

Giant Tours

Creative Science Workshop Exploring the Human Body with Primary-age Children

Evaluation Report

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1. Introduction

I was invited by MakeBelieve Arts in October 2010 to become an advisor on evaluation, scientific content and pedagogy for an application to the Wellcome Trust People Awards for a creative science workshop aimed at primary schools, provisionally entitled 'Looking after a Giant'. **The workshop proposed to help children become more aware of body systems – digestion, circulation, immune – ways of keeping healthy and issues relating to biomedical science such as ethics.** Once the grant had been awarded by Wellcome Trust I participated in a planning day for the workshop in June 2011, during which the idea of taking a 'tour' around a giant – 'Giant Tours' – emerged. The workshop was subsequently developed by the MakeBelieve Arts team and I attended its first pilot sessions with groups of children on 17th October 2011. I worked with the team to develop a number of evaluation instruments for use with children and their teachers, some of which were used during the first pilot. Further data were collected using these instruments during subsequent pilots and forwarded to me for analysis. This report summarises the findings from the data collected.

2. Evaluation Methodology

The key questions which this evaluation sought to answer were:

1. How has children's awareness of internal body organs associated with digestion, circulation and defence against infection changed through participation in the 'Giant Tours' workshop
2. What other learning is evidenced through children's and teachers' comments (for example, concerning the ethical implications of biomedical research)?
3. What features of the workshops have – in teachers' views – been important in engaging the children in a creative experience of science learning?
4. What suggestions do teachers and children have for further development and enhancement of the workshop?

In order to address question 1, we used a simple pre-test/post-test methodology using a range of instruments administered immediately prior to children's participation in the workshop, and immediately afterwards. These were:

1. A blank body outline in which children were invited to draw their ideas about the internal organs associated with the body systems. This is an approach which has been used by Osborne *et al.* (1992). The first version of this instrument (appendix 1) focused only upon the digestion system, and was used with 14 Y5 children during the first pilot on 17.10.11 and 19 Y2 children on 18.10.11. The second version (appendix 2) asked for organs associated with the digestive and circulatory systems, in pencil and pen respectively to determine which organ children associated with each system. This was used with 25 Y4 pupils. A third version (appendix 3) asking children to draw and label 'all the parts that are inside the body' was used with 22 Y3 pupils.
2. Free text boxes inviting children to draw or write about what could give them an 'upset tummy' (potential sources of infection or poor diet) and their ideas about remedies (e.g. medicines or factors leading to a healthier lifestyle) (appendix 4). These were only used with the first two pilot groups (14 Y5 children and 19 Y2 children).

3. An activity to match pictures of the main organs introduced during the workshop with short descriptions of their functions (written in similar language to that used during the workshop) (appendix 5). These were used with 20 Y3 children.
4. An activity to identify organs from a list associated with the three main body systems introduced during the workshop (digestion, circulatory and immune) (appendix 6). This was used with 15 Y3 and 27 Y4 children.

To provide further background data concerning children's knowledge about the human body before the workshop, we asked their teachers to fill in a brief questionnaire (appendix 7). 25 were returned.

To address question 2 we used observations of children during the first pilot workshop (on 17.10.11) and teachers' observations of their class during subsequent workshops (appendix 7). This gave a total of 24 observations. Additionally, teachers questioned the children at the end of the workshop about what they had learned and noted their responses.

To address questions 3 and 4 we included a section in the teachers' questionnaire (appendix 7) inviting them to comment on the aspects of the workshop which had most engaged learners, together with any suggestions they had for further development.

3. Findings



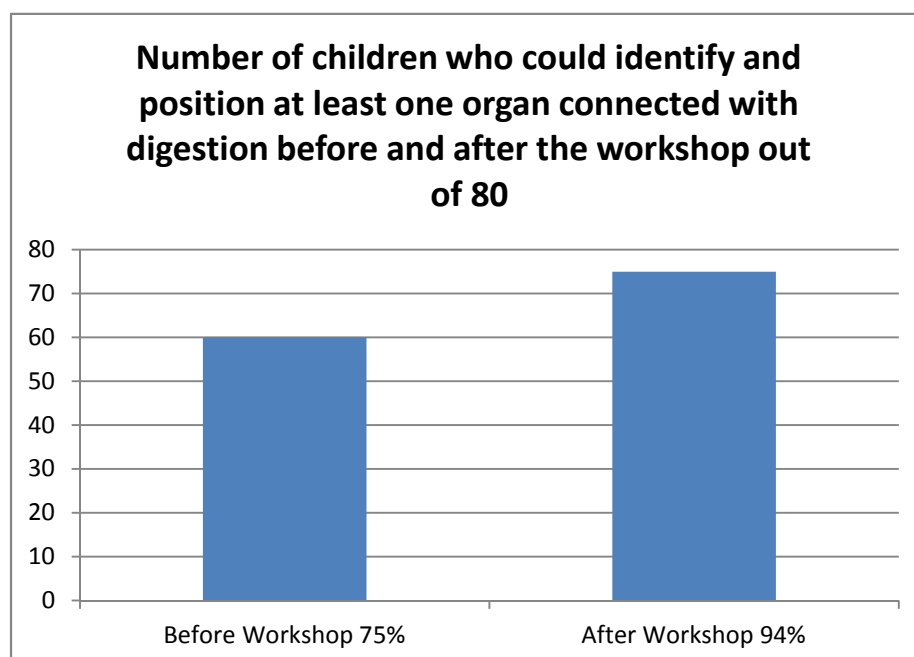
3.1 Children's awareness of internal body organs

From the children's drawings (appendices 8-11), **the average number of internal organs identified before the workshop was 2.9, which rose to 4.1 after the workshop.** However, only in the case of the Y3 class (appendix 10) were children asked to draw all the organs they could think of, so using only these data the averages are 4.6 and 6.0 respectively. Overall, the number of organs correctly positioned also rose from an average of 2.9 to 4.1, with evidence of greater complexity in 52 of the 80 'after' drawings (65%). From the body parts matching activity (appendix 14) the average number of organs Y3 children could correctly match to their function rose from 1 out of 7 to 3 out of 7. However, as would be expected after only one intervention (the Giant Tours workshop) most children's ideas about their internal organs remained vague, with evidence from their drawings of confusion between systems (e.g. the tubes linking the mouth with the stomach and lungs).

3.1.1 Digestive system



From the teacher questionnaire, only 1 teacher (4%) reported having covered digestion during the two months of the current academic year, whilst 6 (24%) thought that children would have studied teeth and digestion during previous years. Of the 80 children who completed before and after drawings (appendices 8-12), 60 (75%) could identify and position at least one organ connected with digestion before the workshop. In most cases this was the mouth and/or stomach, though the stomach ('tummy') tended to be located lower in the abdomen than is anatomically correct. **After the workshop this had risen to 75 children (94%)**, whilst the mean number of organs linked to digestion rose from 1.5 to 2.8. This included evidence of greater awareness of organs such as intestines (in 34 drawings), the liver (in 28 drawings) and oesophagus (in 7 drawings). This is supported by data from the teacher questionnaire, where 7 teachers reported children's awareness of the intestines and 5 reported interest in the function of the liver after the workshop. Additionally, in the Y4 body systems matching activity (appendix 15), the number of children linking the liver with digestion rose from 3 (12%) to 13 (52%), though the other data relating to the digestive system from this instrument show little change after the workshop. In only very few of the children's drawings either before (9) or after the workshop (15) was there evidence of a journey of food through the digestive system.



3.1.2 Circulatory System

Two of the 25 teachers answering the questionnaire (8%) reported having covered aspects of circulation (e.g. function of the heart, pulse rate) during the current academic year, whilst none made specific reference to coverage in previous years (2 mentioned the 'main organs' whilst a further 5 referred to exercise, which may have been linked to circulation).

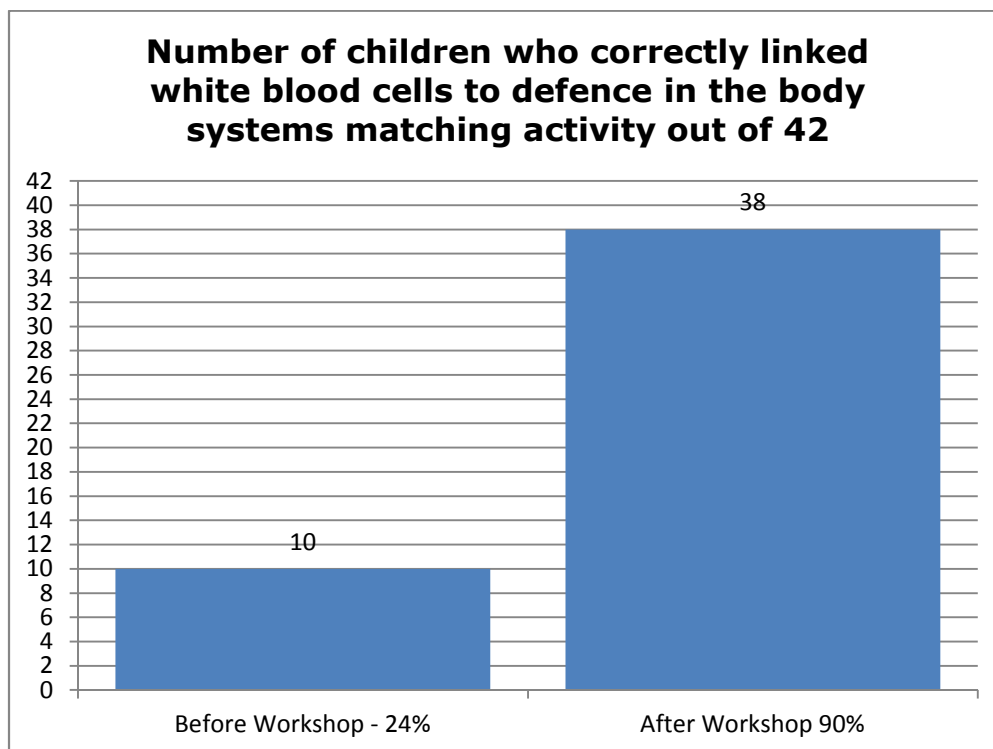
From the 47 Y3 and Y4 children's drawings (appendices 10 and 11), 42 children (89%) could identify at least one organ in the circulation system (usually the heart) before the workshop, whilst all could afterwards.

The average number of organs in the circulatory system identified rose from 1.4 before the workshop to 1.8 afterwards. These additional organs were the lungs in 9 drawings (19%), veins in 4 drawings (9%) and blood cells in 9 drawings (19%). This is supported by 7 teachers' observations of children discussing blood cells during the workshop and 10 reports of children discussing the job red blood cells do carrying oxygen and getting rid of carbon dioxide after the workshop. Also, in the body systems matching activity (appendices 14 and 15), **the number of children linking red blood cells to the circulation system rose from 9 (21%) to 28 (67%)**, though the numbers linking the lungs and veins did not show similar increases. Interestingly, there was no evidence of blood flow around the body in any of the Y3 drawings, either before or after the workshop, whilst the number of Y4 drawings showing blood flow increased modestly from 11 (41%) to 13 (48%). In two of the Y2 children's drawings of 'the places food goes when we eat', the focus shifted from digestion to circulation after the workshop, with some evidence of the flow of red blood cells, suggesting that this element had been significant for them.





None of the teachers reported having covered the immune system either during the current academic year or previously (though 5 mentioned coverage of 'health' in previous years, which may have touched upon how the body fights infection). This lack of coverage is unsurprising, given that the immune system does not feature in the National Curriculum for Science at either Key Stage 1 or 2. **From the Y3 and Y4 children's drawings (appendices 10 and 11), no children included reference to the immune system before the workshop, whilst 17 (36%) did afterwards.** These additions were either the spleen (4 drawings) or white blood cells (8 drawings). These data are supported by the body systems matching activity (appendices 14,15) **where correct linking of white blood cells to defence rose from 10 (24%) to 38 (90%);** and from 13 teachers who reported that children had been interested in the job of white blood cells fighting germs/viruses, 3 who commented on children's enhanced understanding of defence systems and 6 who reported on children's interest in a new organ to them – the spleen.



3.2 Children's other learning from the workshop

In addition to the learning about body organs and systems, children also learnt about healthy living and biomedical ethics from the Giant Tours workshop. 9 of the teachers (36%) reported that they had talked with their class about healthy eating and a balanced diet during the current academic year, whilst a further 3 (12%) had discussed the need for exercise. 7 (28%) were aware that healthy eating had been taught in previous years, whilst 5 (20%) knew that the importance of exercise had been covered and a further 5 (25%) reported on previous topics on 'health and growth'. When asked what the children in their class would know about healthy living before the workshop, 19 (76%) thought they would know about eating a balanced diet, and 12 (48%) about the need for exercise. Other factors such as sleep, fresh air and the avoidance of harmful substances were mentioned. In the free-text boxes completed by Y2 and Y5 children before the initial pilot workshops (appendices 12.13) the most 'popular' causes of upset stomach were identified as eating too many sweets or 'junk food' products (23 or 70% of children), whilst the possible 'cures' were identified by Y2 children as eating more healthily (11 or 33%) and by Y5 as taking some kind of medicine (10 or 71%). After the workshop, which had tended to reinforce the messages about eating the 'wrong' sort of food, 9 teachers reported on children's discussion of junk food 'making you ill' by either lowering the immune system or creating a blockage. One child commented: **'your body has to work hard to keep you healthy'**. Another child in my initial observation gained the insight that:

'the inside of our body protects us more than the outside.'



Clearly, children's greater awareness of the division of viruses (observed by two teachers) and the role of white blood cells in fighting diseases (noted by 13 teachers – see 'immune system' above) contributed to their growing understanding of keeping healthy.

In relation to biomedical ethics, the workshop leaders asked the children whether it would be 'right' to go on a tour inside a giant's body. Some children thought that the ends of finding out what was wrong with Nell justified the means: 'I think it would be good so they could see what's wrong with her', whilst others thought of the benefits to their own learning - 'you get to experience what's happening in the liver' – which might in the same way as medical students' education give them the skills: 'to help other people and sort out problems.' Children who thought that it would not be a good idea to go inside the giant were concerned about potential harm to her - 'Somebody might touch something inside her body and damage it' – or themselves: 'don't go in the giant because you will get germs from the giant'. There was also the fear of getting lost or getting stuck inside. Generally the children seemed more concerned for their own welfare than that of the patient.

3.3 Teachers' views of the most positive aspects of the workshop

Whilst from mine and teachers' observations all the children evidently enjoyed the experience, in the view of 18 of the teachers (72%) it was children's participation in the workshops through the use of drama/role play which had been crucial in engaging their attention,

'making complicated facts accessible' and 'relating science to their own experience'.

By 'being' the teeth, oesophagus, stomach lining, red and white blood cells, children had the opportunity to learn kinaesthetically and express aspects of their creativity. Additionally, what 6 teachers (24%) described as the 'multi-sensory' approach of the workshop – for example laying out the parts of the body on the floor – was felt to cater well for different learning styles. One teacher commented that this approach 'really stuck with my class'. Other features of this multi-sensory approach appreciated by teachers were the use of a story, the role of humour and use of songs to consolidate learning. One teacher liked the use of 'correct scientific vocabulary' whilst another commented positively on the thought-provoking ethical questions at the end of the workshop.



3.4 Teachers' and children's suggestions for further development

Whilst many of the teachers felt that the workshop was fine in its existing form, some did have suggestions for improvement. These included: more 3D representations of organs or an inflatable giant that children could actually go inside (3 similar suggestions from children); the discussion of learning objectives at the beginning which could be revisited during questioning at the end; vocabulary on the wall to help with recall; allowing children not involved in the role-play at any one point to stand in order to see better; and more 'characterisations' of the individual organs along the lines of the 'liver kitchen'. One of the Y5 teachers felt that the workshop was pitched rather low for that age group, whilst a Y2 teacher felt it was a little high, so there may be scope for two slightly different versions for upper KS1/lower KS2 and upper KS2.

4. Summary and Recommendations

From the data analysed above, the **Giant Tours workshop has made the following impacts upon children's learning:**

- Raising children's awareness of organs within the body's digestive, circulatory and immune systems which may have been new to them, in particular the liver, intestines, spleen, red and white blood cells.
- Helping them to relate the story of a piece of food through the teeth, oesophagus, stomach and intestines to the internal structure of the human body (although from their drawings after the workshop, significant areas of confusion are still present).
- Raising their awareness of the movement of blood around the body; particularly the role of red blood cells in carrying oxygen to the muscles and the life cycle of a red blood cell from its birth in the bone marrow to its death in the spleen.
- Helping them to relate their previous knowledge about healthy eating to the dangers of poor diet in lowering the body's resistance to infection and in creating constipation.
- Raising their awareness of the role of white blood cells in defending the body against attack by viruses and bacteria.
- Helping them to think through some of the ethical aspects of invasive procedures (such as entering a giant's body).



The workshop has achieved this learning through the provision of a multi-sensory experience involving extensive pupil participation in role-play, humour and song. **This has engaged children's attention and fired their enthusiasm.** The workshop can perhaps best be characterised as a creative approach to the teaching of science, rather than an exercise in developing children's creativity.

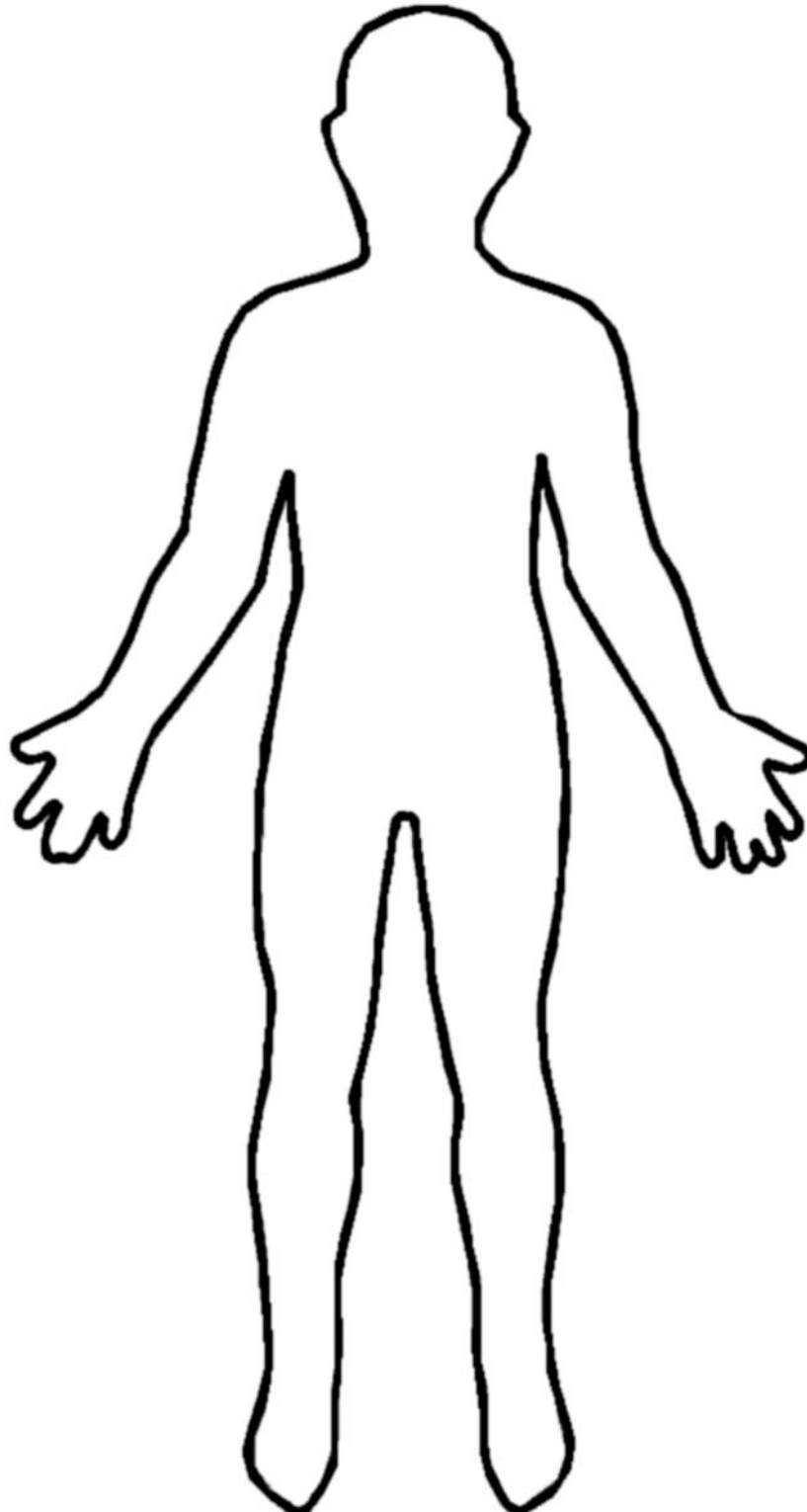
On the basis of the above findings, I recommend that MakeBelieve Arts apply for further funding to roll out the Giant Tours programme to as many primary schools as possible. The workshop could be further developed in a number of ways, such as differentiating the content for older and younger age-groups, making learning objectives and scientific vocabulary more explicit and developing more three-dimensional props. I recommend the continued use of the children's drawing activity as a means of evaluating learning, as it has yielded the richest data of the various instruments used.

Reference: Osborne, J., Wadsworth, P. and Black, P. (1992) *Primary Science Concepts and Exploration (SPACE) Project Research Report: Processes of Life*. Liverpool: Liverpool University Press.

Appendix 1: Drawing activity version 1

Name _____ Class _____

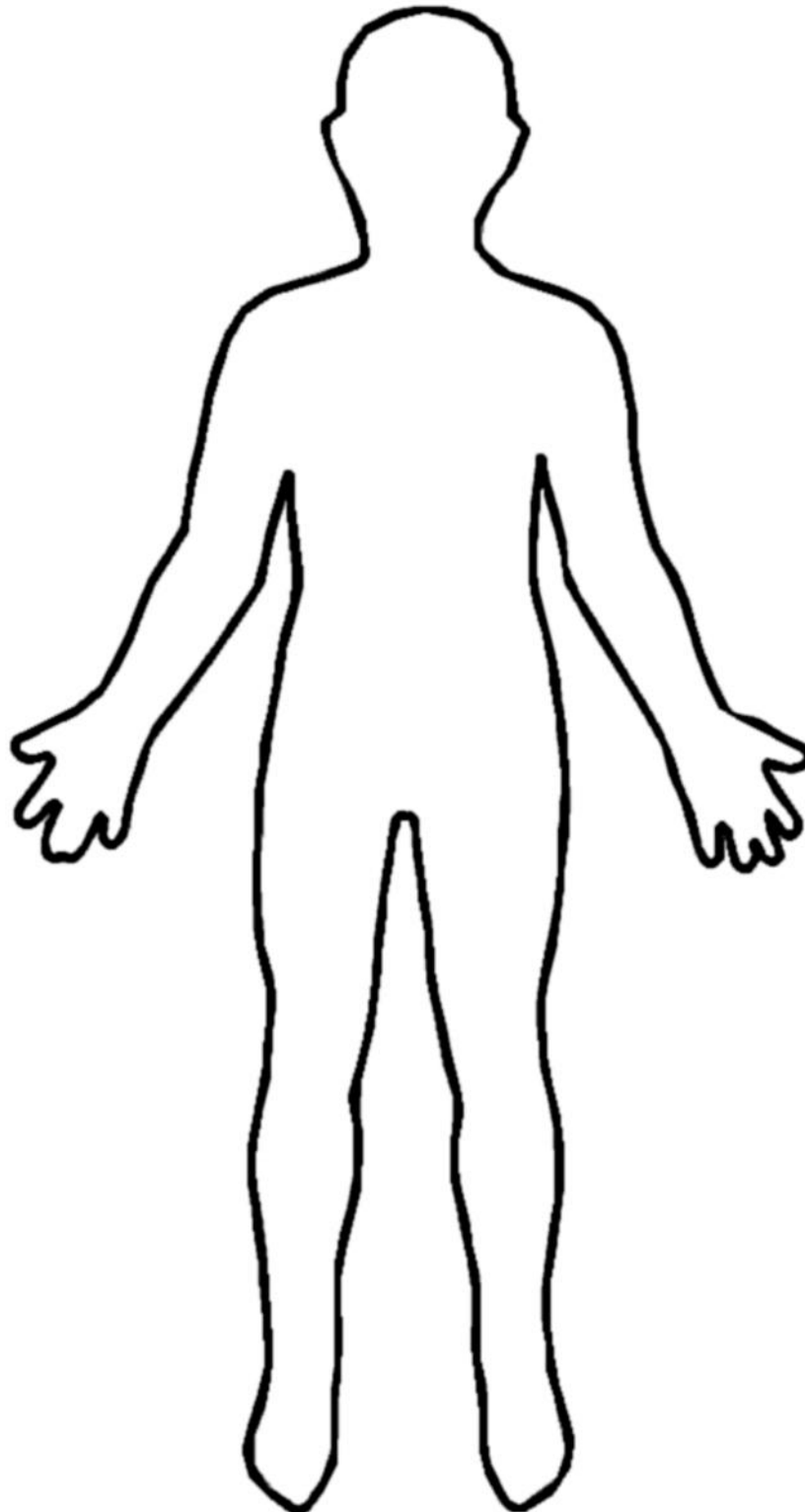
Draw and label all the special places you think food goes in your body when you eat



Appendix 2: Drawing activity version 2

Name _____ Class _____

Draw and label all the parts inside your body where you think your **food** goes (in pencil), and the parts that you think move **blood** around your body (in pen).



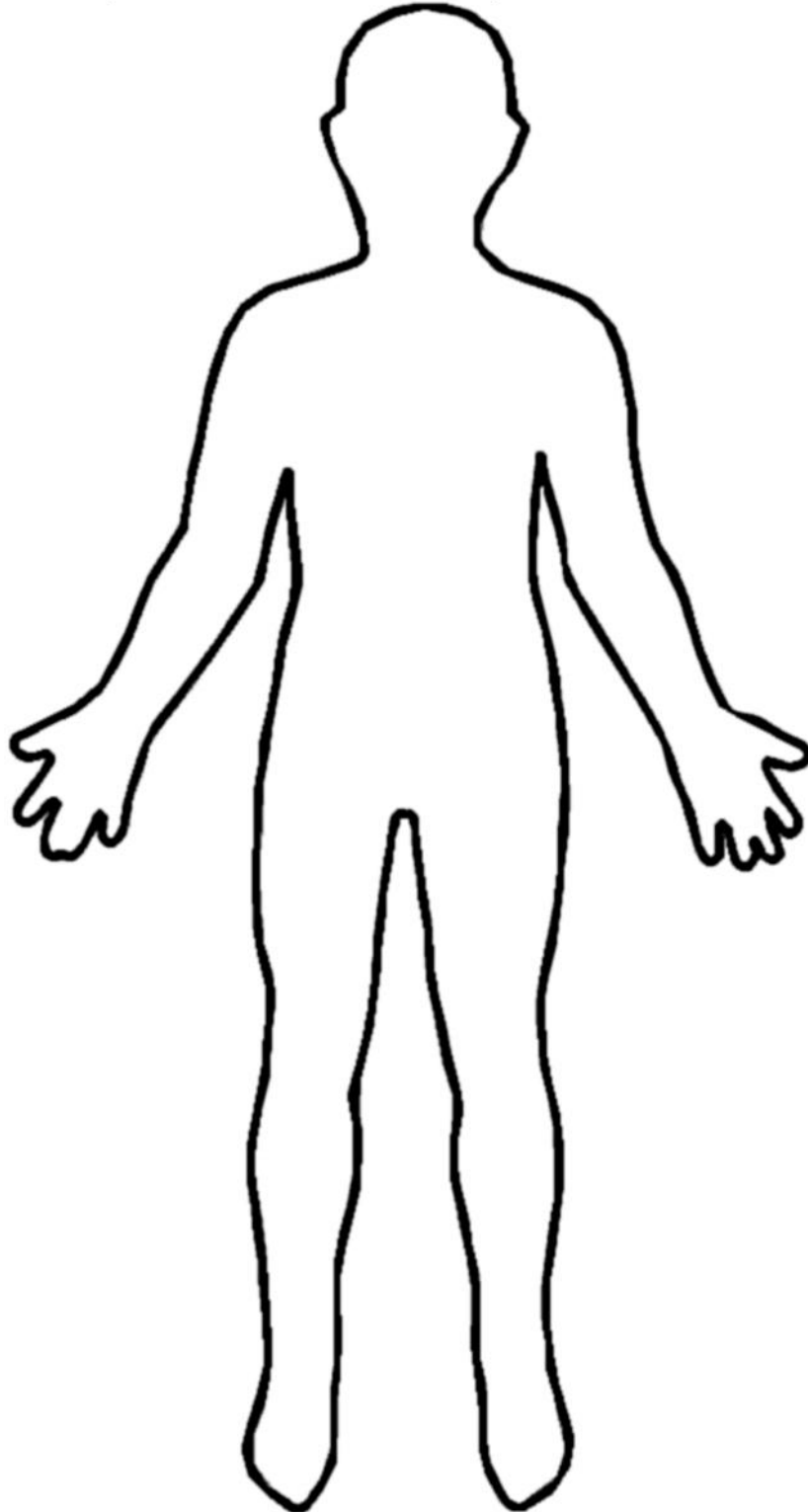
Appendix 3: Drawing activity version 3

Name _____

Class _____

Inside our body

Draw and label all the parts that are inside the body



Appendix 4: Free text box instrument

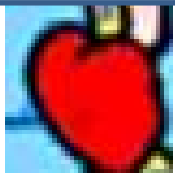
What things could give you an upset tummy?

What things could make you better from an upset tummy?

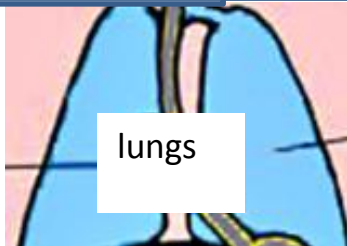
Appendix 5: Body part matching activity

Draw lines from the body parts to what you think they do (one has been done for you)

Body parts



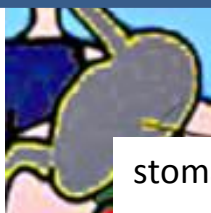
heart



lungs



liver



stomach



spleen



white blood cell



red blood cell

What they do

keeps the body healthy by fighting bugs, diseases and viruses

pumps blood around the body

carries oxygen around the body

breathe in oxygen

where red blood cells go to die

sends energy around the body

breaks food into small pieces

Appendix 6: Body systems matching activity

1. Put a ring around the names of any parts of your body that help you **digest your food**

lungs brain heart liver stomach
kidneys spleen bones teeth arteries
veins red blood cells white blood cells
small intestine large intestine muscles

2. Put a ring around the names of any parts of your body that help you **get energy and oxygen to your muscles**

lungs brain heart liver stomach
kidneys spleen bones teeth arteries
veins red blood cells white blood cells
small intestine large intestine muscles

3. Put a ring around the names of any parts of your body that help **keep you well by fighting viruses**

lungs brain heart liver stomach
kidneys spleen bones teeth arteries
veins red blood cells white blood cells
small intestine large intestine muscles

Appendix 7: Teacher questionnaire and observation schedule

Before the workshop:

1. What have your class been taught about how the human body works during the current academic year?
2. What do you think they might have covered in previous years?
3. What are the children's ideas about keeping healthy?

During the workshop:

4. Please jot down any significant things you hear the children say about the areas of science covered (digestion, circulation, immune systems)

After the workshop:

5. Ask the children what they have learnt from doing the 'Giant Tours' workshop. Please jot down any significant comments
6. What in your view were the best aspects of the Giant Tours workshop in helping children to learn science in a creative way?
7. What aspects of the Giant Tours workshop could be improved, and how?

Appendix 8: Analysis of children's drawings (Y5, first pilot)

Number of organs correctly...						Notes	
Identified		Positioned		Linked to digestion		Before	After
Before	After	Before	After	Before	After		
1	3	1	1	0	1	Tube from heart to 'tummy'. 'travels around heart' 'travels around bloodpipe'	'travels around heart', no links to 'lungs' 'saxfix tube', 'tummy', 'liver'
0	0	0	0	0	0	Structure near mouth position - tongue? Short pipe leading downward	Pipe now opens out to suggest lungs. Structure resembling stomach positioned in abdomen. Small 'brain' structure
1	4	1	3	1	3	Mouth not connected to oval structure labelled 'digestive system' in abdomen	'Mouth', 'lungs', 'liver' 'stumic' not linked but stumic linked to 'digestive system'
0	5	0	5	0	2	No labels but mouth, lungs, heart, stomach, intestine drawn and linked. Heart separate	Mouth linked to lungs with tube, Heart now between lungs, 'stumch' and liver not connected. Brain drawn/labelled.
1	5	1	3	1	3	Mouth connected to 'bottom' by straight 'food tube'	Mouth connected to liver and 'stumch' by branching tube. Heart between lungs. 'Bottom' not connected
0	0	0	0	0	0	Mouth with tube below (not connected). Two small 'heart' shapes and chicken bone in open-bottomed 'stomach' structure	No mouth, similar tube and open-bottomed stomach structure with 3 pieces of food. No heart shapes.
1	7	1	6	0	4	'food getting chewed in mouth, linked by long tube,	3 tubes in throat, 2 connected to lungs, 1 going

						flaring into stomach-like structure in abdomen with chicken bone, linked to rectum.	behind them (to heart?) various lobe-shaped structures joined to heart and lungs, labelled 'kidney' 'liver' 'stomach'
3	5	2	1	2	4	Tube from mouth to 'tummy' surrounded by 'tummy muscle'. Tubes to arms rubbed out.	Tube from mouth to 'kidney' (positioned in rectum) – no connection to stomach or liver
2	6	2	4	0	0	Structures resembling ribs labelled as 'muscles' and 'lungs' with bar of dairy milk lodged between them	Rib structures now labelled 'breastbone' flanked by 'lungs' in abdomen. Heart, chest, belly labelled but not connected.
3	4	3	4	1	1	2 tubes connecting mouth to 'stomek' and 'pelvis', with 'bladder' to side	Tube from mouth dividing at lungs and continuing down to divide again at kidney-type structures.
2	2	0	2	0	1	'food chube' connecting throat to lungs with heart at side	'food tube' from throat now bypasses lungs and stomach, which appears to be stuck to side of tube.
3	3	1	1	0	1	Food in mouth area linked by tube through throat (labelled as 'lungs') to large stomach-like structure in abdomen.	Tube down centre of body past 'lungs' 'ribcage' and 'liver' but ending open.
3	8	3	8	2	4	'the food passes through the throat', 'food tube' past lung-like structures into 'stomach'. Pelvis/bum not connected	Food tube from mouth through heart down to 'pelvis' with stomach and liver either side
0	8	0	8	0	7	Mouth connected by	'astrofagus' from mouth to

						tube to stomach structure (between lungs) and into intestines	stomach between lungs, then connected to 'intestines' with liver, kidneys and spleen surrounding.
20	60	15	38	7	31	< Totals	

Appendix 9: Analysis of children's drawings (Y2, second pilot)

Number of organs correctly...						Evidence of...				Notes	
Identified		Positioned		Linked to digestion		Journey of food		Blood circulation			
Before	After	Before	After	Before	After	Before	After	Before	After	Before	After
2	0	2	3	1	2		√		√	'belee' with whole fruit inside	Balls moving around body – red blood cells carrying oxygen?
2	1	2	2	1	1	√	√			'belley' in stomach position	Yellow area where intestines shown on body image, replaces 'belley'
0	0	3	2	3	1	√			√	Mouth connected by tube (with piece of food?) to stomach – no labels	Focus on circulation rather than digestion – blood cells moving round all parts of body
0	0	3	7	3	5					Mouth connected by tube to small stomach	Addition of intestines, liver and bones
1	0	3	1	2	1					'tummy' in stomach position, not connected to mouth	'tummy' now not labelled and further down , no mouth
1	0	2	4	1	2					Single line oesophagus, pieces of food in centre of body	Food pieces now enclosed, single line oesophagus connected to heart
1	0	3	4	2	3					'tummy' structure in abdomen	'tummy' now moved up but not labelled. Intestine in abdomen.
2	1	4	1	2	0					Round stomach structure in centre of body surrounded by whole pieces of food	Only 'heart' appears
2	0	4	2	3	1	√				Tube from mouth to 'tummy' with down	Mouth, oesophagus and tummy all disappeared –

										arrow	yellow intestine structure in abdomen
1	0	4	5	3	3					Tube from mouth to 'tume' with whole pieces of food piled on top of 'tume'	Tube now shorter, above heart, not connected to mouth or stomach. Food still outside stomach. Intestine structure In abdomen
0	0	4	5	3	3		√			Tube leading down into stomach with whole pieces of food in it	Arrows on tube from mouth to stomach. Some indistinct structures below stomach
0	0	3	4	2	3		√			Vertical tube from chest to abdomen, apple and banana at the bottom	Tube with arrow now leads from mouth to stomach, which encloses several pieces of food.
0	0	3	3	2	3					Vertical line from head to stomach	2 hearts. Line now leads from mouth curving right to rectangular stomach near side of body. Vague intestine structure below.
2	0	4	4	3	3		√			Tube from mouth to 'belee' with whole pieces of food and liquid inside	More complex with tube looping through stomach and down to intestines. Food outside intestines.
2	0	3	3	2	3		√			2 tubes from shoulders bending either side of heart into 'belee'	More complex with tube from head (mouth?) through stomach to intestines. Pieces of food collected in rectum.
2	0	2	4	1	4		√			Vague vertical line from head to 'tume'. 'Hart' in abdomen	Clearer line from mouth to stomach (in abdomen) then down to

											rectum
0	0	2	3	2	3					Overlapping globular structures which could represent stomach	Squiggly line from mouth to small stomach structure in abdomen.
1	0	2	1	1	1					Large round 'tummy' in abdomen	Very similar, but not labelled
1	0	2	3	3	3					Tube from throat to 'belle' located around rectum area	Two vertical lines (wide oesophagus?) from throat to stomach in abdomen with piece of food. Structure beneath stomach resembling an orange.
20	2	55	61	40	45	3	7	0	2	< Totals	

Appendix 10: Analysis of children's drawings (Y3)

Number of internal organs correctly...										Evidence of...				Notes	
Identified		Positioned		Linked to digestion		Linked to circulation		Linked to defence		Journey of food		Blood circulation			
Before	After	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After
4	4	3	4	2	2	1	1	0	0					stomach in abdomen	lach' (stomach?) nearer heart
1	4	1	4	0	1	0	2	0	0					lung-type structures in shoulders. 'Stomack' used to indicate general area of abdomen	pipes' leading from near brain to near heart
4	6	4	5	2	2	1	2	0	1					Intetestine structure labelled as 'belly'	Belly' now looks more like stomach and positioned higher
5	6	4	6	1	3	2	2	0	0					Vains' throughout body	Addition of 'belly' (stomach) and 'intesting'
4	4	3	3	1	1	2	2	0	0					longs' below 'hart'	addition of tube to stomach-like structure and possible intestines,

4	7	4	7	1	4	2	2	0	0					hart' between 'langs' in thorax	addition of tube from mouth, 'kines' and 'intesten'
4	0	4	6	1	3	2	2	0	0					hart' between 2 'luab' in thorax	no labels, addition of oesophagus and square intestinal structure
4	5	3	2	0	3	2	2	0	0					dighjested food' loose in abdomen	fod now missing, 'intesting' 'kidny' and 'liver' added
6	10	4	6	1	5	1	2	0	1					large stomach in abdomen surrounde by ribs	addition of 'splee', 'small intestine', 'big intestine' 'kidny', lungs
6	6	4	4	2	4	2	2	0	1					kidney structures labelled as 'ribgs'	Addition of 'testings', 'stumeck', 'pipe' (oesophagus , blood cells
8	6	6	3	1	2	2	2	0	1					lungs inside stomach/ abdomen	addition of spleen, 'big liver' and 'small liver'

6	8	4	4	1	4	1	2	0	1					emphasis on bones (backbone, ribs)	lungs and 'intestings' labelled twice in different places. Addition of 'beley', 'liver', 'kidnes'
4	9	4	9	1	4	1	1	0	1					heart in ribcage in thorax, intestines in abdomen linked to pelvis/leg structure	addition of stomach, 'sleen', liver, big and small intestines, all accurately drawn and positioned
4	4	3	3	2	2	1	1	0	0					heart fills thorax, 'tummy' fills abdomen	little change, heart now smaller, 'stumerk' still fills abdomen.
3	6	2	5	1	2	1	2	0	1					lungs in shoulders, belly fills abdomen	addition of oesophagus tube, vein-like structures, 'intesteds'
6	7	5	6	2	3	1	2	0	0					liver below 'inestergen s' in upper abdomen	intestleargen s' now in lower abdomen,

																		addition of lungs, liver, 'stumec'
3	7	3	6	1	5	1	1	0	0					heat' only internal organ in trunk				addition of 'sumak', 'little intesting', 'big intesting', kidney
4	6	4	6	1	3	1	1	0	0					herert' and stomach in correct places				addition of 'sakoregos' (oesophagus), kidney
101	131	83	110	27	68	31	37	0	8									

Appendix 11: Analysis of children's drawings (Y4)

Number of internal organs correctly...										Evidence of...				Notes	
Identified		Positioned		Linked to digestion		Linked to circulation		Linked to defence		Journey of food		Blood circulation			
Before	After	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After
4	5	4	4	1	2	1	1	0	0					stomach, heart and brain in correct positions	stomach now in abdomen, vertical oesophagus structure from mouth southward
2	2	2	2	2	3	0	1	0	0					round stomach structure	very similar with addition of

																			in abdomen with whole pieces of food	'liver' label but no corresponding structure
																			heart in throat, large long 'tummy' stretching from throat to abdomen	tube' from mouth to 'tummy' (still in abdomen). Addition of lungs and blood cells.
3	4	1	3	1	3	1	1	0	1											
																			liver correct, stomach in abdomen, kidney in leg	addition of lungs, intestine. Stomach now higher
5	5	3	5	4	3	1	2	0	0											
0	5	0	3	0	2	0	1	0	0										blank	addition of brain, heart, liver, stomach
4	4	4	3	1	1	2	3	0												
														y	y				detailed annotation concerning circulation, keeping healthy	addition of lungs, stomach

3	7	2	7	2	6	1	2	0	1				y	3 pipes' from neck to stomach in abdomen, full of whole food	reference to red and white blood cells, carbon dioxide, addition of liver, kidneys, intestine
3	3	2	2	2	2	0	1	0	0					labels not connected to structures ('bladder', belly)	very similar, reference to 'blood system' but no drawing.
4	4	3	4	2	3	1	1	0	1					bones drawn but not labelled, heart in shoulder, lungs at sides of abdomen	addition of tube from mouth to 'tummy', reference to 'blood cells'
4	7	4	5	2	5	2	3	0	0	y		y	y	tubes linking heart with limbs and mouth with stomach (reference to 'digesting	addition of 'digesting system', large intestine, small intestine, kidneys

																acid') then down through intestine area to anus	
5	6	5	6	2	3	2	3	0	1	y	y			y	tubes connectin g mouth to 'tummy' and on down to anus	addition of 'digestion system', spleen, kidneys, veins	
2	11	2	8	0	7	2	3	0	1						heart labeled as 'ribs', oesphagu s labelled as 'longst' (lungs?)	addition of 'esophagus', 'blood sells', small and large 'intestions', veins, liver, kidney, stomach. Heart now correctly labelled	
5	6	3	6	3	3	1	1	0	1	y	y	y			there's a choob what brings food around', 'your heart brings	speen is wer all the ded blud celce go after 4 months'. Addition of intestines but no stomach.	

																blud around'. Legs are 'full of blud'	'are mouth is were we grind and stir food'
2	4	2	4	2	3	0	1	0	1	y	y			y	the food goes into your stumick and digests'	your blood sells go to every part of your body' 'this is the liver where the blood cells stay and just die', 'the heart is the biggest blood sell in your body'	
4	6	4	4	2	4	2	2	0	0				y	y	tube in your throat' leads straight to bladder	addition of intestines, kidneys, lungs	
2	2	2	2	1	1	1	1	0	0						hert' and 'tume'	tume' now 'stumik'	
5	8	5	8	2	6	2	1	0	1	y	y	y	y		complex digestive structure s drawn but not labelled	addition of 'stomach', kidneys, spleen, intestines, liver	

4	6	3	5	1	2	3	3	0	0		y	y	y	blood cells drawn in veins from heart to arms and legs. Stomach in abdomen	addition of oesophagus (not labelled), kidney. Stomach in abdomen
6	8	5	8	2	4	3	4	0	0					tube leading to stomach in abdomen	addition of lungs, intestines
3	5	2	4	2	4	1	1	0	0	y	y			the food goes in the mouth, then it goes in a hole, the food goes in your stumerk'	it travels in the chube'
6	4	4	4	4	1	1	2	0	0					stomack and liver in abdomen, blood 'cells' from heart to arms and legs	stomach replaced by intestine-type structure

5	4	5	3	2	1	3	2	0	0									choob' to stomach in correct place (not labelled)	more confused
3	7	3	6	1	4	2	2	0	0					y				pieces of food in 'tummy' and in leg. Labelling places round the body where 'food' and 'blood' go to	addition of liver, intestines, lungs, 'tummy' now 'sumac'
4	6	3	6	2	2	1	2	0	1	y				y				you eat your food and it goes in your food hole (that's also for air). It travels to your stomach'	the brain tells the heart to pump blood' 'the veins carry the blood' (spleen) 'where all the dead blood cells go'. 'tube that carries food to instein'

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															veins carrying blood cells from heart around body	foodline' from neck via stomach structure to anus. Addition of kidneys
3	6	3	6	0	2	3	4	0	0		y	y	y			
91	135	76	118	43	77	36	48	0	9	6	8					

Appendix 12: Analysis of free text boxes (Y5)

'What things could give you an upset tummy?	Frequency before workshop	Frequency after workshop
Sweets/sugar/chocolate/cake/biscuits/ice-cream	5	10
Junk food/Macdonalds	3	5
Too much food	1	3
Food poisoning	1	1
Salt		4
Unhealthy/fattening food	4	3
Crisps		1
Food you're allergic to/doesn't agree with you	2	1
Hunger (empty stomach)	2	1
Eating too fast	2	1
Rotten/out of date food/drink	3	2
Too much drink/water		2
Glue	1	
Butterflies	1	
Cholesterol	1	
Candle		1
Some types of leaves	1	
Having a cold	1	
Fizzy drinks	1	
Dirty water/food	2	
Eating objects		1
Biting your nails	1	
'What things could make you better from an upset tummy?'		
Medicine/healthy drugs/tablets/injection	10	8
Water/cold drinks/lemon water	3	8
Energy		2
Pooing	3	
Eating healthily/vegetables	2	6
Hot drinks/tea/hot chocolate	3	3
A lot of food		1
Vomiting	1	
Surgery	1	
Exercise		2
Sleep/rest	2	2
Taking your mind off it (picture of TV)		1

Appendix 13: Analysis of free text boxes (Y2)

'What things could give you an upset tummy?	Frequency before workshop	Frequency after workshop
Sweets/sugar/chocolate/cake/biscuits/ice-cream	8	9
Junk food/Macdonalds	6	3
Spicy food/curry	4	
Mixed up food	1	
Poisoned water	2	
Bones	3	1
Seeds	3	
Crisps	3	5
Hunger (empty stomach)	1	
Eating animals (snail, ant, snake)	3	
Fizzy drinks	3	8
Dirty water/food	1	
Peas	1	
'What things could make you better from an upset tummy?'		
Medicine	7	
Water	4	1
Pooing/going to the toilet	1	1
Eating healthily/vegetables	11	3
Hot drinks/tea/ soup	5	
Going to the doctor	1	
Sleep/rest	2	
Comfort food (Ice-cream, toast, spaghetti, cake)	8	

Appendix 14: Analysis of body organ matching exercise (Y3)

Correct links	
Before	After
2	1
1	3
0	2
0	3
2	3
3	6
0	0
1	4
1	3
0	3
2	4
1	6
2	3
0	2
0	2
1	4
2	3
1	3
1	2
0	1
20	58

Appendix 14: Analysis of body systems matching activity (Y3)

1. Digestion										2. Circulation										3. Immune			
liver		stomach		teeth		small intestine		large intestine		lungs		heart		arteries		veins		red blood cells		spleen		white blood cells	
before	after	before	after	before	after	before	after	before	after	before	after	before	after	before	after	before	after	before	after	before	after	before	after
1	1	1	1															1	1				1
1	1	1	1	1						1	1								1				
	1			1	1				1			1	1										
1		1	1			1			1			1				1	1			1			1
1		1	1									1	1								1	1	
1		1	1	1								1				1	1			1			1
	1		1			1	1	1	1	1		1			1			1	1				1
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1
1		1	1	1		1			1							1			1				1
	1		1			1	1	1	1	1	1	1	1		1							1	1
1	1	1	1	1		1	1	1	1	1	1	1	1	1	1		1	1	1				1
1	1	1			1		1	1	1	1	1						1		1			1	1
1		1		1			1		1			1							1				1
	1	1	1		1																		1
	1		1	1	1							1	1						1				1
10	10	11	12	8	5	6	6	8	6	6	5	11	6	2	4	4	5	4	9	3	1	4	12

Appendix 15: Analysis of body systems matching activity (Y4)

1. Digestion										2. Circulation								3. Immune					
liver		stomach		teeth		small intestine		large intestine		lungs		heart		arteries		veins		red blood cells		spleen		white blood cells	
before	after	before	after	before	after	before	after	before	after	before	after	before	after	before	after	before	after	before	after	before	after	before	after
		1	1	1	1			1		1			1										1
		1						1							1		1	1			1	1	
		1	1							1								1			1	1	
		1	1	1				1	1	1	1							1				1	1
	1	1	1	1	1		1	1	1	1			1	1			1						1
		1	1							1	1								1				1
		1	1				1			1	1	1								1			1
1		1	1	1	1		1		1	1	1	1								1			1
		1	1																				1
		1	1				1		1						1	1				1			
	1	1	1		1					1												1	1
		1	1				1		1						1								1
		1	1	1	1					1		1	1						1				1
	1	1	1	1	1											1	1			1			1
		1	1	1	1																1		1
1		1	1	1	1		1		1				1							1			1
		1	1	1						1									1	1			1
	1	1	1		1							1							1	1			1
1		1		1	1															1			1
		1	1	1	1				1			1	1							1			1
		1	1				1		1			1								1		1	1
		1	1	1	1	1				1											1		1
3	13	26	24	14	15	4	3	7	4	15	5	9	6	1	1	4	2	5	19	2	0	6	26