bring them out during class to explain some things. We can also l...	Yes	No	Yes	Yes	7.00	3.00	1.00
18	PG Masters	Christian	Yes	Yes	Yes		Yes	No	Yes	Yes	6.00	2.00	1.00
19	PG Masters	Muslim	Yes	Yes	Yes	Plastinated specimens are available to all students registered for anato...	Yes	No	Yes	Yes	8.00	3.00	1.00
20	PG Masters	Christian	Yes	Yes	Yes		Yes	No	Yes	Yes	5.00	2.00	1.00
21	PG Honours	Christian	Yes	Yes	Yes	We learn the anatomical structures from plastnated specimen	Yes	No	Yes	Yes	7.00	3.00	1.00
22	PG Masters	Christian	Yes	Yes	Yes	Lectures/practicals museum display	Yes	No	Yes	Yes	7.00	3.00	1.00
23	PG Honours	Christian	Yes	No	Yes	during practicals for better understanding on what was done in a lecture	Yes	No	Yes	Yes	6.00	2.00	1.00

	3.12Childrenovertheageof2yearsoldarepermittedtoentertheseexhibi...	VAR00005	occ	edc	rel	lern	Per_cata	perc_PD_cat	Occupation	Perc_Edc_Cat	Age
1	tance I fully disagree with this practice. The supposed reason for th...	6.00	2	3	3	2	2.00	2.00	1	2.00	2
2	ucational tool for children. Since children are allowed to enter other...	7.00	2	3	3	3	3.00	3.00	1	3.00	2
3	oo young to even understand what they are looking at and some m...	2.00	2	2	2	3	2.00	1.00	1	2.00	2
4	ts cedide to expose children to such exhibitions	6.00	2	3	2	3	2.00	2.00	1	2.00	2
5	a great idea as children start to build their interest in Anatomy from...	5.00	2	3	2	2	3.00	2.00	1	3.00	2
6	e sex emulating displays children age limits should be reconsidere...	3.00	4	2	2	3	3.00	1.00	1	3.00	2
7		4.00	2	4	2	3	3.00	2.00	1	3.00	3
8	to these displays at an age without complete understanding is an i...	2.00	3	2	2	3	3.00	1.00	2	3.00	1
9	is wrong because they do not understand these thins yet. They sh...	2.00	4	2	3	3	3.00	1.00	2	3.00	1
10	ents feel they are ready to see such, I don't have any problems wit...	5.00	3	2	3	3	3.00	2.00	2	3.00	1
11	erly disturbing. There are age restrictions for movies, why would a00	5	3	3	3	3.00	1.00	2	3.00	3
12	y, children should be protected from such experiences until they ar...	2.00	3	2	2	3	1.00	1.00	2	1.00	1
13	ittle children should not be allowed to enter considering the "exotic...	8.00	4	3	2	3	2.00	3.00	2	2.00	1
14	ink its a good idea to expose children	1.00	5	3	3	3	1.00	1.00	2	1.00	3
15	brains are very easily influenced and witnessing such exhibits ma...	3.00	3	2	2	3	2.00	1.00	2	2.00	1
16	y unethical and wrong to allow children at this age into the the exhi...	3.00	4	2	2	3	3.00	1.00	2	3.00	1
17	idea, although I'm not sure about the exotic poses. But I would tak...	5.00	3	2	2	3	3.00	2.00	2	3.00	1
18	and ridiculous, I did not know this.	1.00	4	2	2	3	2.00	1.00	2	2.00	1
19	't be allowed.	3.00	4	2	3	3	3.00	1.00	2	3.00	1
20	the age restrction is too low - it should be raised to 18 years and ol...	5.00	4	2	2	3	2.00	2.00	2	2.00	2
21	being exposed to things they should not see	7.00	3	2	2	3	3.00	3.00	2	3.00	1
22	not understand what they are looking at and cannot appreciate the ...	4.00	4	2	2	3	3.00	2.00	2	3.00	1
23	may be good and it may be bad, depending on what is displayed i...	2.00	3	2	2	3	2.00	1.00	2	2.00	1