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# *Playful Learning for Anatomy: Using Play-Doh to Visualise the Heart*

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*Mastery of cardiovascular skills and knowledge has long been challenging for students, with higher order thinking proving difficult despite modern technological advancements, and well-established approaches like dissection. We therefore sought to incorporate active, playful learning into our foundation instruction in Cardiovascular Anatomy and Physiology. Seventy-seven Foundation Year students undertook an online didactic lecture and then one week later, attended the playful learning session where they used Play-Doh to make a detailed model of the human heart under the instruction of an academic, consolidating their prior learning. They were given a post activity, five-point Likert questionnaire, with four additional open answer questions, and responses were analysed using a weighted average ($\bar{x}_w$) as a threshold for positive response. Broadly, students enjoyed and would repeat a playful activity, and felt that the activity increased their interest, improved their knowledge, identified their weaknesses, checked their existing knowledge, and allowed them to interact with their team, but students did not feel that they were able to learn more than in traditional activities per se. Using Play-Doh to model the heart is a fun and effective way of teaching anatomy, and further research is needed to ascertain its impact on student outcomes.*

## Introduction

Mastery of knowledge and skills in general cardiology has always been a difficult task for undergraduate students (Greenberg and Mansour, 2022). In particular, the complexity of the anatomy of the heart, and the condensed time available for lectures, pose a difficult challenge (Chong *et al*., 2021). Irrespective of the wide range of audio-visual aids available (including whiteboard, PowerPoint presentations, YouTube videos and anatomical 3D heart models), it has long been known that deep learning and higher-order thinking are often difficult to achieve (Zohar and Dori, 2003). We therefore developed an active learning component to teach the anatomy of the heart, based on the Aristotelian thought 'for the things we have to learn before we can do them, we learn by doing them.'

The concept of incorporating playful learning activities in adult learning has been demonstrated in a few studies (Rice, 2009; Nerantzi *et al*., 2015). When students are captivated in a playful activity, it has the potential to increase learning while simultaneously increasing student satisfaction (Csíkszentmihályi, 2022). At present, within our Bioscience programmes, students are encouraged to contextualise their learning of heart anatomy through kinaesthetic and active learning approaches such as conducting sheep heart dissections. The use of dissection has been a pillar of anatomical learning for generations and, even now, students seem to feel that it increases their three-dimensional understanding of the subject (Kalthur *et al*., 2022). However, in some early dissection classes, students often require more guidance and follow a numbered methodology step by step, which can limit opportunities for creative or explorative learning as they may seek more structured support. Although medical students typically favour dissection during their pre-clinical training to solidify foundational knowledge before clinical studies (Webb *et al*., 2022), its effectiveness within a Foundation cohort remains uncertain. Some students in this cohort may already struggle with grasping basic concepts in heart anatomy as they are new to anatomy or experiencing initial anxieties, prompting the need for supplementary anatomical learning activities before dissections are carried out.

It has long been known that student engagement increases when learning under a state of emotional arousal (Dolcos *et al*., 2004). Therefore it could be argued that as educators, we should be trying to create activities which enhance happiness and creativity. Additionally, with the increase in mental health problems, such as depression and anxiety, in young adults in a post-pandemic world (Hitch and Zaman, 2022; Zhang, 2022; Farfán-Latorre *et al.*, 2023), there is more need than ever for positive emotional experiences in teaching.

Play-Doh is a popular clay modelling compound used by young children, and for adults born after the 1950s it has the capacity to evoke emotions of nostalgia and happiness whilst adding a creative twist to a learning activity. Previous studies have shown that modelling of anatomical clay increased knowledge retention and improved attitudes towards learning in class (Herur *et al*., 2011). Therefore, with the aim of increasing engagement and learner enjoyment, we created an activity using Play-Doh to model the anatomy of a heart.

## Methodology

### *Activity*

This study was conducted with Bioscience Foundation Year students at the University of Surrey. The inclusion criteria for the study was that all the participants had to be Foundation Year Bioscience students. Seventy-seven foundation students undertook the following activity. Traditionally, students would be expected to attend a 90-minute heart anatomy class, then would engage in a dissection laboratory the following week without the inclusion of a Play-Doh session in-between. In this activity, all students were first taught about the different parts and circulatory system of the heart using a PowerPoint presentation in a 60-minute lecture delivered online using Panopto. The week after the lecture, the students attended a two-hour active learning class using Play-Doh to consolidate knowledge they had been previously taught. Students were expected to make a model of the heart under the supervision and guidance of an academic. Students were first asked to prepare the external anatomy of the heart using coloured dough, and by using a 3D heart model for guidance (Figure 1).

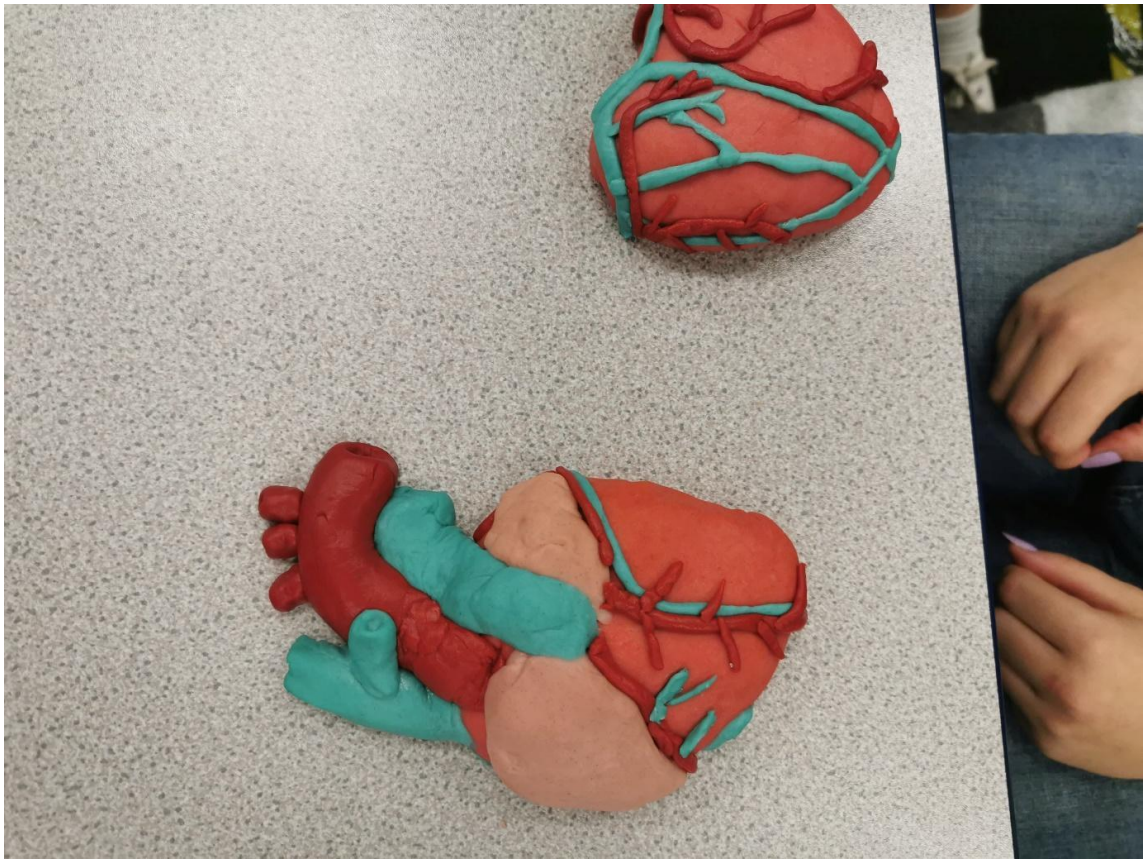

Figure 1: Heart model created by a respondent.

Students were told that their heart model should contain the following components: auricles, pulmonary veins, aorta, inferior vena cava, superior vena cava, pulmonary artery, interventricular septum and apex (appendix 1).

Later, the students were instructed to add the vessels of the coronary circulation. After finishing the task, students were asked to demonstrate and explain the different parts of the heart that they had modelled, which comprised the assessment part of the class. The week after the Play-Doh activity, students attended a dissection laboratory (two hours), where they dissected a pig or sheep heart.

### *Analysis*

Students were given a post-activity questionnaire (Manzano-León *et al*., 2021) immediately after completing the activity in October 2023, consisting of sixteen questions addressed via a five-point Likert Scale from 1 (Strongly Disagree) through 3 (Neither Agree nor Disagree) to 5 (Strongly Agree) as follows:

> *Following your participation in this learning activity, to what extent do you agree with the following statements?*
>
> *In general, I have enjoyed this playful activity*
>
> *I would repeat these types of activities*
>
> *I have felt motivated*

*I improved my knowledge of the subject*

*My interest in the subject has increased*

*This activity format has been appropriate to check my knowledge of the subject*

*This activity format has helped me identify my weaknesses in the subject*

*It helped me understand the content of the subject*

*With these types of activities, I learn more*

*I feel like I was able to connect with my teammates to learn*

*I learned from my classmates during the activity*

*I found the game elements fun*

*The game elements have motivated me to carry out the activity*

*While playing I was not aware of what was happening around me*

*I felt capable of carrying out the proposed activities*

*I found the activities comforting and valuable to me*

There were then four questions addressed by open answer as follows:

*Were there any obstacles with participating in the activity?*

*If yes, what were these?*

*In your view what worked well with the activity?*

*In your view what could be improved with the activity?*

Data were collated and responses logged from 1 to 5 for statistical analysis, while responses for each question were calculated as a percentage. Open ended questions were analysed for repeated themes and presented as direct quotes for enrichment of discussion.

### *Ethical Considerations*

A member of the research team communicated the objectives of the questionnaire, the confidentiality of information provided, and ethical considerations to the prospective participants. All participants were provided with an information sheet and informed consent was required prior to starting the questionnaire. Approval for administration of this survey was obtained from the University of Surrey ethics Committee (FHMS 21-22 264).

### *Statistical analysis*

Data were analysed in IBM SPSS Statistics (SPSS) version 29.0.1.0 to calculate mean, standard deviation (STDEV) median, and mode of each question.
Weighted average ($\bar{x}_w$) was calculated as follows:

$$\bar{x}_w = \frac{\Sigma\bar{x}}{\Sigma L}$$

Where Σx̄ is the sum of the mean score (1-5) of each Likert question and ΣL is the total number of Likert questions, i.e., 16.

A mean percentage score (see table 1) of respondents greater than the $\bar{x}_w$ was then set as a threshold for a positive perception to the Likert question (Alonazi *et al*., 2019; León-Mantero *et al*., 2020).

## Results

This activity was a teacher-centred method of instruction, where kinaesthetic learning was employed. There was a potential population of 77 students and there were 42 responses to the questionnaire (a response rate of 58%). Weighted average was calculated as described in the methodology, where the $\Sigma\bar{x}$ was calculated to be 62.89, divided by $\Sigma L$ (16), giving a $\bar{x}_w$ of 3.93. The full results are presented in Table 1, but in summary the students appeared to enjoy the playfulness of the activity, with 88% of respondents giving a positive response, and 40% strongly agreeing with the statement. 76% of respondents agreed that they would like to repeat the activity. Interestingly, although 67% said that it motivated them, this fell below the $\bar{x}_w$. 7% did not enjoy the playfulness of the activity, 10% would prefer not to repeat the activity and 12% felt it did not motivate them (Figure 2).

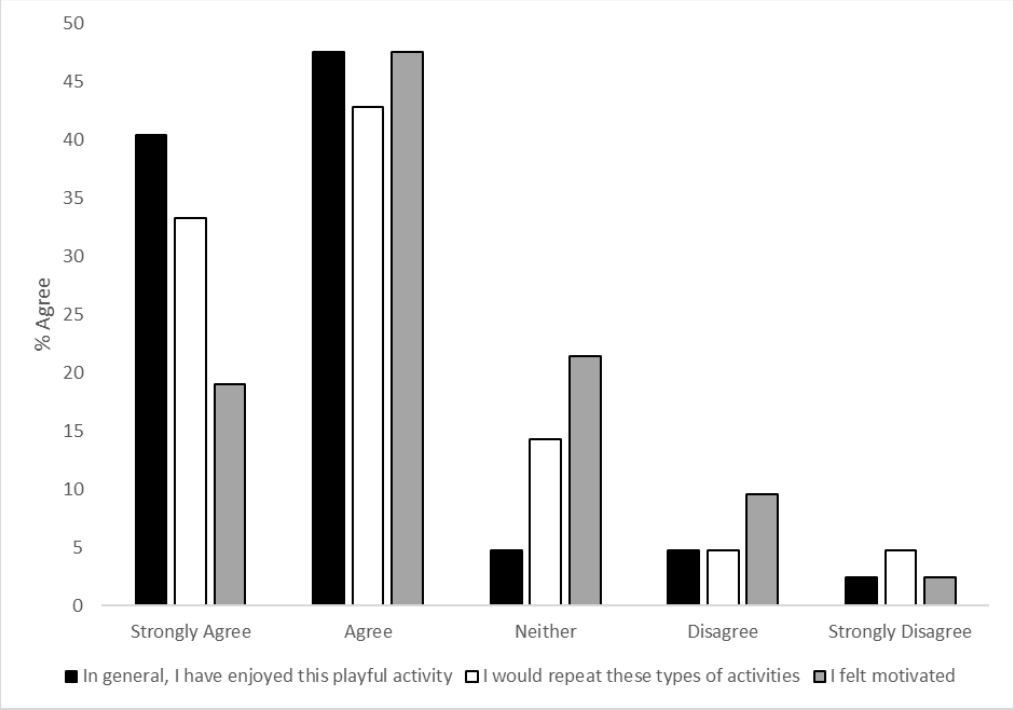


Figure 2: Responses Regarding Student Enjoyment of, and Motivation by the Playful Activity.

90% of students reported that the activity improved their knowledge of cardiac anatomy, 71% reported that it increased their interest in the subject and 83% felt the new format was appropriate to check their knowledge. Most interesting was that despite 5% of respondents not wanting to repeat this type of learning activity, there were no respondents who felt it did not increase their knowledge on the subject.

83% of students felt the playful method helped identify weaknesses in their knowledge of cardiac anatomy, with 2% disagreeing with the statement, and 90% felt it helped them understand the content of the overall subject area. While 67% agreed that this type of activity helps them learn more, this fell below the $\bar{x}_w$. Regarding the latter statement, 21% were indifferent, and 12% disagreed.

Regarding teamwork, 81% of students felt they were able to connect with their team during the activity, and 76% felt that they learned from their teammates during the activity. Only 5% and 10% respectively disagreed, however the response to the second statement was below $\bar{x}_w$.

The students found the game element fun (86%) and motivating (78%), with only 2% not finding it motivating. 2% of students did not find the game element fun and 2% strongly disagreed that the gamification was fun. Only 33% of students lost themselves in the activity, with 31% disagreeing with the statement that they were not aware of what was happening around them, and 36% indifferent to the statement, which was below $\bar{x}_w$. All students felt capable of carrying out the task and only 7% of respondents found the activity to not be valuable. This response was again, below the $\bar{x}_w$.

| | SA (5) (%) | A (4) (%) | N (3) (%) | D (2) (%) | SD (1) (%) | MEAN (SCORE) | STDEV (SCORE) | MEDIAN (SCORE) | MODE (SCORE) | DECISION (AU) |
|---|---|---|---|---|---|---|---|---|---|---|
| **In general, I have enjoyed this playful activity** | 41 | 48 | 5 | 5 | 2 | 4.19 | 0.92 | Agree | Agree | Positive |
| **I would repeat these types of activities** | 33 | 43 | 14 | 5 | 5 | 3.95 | 1.06 | Agree | Agree | Positive |
| **I felt motivated** | 19 | 48 | 21 | 10 | 2 | 3.71 | 0.97 | Agree | Agree | Low |
| **I improved my knowledge of the subject** | 36 | 55 | 7 | 0 | 2 | 4.21 | 0.78 | Agree | Agree | Positive |
| **My interest in the subject has increased** | 29 | 43 | 24 | 5 | 0 | 3.95 | 0.85 | Agree | Agree | Positive |
| **This activity format has been appropriate to check my knowledge of the subject** | 21 | 62 | 10 | 5 | 2 | 3.95 | 0.85 | Agree | Agree | Positive |
| **Helped me identify my weaknesses in the subject** | 26 | 57 | 14 | 2 | 0 | 4.07 | 0.71 | Agree | Agree | Positive |
| **It helped me understand the content of the subject** | 24 | 67 | 7 | 2 | 0 | 4.12 | 0.63 | Agree | Agree | Positive |
| **With these types of activities, I learn more than in traditional classes** | 21 | 45 | 21 | 12 | 0 | 3.76 | 0.93 | Agree | Agree | Low |
| **I feel like i was able to connect with my teammates to learn** | 33 | 48 | 14 | 5 | 0 | 4.10 | 0.82 | Agree | Agree | Positive |
| **I learned from my classmates during the activity** | 24 | 52 | 14 | 10 | 0 | 3.90 | 0.88 | Agree | Agree | Low |
| **I found the game elements fun** | 21 | 64 | 10 | 2 | 2 | 4.00 | 0.80 | Agree | Agree | Positive |
| **The game elements have motivated me to carry out the activity** | 24 | 55 | 19 | 2 | 0 | 4.00 | 0.73 | Agree | Agree | Positive |
| **While playing i was not aware of what was happening around me** | 14 | 19 | 36 | 26 | 5 | 3.12 | 1.11 | Neither | Neither | Low |
| **I felt capable of carrying out the proposed activities** | 21 | 67 | 12 | 0 | 0 | 4.10 | 0.58 | Agree | Agree | Positive |
| **I found the activities comforting and valuable to me** | 17 | 50 | 26 | 7 | 0 | 3.76 | 0.82 | Agree | Agree | Low |

Table 1: Responses to student perceptions of a gamified Cardiac Anatomy session. SA = Strongly Agree, A = Agree, N = Neither Agree nor Disagree, D = Disagree, SD = Strongly Disagree. Positive denotes mean score is above the $\bar{x}_w$ for the response, Low denotes the mean score is below the $\bar{x}_w$ for the response.

## Discussion

The main findings of this work are as follow. Firstly, students enjoyed and would repeat a playful activity in their learning of cardiac anatomy. Secondly, students felt that the activity increased their interest, improved their knowledge, identified their weaknesses, and checked their existing knowledge. Thirdly, the activity allowed them to interact with their team. Finally, students did not feel that they were able to learn *more* during the activity than in traditional activities *per se*.

The use of gamified sessions in education is not a new idea and there is strong evidence for its efficacy with regards to motivation and student engagement (Boyle et al., 2016). However, these gamified approaches often focus on outcomes, competition and even extrinsic reward (Deci *et al*., 2001; Söbke, 2019). This activity focused on playful learning and, as previously mentioned, with poor mental health being so prevalent in university students, to the extent that mental disorders even pre-pandemic were present in 33% of first-year students in 19 colleges across 8 countries (Auerbach *et al*., 2018), it could well be argued that educators must foster an environment where academic attainment is nurtured through joy. Playfulness, though poorly described in adults (Guitard *et al*., 2005) is intrinsically linked to positive emotions (Yarnal, 2006). Indeed, when adults are asked 'what does it mean to you to be playful?' five key areas emerge: a positive outlook, activities, relationships, humour, and experiencing life (Lubbers *et al*., 2023). If thought of as a personality trait, playfulness is found to be a key element in the ability to regulate one's emotions (Gordon, 2014), particularly in the domain of coping strategies. Indeed, there is emerging evidence to suggest that adult playfulness positively impacts on perceived self-efficacy, and perceived helplessness (Clifford *et al*., 2022) which when viewed alongside its long-known positive interaction with dealing with difficult life-events (Bundy, 1993) suggests quite powerfully that adult playfulness is an important coping resource that higher education facilitators should encourage.

Play is regarded as not only a fundamental component of the human experience, but also a valuable way to improve pedagogical practice (Nørgård *et al*., 2017), so it makes intuitive sense that educators should incorporate it more. Indeed, recent research has shown that play is relevant to learning in three key areas as follows: physical and mental resilience, social intelligence, and cognitive flexibility and intellect (Koeners and Francis, 2020), which all comprise modern graduate attributes (Wong *et al*., 2022).

The students both enjoyed this activity and found it fun, and the staff delivering the session reported that students were eager to participate in modelling Play-Doh and were enjoying using their hands to learn. Given that 'create' is at the top of the revised Bloom's taxonomy (Anderson, 2009), it can be suggested that this activity was giving students the opportunity to synthesise what they had learnt previously in the pre-recorded lectures. The ability to create sculptures requires a high level of critical thinking, a key graduate attribute long-valued by employers (Pithers and Soden, 2000), and one in which previous cohorts of foundation year students are (in the authors' experience) often lacking. Not only this, but the activity also proved to be an enjoyable way of formatively assessing students in anatomical terminology. Previous cohorts of foundation students in our programmes have utilised traditional dissection to achieve a similar learning outcome as this activity. However, some students feel uncomfortable working with these specimens for, for example religious and/or dietary reasons, and that modality suffers from the low effectivity of passive learning (Richardson and Birge, 1995; Krontiris-Litowitz, 2003). Indeed, previous research has shown that students carrying out cadaveric dissection can have a combination of physical and emotional responses to cadavers in the dissection room from eye soreness and dizziness through to depression, guilt and anxiety (Lee *et al*., 2011). Interestingly, the current literature suggests that there is no difference be-

tween the sexes or major religions (Christian and Muslim) in the levels of self-perceived anxiety prior to their first encounter with a cadaver (Asante et al., 2021). There is however, evidence that the other major Abrahamic religion has more issues with the balance between faith and science when considering cadaveric samples (Notzer et al., 2006). There is also compelling evidence that simply holding a belief that there is a soul is more important than an adherence to a particular belief or faith is the more important determinant when it comes to pre-dissection anxiety (Martyn et al., 2014). The kinaesthetic activity presented in this case study could therefore ultimately have a greater impact in the long and short-term, allowing the students to have the three-dimensional learning aspect found in dissection, but without the anxiety, compared to students making team presentations, drawings or purchasing a pre-made model of the heart (Richardson and Birge, 2000; Nageswari et al., 2004).

### *Impact*

Students seemed interested and engaged about making their own heart models, as they were activity involved in making something and thinking about where each component originated and where each blood vessel innervated.

Responses to the open-ended question 'In your view what worked well with the activity?' were as follow:

> *Interactive and highlighted areas that need revising*
>
> *Able to identify parts of the heart easily and see what I needed to improve on*
>
> *The playfulness*
>
> *Visualising where everything is*
>
> *We were able to look at each vessel carefully and distinguish the differences on the back and the front*
>
> *Interactive meant I learnt more about the physical structure*
>
> *Fun and engaging*

They thought that learning anatomy by modelling Play-Doh was a much more pleasurable experience, compared to using a textbook or completing a worksheet labelling activity. Given that all students found it difficult to visualise the heart in 3D previously, this topic was specifically chosen for the activity.

Eftekhar *et al*. (2005) reported that some medical students were uncomfortable and showed initial resistance to the use of Play-Doh in surgical training; however, the feedback from these students was positive. Many students expressed gratitude and few students asked if more anatomy classes could include Play-Doh in the future. Many students compared the experience to their positive memories at primary school, and stated that this mode of learning was very effective in retaining information for their class exams. Among the student comments were:

> *This exercise was a new learning experience for me at University. It was really fun and I think I can visualise what I had modelled for the exam by memory, as I thought about every step when making the heart model*.

> *This lesson was super fun and brought back memories of being at nursery school, where learning was through playing. I usually struggle and stress out when I have to read anatomical textbooks, but this method of teaching calmed me down, and I can actually remember all the parts of the heart now.*

It is crucial to acknowledge some limitations to this study. Experiences shared may not represent the entire Foundation Year Bioscience student population, but the response rate was adequate (Babbie, 1990; Schutt, 2015). Participants' responses reflect their opinions at a specific moment, subject to change over time. Our sampling method was not designed for broad representation, potentially limiting generalisability to other academic institutions within the country, and the lack of a control group cannot go unmentioned. As with any questionnaire, there is always discussion to be had about the reporting of the central tendency (Wilcox and Keselman, 2003; Viswanathan et al., 2004) and whether mean, median or mode should prevail as the measure of central tendency. We deliberately chose to use the weighted average as the measure of central tendency to help more robustly discriminate between how influential or not each domain of the questionnaire was (Tastle et al., 2005; Alonazi et al., 2019). We would also point out that the claims made in this study could have been further substantiated by formally questioning the staff delivering the sessions; however we chose deliberately to focus this work on the student perception of the playful activity. Furthermore, when considering the use of Play-Doh in this activity it should be noted that modelling clay can be expensive to buy and it is often not reusable as it can dry up over time, and can become contaminated if used alongside cadaveric material; furthermore the mixing of colours can pose a challenge (Keenan et al., 2017).

Future research could investigate the relationship between examining the durability of knowledge retention achieved through this Play-Doh modelling and contrasting it with the recall efficiency of traditional teaching approaches. Researchers may also extend their inquiries to the cross-disciplinary application of this approach, assessing its effectiveness in modelling other anatomical structures.

In summary, using Play-Doh to model the heart is an enjoyable and effective way of teaching anatomy. Play-Doh is low-cost, minimises the need for cadavers and is also readily available. Further research is required to ascertain if the impact of playful learning extends to increased grades.

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