The understanding of human anatomy elicited from drawings of some Bangladeshi village women and children

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Abstract

This chapter is about conceptual development of a particular biological phenomenon. There has been research conducted on how learners build up an understanding of what is inside the human body. What the learners tell you or draw is their expressed mental model A number of studies have used drawings to elicit the understanding about phenomena because drawings are universal and are a useful too to elicit the understanding of learners of the inside of the human body, e.g. Reiss and Tunnicliffe, (1999), Cuthbert, (2000)Tunnicliffe and Reiss, 2001, Palov et al., (2007) The most studied organ in the human body is the skeleton e.g. studies by Carivita and Falchetti (2005), Guichard (1996). However, it is recognised that some subjects, particularly youngsters or adults with very limited writing and other literacy skills, in particular may have difficulty drawing an outline and in some research an outline of the human body shape has been used. An advantage of using drawings as an approach to discover the level of understanding about human anatomy is that drawings are universal whatever the spoken tongue, the age and educational background This study however was an investigation into the understanding of human organs and their arrangement of as understood by hitherto destitute country women at Sreepur Village in Bangladesh. We asked if they had attended school and, if at all, it had been for a minimum time in a primary school. Only 5% finish primary education in that country (2013). The women were provided with the outline of a human body and invited to indicate, by drawing, the internal organs in their approximate location. They were then asked from where they had acquired this knowledge. It was from peers and communities, not formal education. They understood the presence of the heart, bones and lungs and, unusually when compared with the Western data of learners, some knew about kidneys. Their knowledge reflects a public and utilitarian understanding of human anatomy. The sons of a few women were present in the village, attending the village school, and also drew. Some of the school children at the village completed drawings and interviews. Children who had had received education and the older children knew more organs than their mothers.

Introduction

There are a number of methods of obtain information about a persons understanding of science (White and Gunston, 1992, Tunnicliffe and Reiss 1999a). Drawings are considered one useful tool (Haney et al. 2004) .Most techniques require respondents to talk or write their answers to questions. Osborne and Gilbert (1980), used oral questions whilst written responses have been analysed , for example by Lewis, Leach and Wood-Robinson (2000). Tunnicliffe and Reiss 1999b elicited children's spontaneous conversations about learners interpretations of brine shrimps. An increasingly popular technique in eliciting learners understanding of ideas is the concept map introduced by Novak (1990). This technique is much used modified as mind maps and is focused not on words but in a visual representation which is universal transcending language. Reiss and Tunnicliffe have postulated that different aspects of the understanding of an individual of a particular phenomenon are revealed through using different methodologies in this study we recognise that the drawings indicate only one aspect of the understanding of the participants of the internal anatomy of the human body. Using drawings has advantages over written responses because interpretation of drawings is universal without the need for language, although interviews can enhance the level of participants understanding but that has language limitations. There are, of course, always the provisos that the subject can achieve the technical and manipulative skills of drawing. Hence using an outline of the organism being considered, referred to as a "supported" drawing (a drawing framework, not unlike a table or other organizer to assist learners) helps focus the drawer on the concepts about which you are seeking their understanding.

The mental models drawn by the child in a drawing are representations of an object, or an event, the image which the drawer is seeking to produce is formed by the process of mental modeling (Duit and Glynn, 1996) who state that the process of forming and constructing models is a mental activity of an individual or group. The models are personal and unique, their own knowledge of the phenomenon, animals, plant or human or habitat in the case of biological phenomena, seen, and thus formed in the everyday environment, museums, nature parks zoos or representations in books and in the electronic media these personally observed and constructed models are in contrast to the conceptual knowledge learnt through formal education. Rapp (2007) refers to mental models as 'memory structures that can be used to extrapolate beyond a surface understanding of presented information, to build deeper comprehension of a conceptual domain' (p. 43). However, there is a relationship between the mental model, habitats, organisms or human, looked at (the trigger or real object) and what the child comments upon (the expressed model- in words models or drawing). Brooks (2009) suggests that through visualization and expression through representation of ideas the essence that has been understood is early focused in consciousness, thus she suggests a drawing is an externalization of a concept or idea. Thus drawings are products of the drawer's imagination (Reiss, Boulter and Tunnicliffe, 2007) and memory as expressed models. (Gilbert and Boulter, 2000),). As Brooks (2009) points out, drawings and visualisations can also help young children to shift from everyday or spontaneous concepts to more scientific concepts whilst their construction also enables children to come to terms with spatial visualisations, interpretations orientations and relations and she claims that when

children are able to create visual representations of their ideas they are more able to work at a met cognitive level.

When subjects are asked about their understandings of anything, subjects respond by presenting 'representations' of various genres, verbal, 3 dimensional, described by gestures, symbols or by drawings, depending on the topic, the interviewees and the objectives of the interviewers. We must acknowledge the limitations that adults and children can achieve in the technical and manipulative skills of drawing as well as their personal subject knowledge. Whatever form they take, these representations can be considered as expressed models generated from the mental model, the personal cognitive representations, held by individual subjects.

Using drawings about organism to identify understanding

Research using the drawings of children to access their ideas have became more frequent. Children's drawings provide a 'window' into their thoughts and feelings, mainly because they reflect an image of his/ her mind (Pridmore and Bendelow, 1995). However, using someone's drawing to elicit the person's understanding of a given phenomenon or process depends on how the researchers interpret the end product and the skill of the person making the drawing. It is a more difficult task for a younger or inexperienced adult drawer because of their lack of experience in using drawing tools and lack of this type of representation in their society.

Some children find it easy to draw their ideas; others do not. While many children dislike answering questions, drawings can be completed quickly, easily and in an enjoyable way. However, Strommen (1995) found that children's drawings of forests yielded less information than interviews. Combining drawings with subsequent interviews (Tunnicliffe and Reiss, 2014) can yield interesting and fuller information.

Symington et al (1981) proposed three stages in the development of the ability of children to draw, starting with the youngest with 'scribbling', the result being unintelligible to adults. Secondly a child enters a stage in which drawings shows very little resemblance to the object and the picture is used more as a visual representation of the child's ideas, a symbol, an older child shows 'visual realism', where the object and the drawings is identifiable bearing a closer resemblance. Earlier than the age of 6 children know there are some different organs but Hatano & Inagaki, (1993,1994) working with young Japanese children, suggest at this age the learners form biology as an autonomous domain but until about that age children talk about the organs as independent creatures that have needs and initiative. Through their observations and hearing comments in their community children become aware of the existence of organs in their bodies (Cuthbert, 2000) and this they apply to other organisms. Tunnicliffe and Reiss (1999a) found that English children in their first week of school (5 yrs) already knew there were a few intetrnal organs, brain, bones stomach and heart were drawn, infortaioan gleaned in their everyday lives from family, friends and media.

Children see objects and organisms from their earliest years and can begin making representations, which become more 'accurate' as they acquire certain skills they can represent them. Krampen (1991) suggests that one way if looking and drawing conclusions about the drawings of children is to focus on one figure, such as the human and he reports that it was soon discovered that such drawings change from the tadpole man to a realistic presentation. The ability of young children to draw a human, represented as a "Tadpole man' is a recognizable stage in achieving realistic representation that can be recognised and identified others.

Figure 1. "Me' drawn by Luc, aged 4. A Welsh boy.

However, the question to subjects of what is inside organisms is a relatively new area of study amongst biologists. Bartozeck and Tunnicliffe (2013) interviewed Brazilian children about their understanding of the internal structure of trees'. However, some children interpret 'inside' as internal to the outside of the tree, inside the trunk and branches but not internal to the structure of the tree and some drawers consider external features such as navel, eyes to be internal organs (Personal observations). Five-year-old Polish children did not always regard trees as living organisms but all but one child in their study of 57 children included a heart, (Rybyska et al, (2014). These children had received no formal teaching in this subject. These children transferred their knowledge of

bones, muscles, veins and heart that are peculiar to vertebrates to the tree, using as Carey (1985) identified, the self as their template also found with 7 year old English children by Tunnicliffe (1991). Symington's perspective acknowledges that children's drawings develop from scribbling to realism (Symington et al, 1981).

Several researchers have recently researched children's understanding of the anatomy organs of invertebrates. Bartozeck et al, (2011) used drawings to elicit children's understanding of the external anatomy of insects. Rybsyka et al. (2014) used drawings and interviews to elicit the understanding held by 5, 7 and 10-year-old Polish children of the internal anatomy of snails. Where the most often drawn organ was a heart although all the children drew organs in the foot of the mollusc and not within the shell. If the learner is subsequently interviewed with their drawing they may reveal a greater understanding as has been carried out by the above researchers.

The understanding of internal organs of vertebrates, beginning with bones was elicited by Tunnicliffe and Reiss, (1999) who then studied understanding of organs in some vertebrate specimens from fish to humans (Reiss and Tunnicliffe (2001a). These researchers showed real (specimens of a fish (fresh, a herring), a bird and art (preserved, before they aske the children of age 5, 8 years , 14 yr. olds and undergraduates, about internal organs of these vertebrates. Subsequently Reiss and Tunnicliffe et al. (2002) conducted an international comparison of the understanding using analysis of drawings of 15 year olds from a variety of countries, same Western and some from Asia.

A South Africa regional study by Dempster and Stears (2014) found, as did other researchers, that children were able to identify and draw familiar organ but not relationships between them a system and that such information was acquired out of school. Their results showed that most of the children draw bones as lines throughout the body and the ribs are the first bones they know apart from bones in legs and hands. The heart and the brain are the first organs they know and they know that we need to eat healthy food to become big and strong. Occasionally, Reiss and Tunnicliffe (2001), Reiss, Tunnicliffe et al. (2002) found children drew separate organs and labeled them as in a key it a map. On interview, these children, when shown an outline of a body they could indicate the appropriate location of the organs which they had drawn within the outline.

Some studies have looked at one particular organ or systems. Bahar et al (2008) for example looked at student teaches understanding of the heart. Teixeira (2000) looked at Brazilian children's understanding of digestive system, Tunnicliffe (2004) looked at pre secondary children's understanding of the urinary system and its connection with the digestive system and found a greater understanding of the digestive system than of the excretory one. Ozsevgec (2007) asked different aged Turkish pupils to make two drawings each, one of the bones and one of the organs in humans. The children were interviewed about the function of the bones and organs. The children were also given a cracker and a glass of water and asked to describe the way the food goes from mouth and onwards. Other studies where drawings have been used that has focused on a person's ideas about the human body have been summarised by Patrick (2013).

There are few studies we have found of the understanding of human anatomy that have been conducted in other than in the USA and UK. .Ozsevgec (2007) carried out work in the Black Sea region of Turkey from 12 and 14 year old pupils who drew and then wrote about the content of their drawing. Prokop et al (2007) studied the understanding of Slovakian children aged 6-16 years of internal anatomy where the size of the animal affected the undertaking of skeletons but not organs systems. Reiss, Tunnicliffe et al. (20020 considered drawings of 7 year old and 15 year olds from 11 different countries, namely rhea England, Denmark, Northern. Ireland, Portugal, Iceland, Taiwan, Russia, Australia, Zimbabwe, Uganda and Ghana. Although the samples were small the data show that although the fifteen year old has more knowledge of they had little understanding of the organs as part of a system. Furthermore, Óskarsdóttir (2013). explored what kind of ideas a class of Icelandic four year old children have about the location, structure and function of bones and certain organs. Manokore and Reiss (2003) compared the understanding as shown through the analysis of the content of drawings of both genders of 7 year olds and 15 year olds in Zimbabwe. Dempster and Stears (2014) study elicited the understanding of Zulu children in South Africa. There has been no study of human anatomy knowledge in to our knowledge

The Research

The study we present was conducted at Sreepur village in Bangladesh. Sreepur is purpose built village off the Mymensingh Road, north of Dhaka, in the Gazipur District, for destitute women and their children where the women learn a trade and can then return with their children to their communities and earn a living. The women, and their children, were all volunteers and the study was conducted in their free time. Hence it is a self-selected sample. Thus it is an exploratory study.

In this study we collected two expressed models:

a) Drawings from mothers from rural villages in Bangladesh who had not received formal education and some of the children of the mothers who are receiving local state education.
b) The words the participants used to describe and explain their drawings. They were interviewed in heir first language of Bangla. The interviewer then translated the responses into English and annotated their drawing as the participants indicated.

The majority of the women have received no schooling. A few of the mothers at the village have experienced limited years of primary education and occasionally some secondary education, but they did not volunteer, (Tunnicliffe, 2013). The children attend a state primary school in the village whilst older children attend the local secondary schools.

Extension education activities are provided and the ‘Talking Science ‘ project is one such. It is a voluntary activity and the women attend in their free time. The facilitator, one of the authors, a recent graduate in agricultural science from a Bangladesh university, delivers the project with frequent discussion with the other author who is not local. He has other duties in the village, such as teaching the participants how to grow simple crops so that they can grow vegetables when they return to their communities.

We were interested to find out the understanding of these women and decided that using drawings would be the most appropriate way of doing this. We wanted to obtain drawings from school-aged children living in the village so we could compare the understandings. Additionally one of us does not understand Bangla and the women do not speak English. A total of 17 women volunteered to participate in this project. Five of the woman also had their sons with them and agreed that they too could share their knowledge of human anatomy though this drawing technique. Twenty five children in all participated. Fortytwo drawings were constructed and analysed. Participation was voluntary and in the free, leisure time of participants.

Drawing was not a technique to which the participants were used. The participants were provided with an A4 sheet of paper with the outline of the human body in lateral views (a supported drawing). Drawing is not a skill the women felt they had and asked for an outline. They were asked to fill in by drawing on the given sheet what they knew of the internal anatomy of a human body. One of the authors then interviewed each mother who had drawn to clarify what organ or system they had indicated and they named the organs in writing written by the interviewer in English. The children of some of the women who lived at the village were also asked if they would complete the task. Only five mothers and their own children participated.

An individual interview was conducted with each participant after they had finished inserting organs on their outline drawing (a supported drawing). During this time the facilitator wrote the name of the organs on the paper in English. Each participant was asked, in Bangla, some questions when they had identified the parts. Five questions were asked.

The first question asked was, **“** How did you know inside parts of human body? “ All but one of the women drawers replied that they knew from hearing others talk L. begum said that she compared herself with what she knew about the inside of other animals, such as hen and duck. None of the mothers learnt about inside the parts of human body from any school and college. The interview answers were collated and summarized.

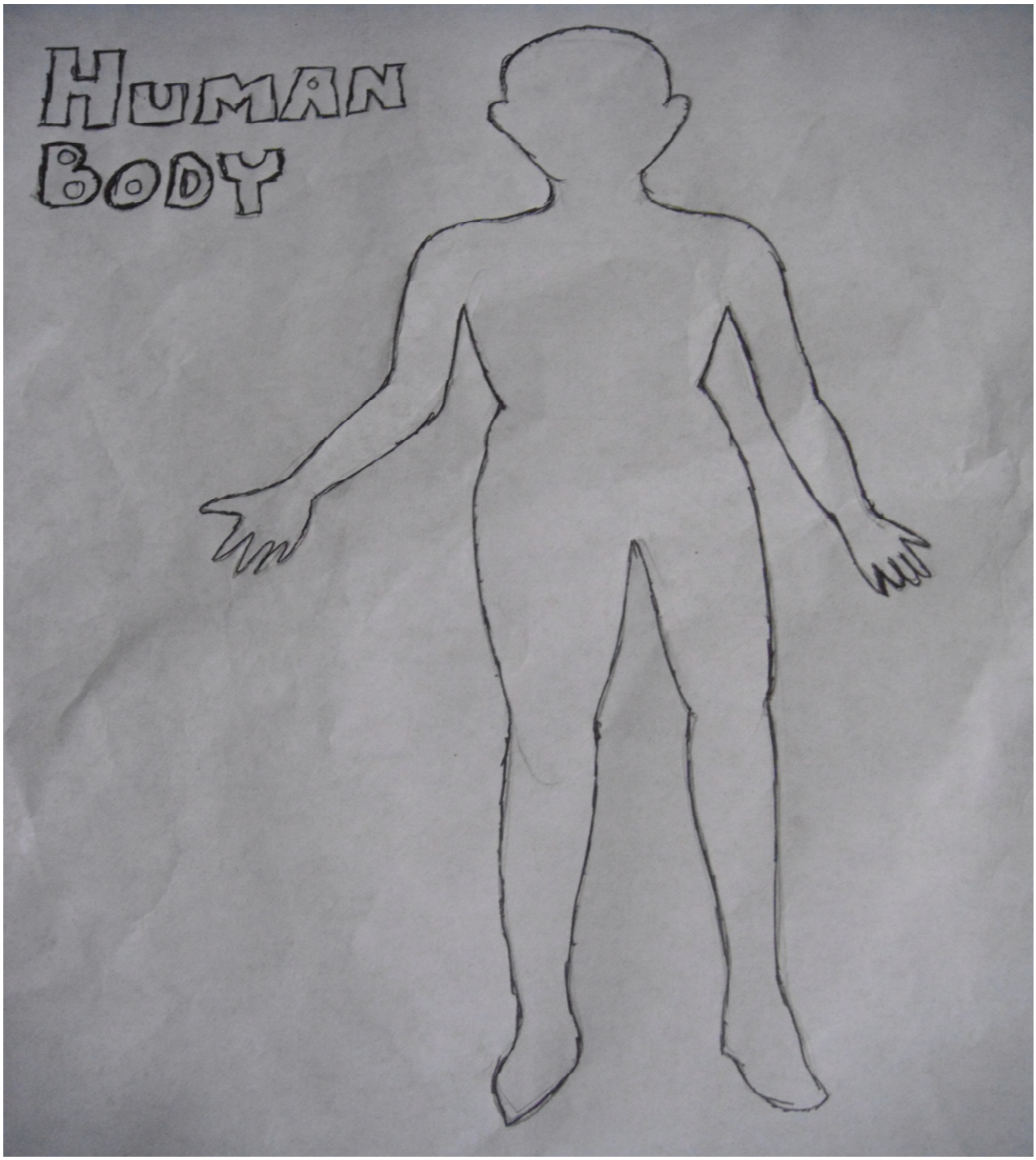
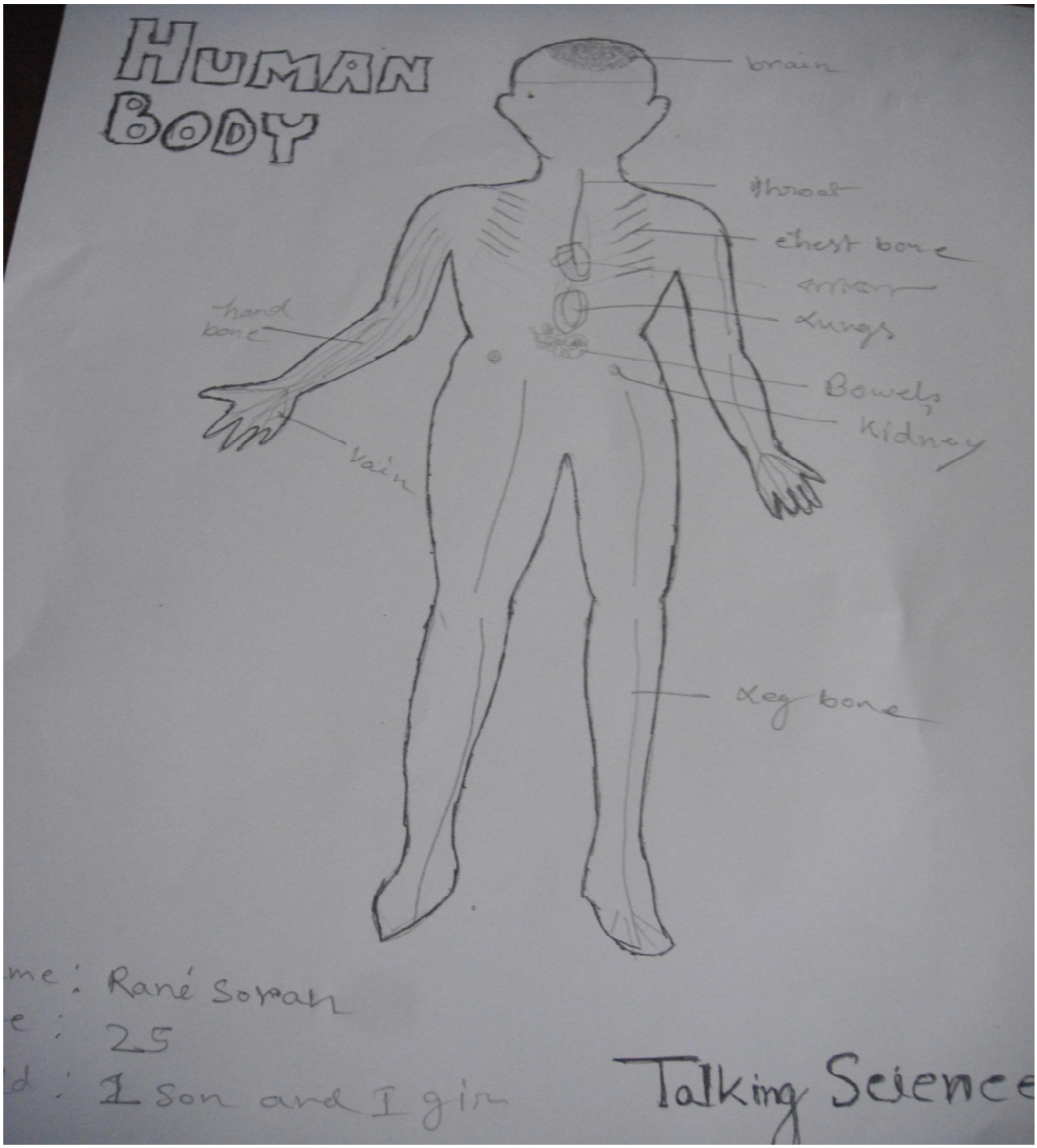
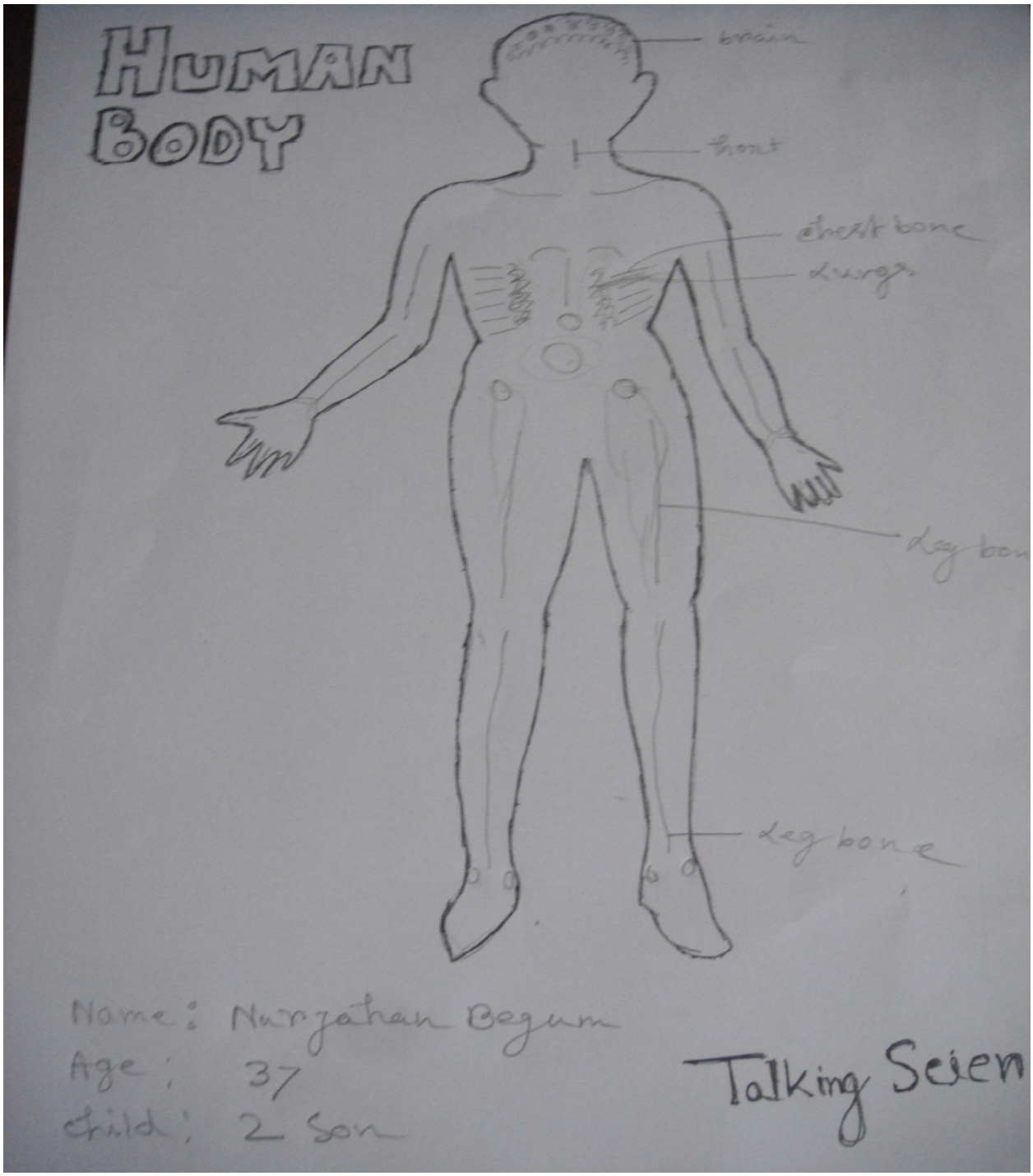


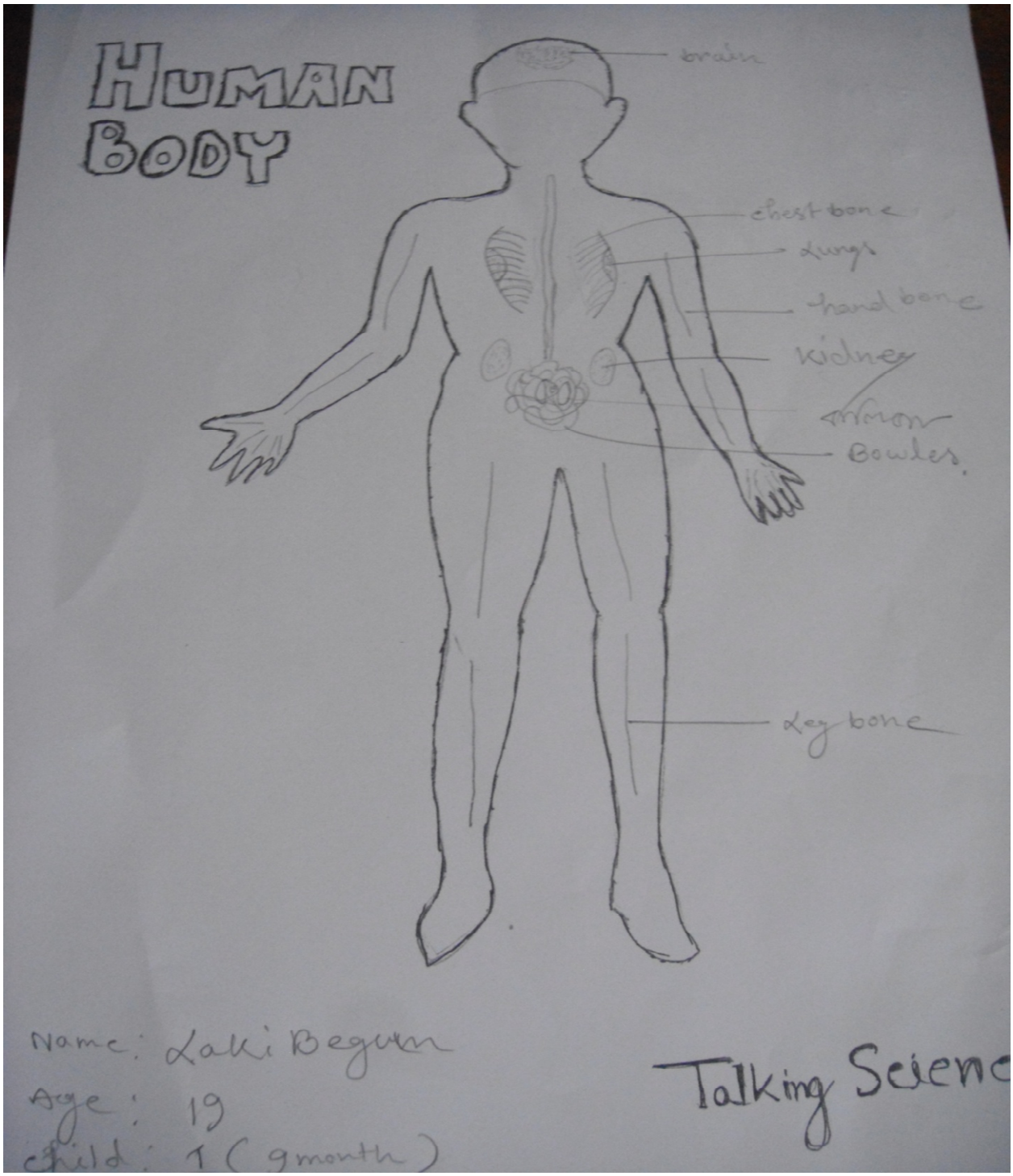
Figure 3 a drawing by one of the mothers



Drawing by Rani Soran
Age: 25



Drawing by Nurjahan Begum
Age: 37 years



Drawing by Laki Begum
Age: 19

Insert figure 4 Photograph of Mothers drawing

Analysis

There are a variety of methods of analysing the internal canted shown though drawings The most often used is that introduced by Reiss and Tunnicliffe (2001), (Tables 1 and 2). In this analysis technique letters stand for organs with a system as defined by Reiss and Tunnicliffe (2001) system , hence an organ that is a component of the nervous system is indicated by a lower case letter, n =-nervous system, s = skeletal system, r = respiratory system, u = urogenital system, d = digestive system. Thus, where each drawing is scrutinised by the researchers separately and organs given a small letter standing for the system e.g. s for bones but a capital letter is to indicate that a complete system, as defined by the rubric, has been indicated. Accordingly, if the skeletal system were indicated it would be denoted by a capital S, S for a skeletal system. The systems and organ rubrics are defined in Table 1, (Reiss and Tunnicliffe 2001). No complete organ systems were recorded hence only small case letters are used and shown in the results tables.

In this work we identified the organs and counted them. No systems were indicated. We then work out the percentage of occurrence in the drawings, although the numbers are small so numbers and percentages are shown. Hence we identified the system to which the organ belonged Furthermore, we identified the number of organs within a system that these participants identified

Table 1 Definition of Systems (Reiss and Tunnicliffe 2001)

Skeletal system	Skull, spine, ribs and limbs.
Gaseous exchange system	Two lungs, two bronchi, windpipe which joins to mouth and/or nose.
Nervous system	Brain, spinal cord, some peripheral nerve (e.g. optic nerve).
Digestive system	Through tube from mouth to anus and indication of convolutions and/or compartmentalisation.
Endocrine system	Two endocrine organs (e.g. thyroid, adrenals, pituitary) other than pancreas [scored within digestive system] or gonads [scored within urinogenital system].
Urinogenital system	Two kidneys, two ureters, bladder and urethra *or* two ovaries, two fallopian tubes and uterus *or* two testes, two epididymes and penis.
Muscular system	Two muscle groups (e.g. lower arm and thigh) with attached points of origin.
Circulatory system	Heart, arteries and veins into and/or leaving heart and, at least to some extent, all round the body

Table 2 Definition of organ. (designated by a small letter) (Reiss and Tunnicliffe 2001)

Level 1	No representation of internal structure
Level 2	One or more internal organs (e.g. bones and blood) placed at random
Level 3	One internal organ (e.g. brain or heart) in appropriate position
Level 4	Two or more internal organs (e.g. stomach and a bone 'unit' such as the ribs) in appropriate positions but no extensive relationships indicated between them
Level 5	One organ system indicated (e.g. gut connecting head to anus)

Level 6 Two or three major organ systems indicated out of skeletal, gaseous exchange, nervous, digestive, endocrine, urinogenital, muscular and circulatory

Level 7 Comprehensive representation with four or more organ systems indicated out of skeletal, gaseous exchange, nervous, digestive, endocrine, urinogenital, muscular and circulatory.

Results

Both authors analyzed the drawings separately by inspection for indication of organs and systems. In accordance with the rubric used by Reiss and Tunnicliffe (2001) and the number of organs belonging to each system were not noted in these tables. just the occurrence of the presence in a system. The number of organs indicated and their position on the drawing indicate the definition of Level of knowledge. However, the organs of the digestive system that were mentioned were stomach, liver occasionally esophagus and bowel. Bones shown were rib but no sternum s, limb bones. Some drawings indicated the navel but as a surface feature we did not included this.

Table 3

Data from all Mothers and all children. All at Level 4

Summary of organs included in drawings. n= nervous system, s = skeleton, r = respiratory system, u = urogenital system, c – circulatory system and d = digestive system. No Representative so the muscular or endocrine system were drawn. The participants drew the navel, an external feature.

Drawer	Average age	n	s	r	u	c	d
Mothers N = 17	28.8	17 (100%)	17 (100%)	3 (18 %)	6 (35%)	0	9 (53%)
All children n = 25	10 (40%)	25 (100%)	25 (100%)	5 (20%)	13 (52%)	2 (8%)	15 (60%)
TOTAL 42		42 (100%)	42 (100%)	8 (19%)	19 (45%)	2 (5%)	24 (57%)

Of the organs of the digestive system, indicated as ‘d’ in the table, which does not indicate the number of orphans cited, bowels and intestines were most often mentioned. Women indicated a liver also in the cooer t positing. Of the bones mentioned, they were drawn in units, arm bones, leg bones, I (upper limb, lower limb with one bone each lower part of the limbs, each segment and slime hand or feet bones. Chest bones, indicating sets of ribs bit no sternum, all floating and as 2 sets, one each side of the chest, (The correct number of ribs indicated. Of the nervous system it is the brain, (n) in the correct position. It is interesting that in all other date collected elsewhere the kidneys are drawn, two mothers indicated them in the correct position but no ureters and bladder were

shown . According to the Reiss and Tunnicliffe analysis two or more component organs an of the digestive system (d) shown at the approximate correct position would at level 4 and the other systems, nervous, urogenital would be level with only one organ belonging to that system indicate in the appropriate position.

Table 4 Summary of data of five mothers and their sons compared (numbers of occurrence not of organs in the system).

Drawer	Average age	n	s	r	u	c	d
Mothers N = 5	32.4 yrs	5	5	0	0	0	5
Their sons N =5	10 yrs.	5	5	4	0	1	5

The sons had received some primary education where they apparently learnt about the lungs and one drew a heart.

Inspection of the drawings showed that the most organs known in a system was the digestive system but the esophagus, stomach, intestines and bowel were mentioned by many participants a complete system (according to the Reiss and Tunnicliffe definition) was not indicated. Likewise no bone systems (skeleton) was drawn but 3 bone sets, each counted as an organ, were mentioned but were drawn in isolation in the appropriate location within the body. These 'bone sets' were, chest bones, leg and arm bones chest bones.

The participants, not the mothers with their sons ,but the other twelve women, were asked 5 questions:

1. Do you know about inside the parts of the human body?
2. How did you draw inside the parts of the human body?
3. Did you look the picture of inside the parts of human body before?
4. Do you know how to work inside the parts of the body?(How the body wroks)
5. Do you want to learn internal anatomy?

The facilitator wrote down their responses in English in a table, which is summarized below. The answers presented are those of twelve mothers who participated voluntarily but without their children. They all answered “No’ to the first question. However, in response to the second question ten mothers said that they just assumed the information but two said they had known it before. Every mother replies negatively to the third question whilst the responses to question 4 about their understanding of the working of the body varied. Two of them replied that they worked it out by what they thought

human internal anatomy would be by extrapolating from that of animals which they knew, presumably from cooking and looking after goats. Four mothers had heard from others or their family and six responded that they did not know All the mothers replied positively to the last question, number five, which asked if they wanted to learn more about the human body. The children were not asked these questions.

The knowledge, accurate or otherwise, in a community is the most frequent source of information mentioned. However, two residents said they had worked out the anatomy but applying their practical knowledge learnt from cooking animals. Women who had come from one in Northern Bangladesh where people visit to purchase kidneys had a knowledge of kidneys (urogenital) which from the literature of other countries has not been noticed.

Discussion

Examination of these data show sons knew more than their mothers. The sons had all attended school. Theses children had more knowledge of the inside the human body than did their mothers. All children knew more than the women. All of women did not learn to about inside the parts of human body from any school and college but from their communities and their own observations. Indeed, it was noticed whilst they were filling in their body outline drawing that they felt bones in their own bodies to find out where bones are before they inserted representation on their drawings.

All mothers knew the same organs, bones, brain and bowels (organ of digestive system). Several mother knew about kidneys and the correct location. The age of mother is not factor about knowing level inside human body. Four out of 5 of the sons knew that we have lung and 2 out of 5 sons knew that we have kidney. 1 out of 5 sons knew that we have a heart. The age of sons appears to be a factor about knowing about the inside the human body but these children have attended schools, their mothers had not.

Discussion

The evidence from the data from the drawings reinforces the observations of Hipkins et al. (2000) that there is the context is important when teaching systems and reinforces the suggestion first voiced by Tunnicliffe and Reiss and reiterated by Manokore and Reiss (2002) , that teaching organs of the human body should begin as learners do spontaneously, with learning organs and assembling them rather than a desegregation for a system to the component organs.

The work reported in this chapter indicates how much human anatomy is learnt in the everyday. Children of the same women who were receiving education knew a few more organs than their mothers but again no systems. The knowledge of kidneys amongst a group of women hailing from the same northern rural area of the country is explained anecdotally through two different personal communications from local people that

villagers in these areas are encouraged to sell a kidney, hence the location and name is known the community. The study indicates the knowledge of human anatomy that is acquired from public understanding and own observations amongst members of communities where participants have received no formal education but highlights the increased understanding held by children of these participants who have received formal schooling. Theses data have implications for the various heath programmes, which are developed, in countries for people with little schooling. Information needs to eb a se don the everyday understanding, and, when related to internal anatomy and physiology, start with what the participants have found out from everyday.

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Education, Vol. 7, No. 2, 2008