Chapter 3 Other animals

Abstract

Animals fascinate children. This chapter discusses the understanding and interest of young children about animals, vertebrates and invertebrates. The information has been derived from research, observations and from particularly the analysis of drawings created by children of animals. Using drawings as such a technique in establishing primary children of the internal organisation of a variety of organisms is becoming more frequently used.. The analyses discussed are from children's drawings of vertebrates, themselves, birds, fish, and invertebrates, namely crabs, earthworms and snails as well as external views of insects.
Drawings were analysed by using a rubric which has adapted for use with invertebrates based on the level of occurrence of organ systems. The drawings are scored per the rubric. A children mature they produce more realistic drawings but gradually learn the internal organs of an organism and even the systems. Of which organs are a part. Young children use their understanding of themselves as their template or reference point for the structure or anatomy of other animals, internal and external, and for physiology and discussing behaviours and needs. In some organisms, the influence of popular culture and pictorial fiction books can be identified.

Introduction

Scientific literacy is increasingly the term used to refer to the understanding of scientific concepts and processes which are considered needed for citizens to be ineed to make decisions and evaluate evidence put to them regarding issue in society. Acquiring scientific literacy together with developing literacy in terms of talking, listening, writing and reading as well as numeracy, is a complex task for most early years' pupils? Biological literacy begins developing too from these earliest years, as children are biological being hence acquire understanding of basic life functions from first-hand experience as well as a basic understanding of biological form and function of organisms in their relationship with the environment (Freeman & Bracegirdle, 1971; Ghazili & Tolmie.). However, even in the first quarter of the 21st Century the situation has not improved since the statement of Tunnicliffe and Reiss (199) that ,' ..to date insufficient work has been carried out on how children view living organisms in the environment'. Korfiatis and Tunnicliffe (2010) point out that a two-year-old boy had five words of animal in his first fifty words and point out that observing animals feeding as well as what they do and where they live is a frequent lass time of every young children and thus biology becomes part of a child's conceptual framework from the earliest year. Disappointingly, despite the recognition by some educators of the critical age for learn biology (Tunnicliffe and Uckert, 2011) the studying of the relationship of living organisms to each other and their environment is only a small at of school curriculum in most countries.

As educators, we are interested in how children learn. Children have an inherent interact in natural objects, and animals are an important focus of their interest (Tomkins and Tunnicliffe, 2001). Young children are in some consumer societies given toy animals, most usually of a mammal, made of fabric to whom they often have great attachment and can recognise the real animal the soft toy resenting even though such toys are often rather unrealistic and stylised. The movement of animals, attracts the youngest child, Young children want to touch ankus, that come near them but at first do not understand the correct direction of stroke for small, e.g., a pet cat and stroke the hair the wrong way, which cats do not appreciate. A very young child will just grab the fur. Gradually a child usually learns the successful way to interact. They are fascinated by animal and enjoy seeing various kinds. Many parents who can afford such visit take young children to zoos which are usually included in the 'Activities for children' section of guide books

Children also like to draw. Drawings have been intimately linked with humans and communicating for centuries (Katz, P., 2017). As a biologist how beginning learners, emergent biologists, learn about organisms has always intrigued me for it forms the basis of their understanding of which we teachers ought to understand so we can scaffold their further learning based on what they accurately know or the misinformation they have acquired. A means of eliciting that which children do understand can be through analysing their drawings. Indeed, drawings have been used increasingly in science education research studies in recent years as a way of eliciting people's understandings about phenomena. Ainsworth etc al (2011*)* assert that students wall deepens their understanding if they generate their r own representations. A drawing does not reveal all but an indication of what the operons, in this case a young learner, understands in as much as they can draw the information. Sometimes a child will say that they not cannot draw what they want to. However, the analysis of such learner constructed drawings can be useful for educators in providing some of what children think of both the external and internal structure animals, humans. other than their own kind. Asking children with their drawings between you may elicit further information and clarify what they were trying to represent. However, such an approach is not always possible and is dependent on both involved understanding the same language whereas a symbol in a drawing is universal.

Children notice and find out about living creatures around them, including images in the home (Tunnicliffe et al, 2008). Seeing such can provide opportunities for understanding these inhabitants of our everyday world or further afield world. Indeed, observation in the early years is very important for emergent scientists and that this skill is the most important s skill to be acquire (Johnston, 2005). Children's interest in common local organisms can be enhanced through observation of nature (Lindemann-Matthies, (2005). Through observations made children may learn about where particular animals and how animals adapt to habitats, which contribute to their science learning (Tunnicliffe, 2013; Bartozeck et al., 2014). For instance, children know, for example, after their very early years that fish live in water, possibly acquired from seeing illustrations in a book, such as *Fish is Fish* by Lionni (1970), hearing the story read to them or seeing fish in an aquarium or in other bodies of water. They notice flying organisms in their everyday life, usually birds of flying insects. Cultural beliefs influence a child's attitude to animals. Furthermore, if adults fear for example snakes or spiders, the children acquire that emotion because children pick up their culture's attitudes to these animal as well as usually those of their family. Young, 4 to 6-year-old, Brazilian children, for example, children call insects "pachinko", which is roughly translated equivalent to "little creature/beast. Prokop et al (2008) acknowledge that emotions affect the attitude of people to the environment and the animals of the environment they articular mentioned bats and spiders as cause of emotional distaste in Slovakian children. Kellert and Westervelt (1984) wrote that it was their belief that it was necessary that a person had some conception of the environment before they formed attitudes toward it and its animals. Prokop (2018) argued that the rapid response of people to animas, which pose a threat of predation or illness, argues that this has happened throughout human evolution. `As humans who survived gradually passed on that ability and became dominant in e the populations. Prokop found that children did respond more rapidly to both predators, disease carrying organism and those displaying warning colouration such as black and yellow stripes, bright reds and orang .

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Although invertebrates have relatively unfamiliar body forms, unlike the more familiar pattern of vertebrates which is more easily identifiable with a child's own body children,, as well as indeed certain vertebrates, snakes and bats for example, and often express distaste of certain invertebrates (Loopy and Wood, 2006; Prokop and Tunnicliffe, 2008). We believe this possibly is because their external morphology and behaviours are not as familiar as that of other vertebrates that children are used to but invertebrates do attract children´s curiosity as many primary teachers and parents will testify. Young children delight in turning over stones to see what is living there, frequently small earthworms and slugs, centipedes and particularly woodlice. Such kind of experiences may, some researchers feel contribute to further science achievement (Spektor-Levy et al. 2013).

There is relatively little published about children's understanding of both vertebrates, for example, Tunnicliffe and Reiss, (1999); Bartozeck, (2011) and even less on invertebrates. Prokop at al., (2007), Rybyska et al., (2014), Tunnicliffe (2015) have all researched and written the understanding held by children of the internal anatomy of invertebrates per children´s ideas.

The vertebrate pattern is more easily recognizable and identified by people as it has a distinct familiar pattern. Namely a longitudinal rounded rectangle body, four limbs, one at each corner, a head at the front end which leads as the animal moves and a tail at the other end, over the exit of the through tube the gut or deserve system. The evolution of a through gut was a big breakthrough in animal evolution as animals became three, layered, in contrast to their two layered ancestors such as the Jelly fish group. Essentially the basic b body plan is a tube with inciter 2 layers' b built around them, gteh in a body cavity and an external cover, the skin. Then food could go in one end, was processed as it traveled this gut, which became hinderingly convoluted and differentiated, waste was stored at the end of, which we call the rectum and voided through a hole (anus) in mammals controlled by muscles (the hole is the anus, the ring of controlling muscles is called a sphincter. Unlike two legged animals where food enters into the body through one hole and waste is ejected from the same opening as in, for example, jelly fish and sea anemones.(Cnidaria Class).

Children very readily crawl along the floor, like a four-kegged animal but realise that to see where they are going the cannot keep their neck straight but must bend it inwards. Ask children how many animals have a short straight neck, examine photographs and videos or observe live animals and notice where their head is in relation to their torso, most have a neck of some form with their head at the end arranged at such an angle that they can see in front of themselves. Observe, say a giraffe and tortoise. It is an interesting activity to ask children to pretend to eb a four legged anikmal and then ask them why they have difficulty seeking if they keep neck straight, in the usual position when they are upright What do other two legged animals do? Bipedalism comes at some price!

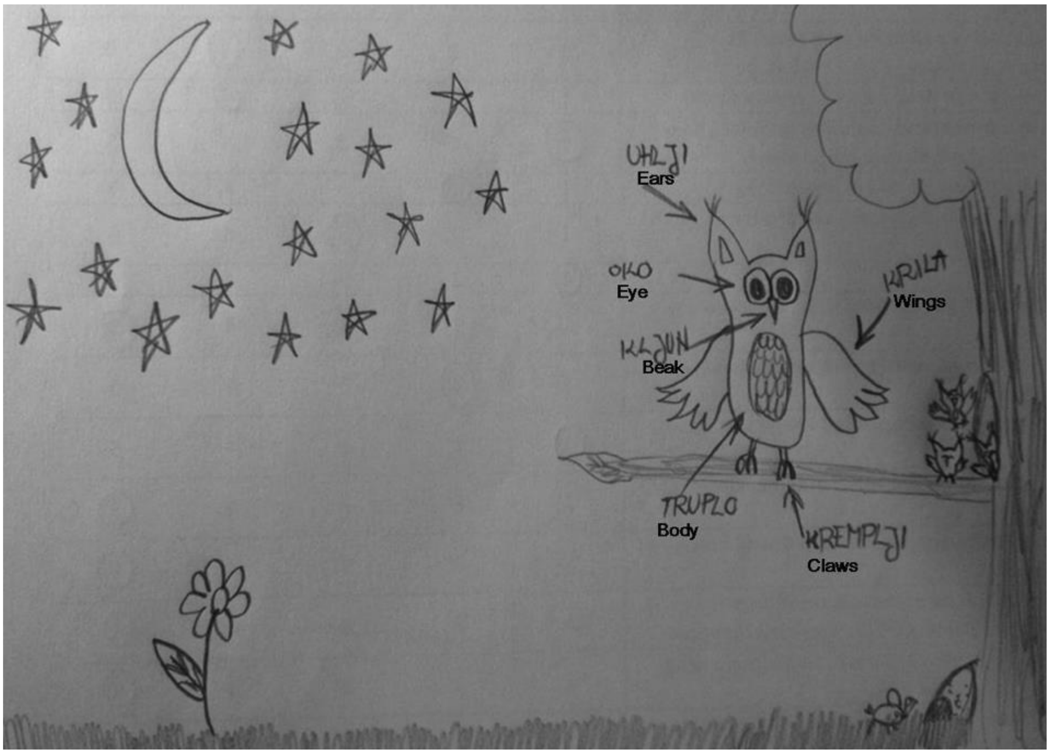
Animals do not have external ear flaps except mammals. Seals are the exception, they do not have ears. If you look at a bird's head for example you can see the opening for the inner ear like a stretched membrane, so it is called, as in ourselves, an ear drum and it moves when it receives sound waves, as a round, covered hole at either side of their head. This may also be seen on Amphibians

The invertebrate pattern is not so clearly defined and depends on different groups. Insects, for instance have, 3 parts to their body, head, middle part called the thorax (We call our chest the thorax) and abdomen. Legs are attached to the middle part, the thorax, and are 3 in number each side. One of the misunderstandings possessed by adults and children is that insects, usually typified by a butterfly adult, called an imago, as having wings and legs attached to their abdomen. Spiders, Arachnids have two parts to their body, a head and thorax as one, called the cephalio (head)thorax, then a more rounded abdomen. Spiders have four pairs of legs attached to the cephalothorax.

Crustaceans, another group of the Jointed legs, hard outside skeleton animals, called an exoskeleton, as body covering group, knows as arthropods. Crustaceans have six pairs of legs This group contains shrimps, the tiny water living animals such as water Fleas, *Daphnia* sp., which are often used as food for fish. Crads, shrimps and lobsters , ware ,livers and woodlice, land livers, which are common under stones and in damp places in colder climates where there is moisture(there is also a fresh water woodlouse, *Asellus aquaticus* to be accurate and most crustacean live in water. Millipedes and centipedes are also `Arthropods but are a different group form ghee insects. Another invertebrate animal without bones , are the segmented worm group, children notice these. Most often seen are earthworms in temperate climates, and the Molluscs. Molluscs are slugs, and snails and the cephalopods, (head-legs), like squids and octopi one with an external shell the Nautilus. These all had a skeleton which was once in their distant ancestors as a shell in Molluscs like snails, and but very reduced in slugs. Octopi and squid do to have a skeleton, but are bilaterally symmetrical (One side replicates the other and have eight pairs of legs arranged in twos which look like tentacles and two long tentacles. They use their strong muscles to move. including jet prolusion with jets of water. Squid and cuttlefish have eight arms and two ol tentacles. Cuttlefish have a hard shape inside known as a cuttlebone, often given to caged budgerigars. One Cephalopod, a Nautilus, has a coiled outer shell, the others do not. Nautilus **has** a spherically coiled external shell. Squid and cuttlefish have a smaller internal skeleton but octopi have no hard skeleton at all.

All Cephalopods have had two well-developed eyes used in hunting prey. The insect and crustacean classes of outside skeleton groups of boneless animals, the Arthropods, have large compound eyes on their heralds Children may have noticed these on butterflies and moths or on flies, like the blow flies which settle on food sometimes. These eyes are made up of many similar shaped seeing- units so the animal sees many separate images unlike us with only simple eye. Lenses replicating the view seen by insects and crustacean have can be bought from equipment suppliers. We humans each usually have two simple eyes. Arachnids, gteh slider groups which includes daddy long legs, harvestmen (ticks, Scorpions, also have simple eyes bit differing kiss have a divert number of eyes and harvestmen have two eyes knee on each stalk. Some ticks do not have eyes at all. The true worms, sometimes called segmented worms or ringed worms, because they have a long body which looks like a pile of rings joined together, have different light receptors, not eyes but cells sensitive to light. Arachnids have different numbers of eyes. Scorpions, for example, which are Arachnids, have 7 pairs of simple eyes ln their heads
Eyes are essential light sensors and the less developed animals such as the earth worms (Annelids) do not have eyes like vertebrates or insects but have light and touch sensitive cells called receptor cells. I have observed some birds on my lawn simulating the impact of rain by jumping up and down near an earthworm's burrow and eat the earthworm if it emerges from its burrow.

Finding out the external features of an organism children know



v Figure xx drawings by Slovenian early years child of the external features of birds Trocar et al, (2017

Figure 3 is a drawing of an owl by a primary aged child in Slovenia the external features the child knew and drew are labelled, and English written by them I have invariably found that young children will draw a composition of an animal l in its habitat hen asked draw external features used in deciding what is that animal. Children will often draw the external form of some animals as in their drawing of a human, which, when they have mastered a degree of visual reality has some semblance to the animal, (see Tadpole Man p. 00 chapter 2) they gradually become realistic. `

An activity often carried out with young children is making 'butterfly' prints from painting an outline on one half of a piece of paper, then folding at the middle the age, folding the paper and pressing when unfolded a mirror image but not an accurate one has been made looking like a whole image referred to by all as a 'butterfly' it is an icon not a realistic image

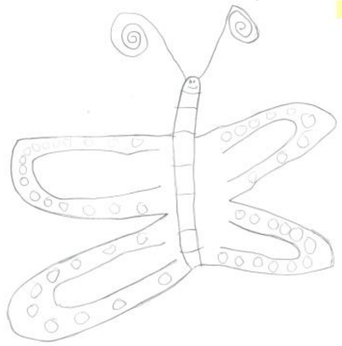


Fig 3 300. A butterfly drawn by a 5-year-old Brazilian girl

This is also an activity used in maths work when we are exploring symmetry and images. Fig 3 3 shows developing learner's attempt at drawing a realistic picture of a butterfly

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A study of 4 -6 year children in a region of Brazil highlighted that the understanding of what is an insect is mainly contextual and a few children take spiders and scorpions to be insects (Bartozeck et al 20017) In the pre-school years in Brazil, natural science [animals/plants/organ/organ system] is poorly covered. Practical classes with insects are seldom done and field trips rare...! This is not an uncommon situation in other countries

The procedure employed in this study, as an exemplar of that used in others, for asking children to draw is simple All that is needed is a piece of paper A4 is usually used, and a pencil. The straightforward instruction is given, 'Please draw for me on the sheet of paper an insect which you have seen and/or what 'insect' means to you'

(Stein et al., 2001). If the understanding of internal organs is the subject the appropriate wording is inserted. Children are asked not to share and do their own work.

Children find out about animals from a variety of places. Tunnicliffe and Reiss (1999a) found, when interviewing children, with animal specimens as cues, that cool, books and media were not the man source of information but that observation of an animal and their home was. Lindemann-Mathies (2005) Noted that boys in Switzerland had more interest than girls in wild annals and bossed a better undertaking of invertebrates and had a more aciculate concept of invertebrate internal organs as they had observed more ‘in the field’...

Tunnicliffe et al (2013) looked at the knowledge children (ages 6, 10, and 15 years) have of animals from a cross-cultural perspective. Students from six countries (Brazil, England, Finland, Iceland, Portugal, and the United States of America) were asked to free-list as many animals as possible and state where they had seen or learned about the animals. The results were analyzed and they indicated that firstly these learners are aware of animals. Secondly they are more aware of mammals as examples of animals. The work confirmed that there is a globally shared folk biological knowledge of animals which children learn and that, lastly, children learn about animals during sociocultural interactions.

Prokop et al (I) in a study, again in an analysis of other data and 1541 drawings made by children in Slovakia, a mid European Country found that looking after pets has some advantages. The keepers learn, factual and conceptual knowledge of their pet and the mind of animals as well as developing these animal’s social interactions. Additionally, these young animal keepers acquired biological; understanding. The study found that the pet keeping children knew more about the internal organs of their pet than did the non keepers However, their understanding of invertebrates was sparse and bones were often drawn inside representations of invertebrate animals. Inagaki (1910) studied Japanese children who kept goldfish. Goldfish keeping taught the keepers more about care and interveinal anatomy than non-goldfish keepers. Moreover, the child fish- keeper could predict from their knowledge the internal anatomy of ore vertebrate animal, the researcher used a frog as the test animal.

External features of animal, boned and boneless

Children recognise boneless animals as they do boned animals by their shape, bits that sick lout and colour and activity. Insects and warms are the most frequently referred to invertebrates, boneless animals, in my experience

Hence insects are often called ‘bugs’ which is, scientifically incorrect, as is the term minibars I knew the School inspector who was also a biologist how coined the term, she said primary teachers and children cloud not manage, ‘invertebrates. (Collis, M personal communication, 1989). I did remark I disagreed, in my experience both teachers and children are quite capable but the term boned and non-boned is a useful half way term. Many young children delight in saying complex names, often they are expert in the names of dinosaurs for example True Bugs are separate insect groups. Children recognise and name animals from their distinctive shapes, colours and behavior butterflies, bees and wasps and ladybirds. Thus, true bugs belong to the order Hemiptera they have piercing mouth like greenfly, which belong to a family, called Aphidian, the aphids and suck juices out of plants. They are not the same group of insects as mosquitos or fleas which such blood.

A zoologist (Baker, 2011) complied the following list of the characteristics of an insect. These are all features and behaviours that can be seen involving the whole insect. It is an interesting exercise to find which characteristic children find most obvious and hence important when they call something an insect. Size and where it is seen also seem to be part of a child' repertoire.

- 3 pairs of legs used for walking but sometimes adapted for jumping;
- 3 parts to the body: head, thorax and abdomen;
- Exoskeleton characteristic of invertebrates;
- Anus at the end of abdomen (no post anal tail as in chordates)
- Compound eyes;
- 2 pairs of wings (attached to thorax);
- A pair of antennae on their head;
- Complete (incomplete) metamorphosis (egg/larvae/(nymph)/pupae/imago)
- Need food, air, and moisture to live.

The following criteria were use by (Bartozeck and Tunnicliffe, 2017) to establish the drawings as recognisable as an insect and which features were portrayed? The salient features drawn which the children found seminal were mainly wings, antennae, legs, body which was sometimes elongated.

Table 3. The rubric used for allocating a grade to the drawings was designed to assess the knowledge and understanding of children about insects asked using the above table. (Bartozeck and Tunnicliffe, 2017)

Level	Insect characteristics
0	Nothing recognisable
1	Scribble I
2	Scribble II with resemblance to body and appendages
3	Has resemblance to an organism with legs and/or antennae
4	Has resemblance to a caterpillar (head/body/appendages)
5	Single body, wings representation, often as a single structure with 2 lobes and/or antennae.
6	3 parts of body and/or antennae or wings.
7	6 legs and wings or antennae.

8	3 parts body, 6 legs on thorax, 1 or 2 pairs of wings, antennae.

Data from this study (Ibid) show that these South American children held a concept comparable with similarly aged American pupils, indicating a universal development of the concept insect. (Shepardson, 2002, Barrow ,2002). In this Brazilian study the most often mentioned insect's were butterfly, beetle and ant, bee. Drawings showing a general insect pattern, sometimes with many legs, antennae and wings, ware created.

Young children often draw the iconic features of a human face. The image created by this young boy in brazil of an insect, in figure x, unusually shown with three parts to the body and six pairs of legs, but only 1 pair of wings (Some flies called the dipteral, do only have one alike for functional wings, the second pair are so reduced and form balance like structures next to the first pair of wings. Beetles (the

Fig 3-04 the outside of an insect drawn by a 5-yr. old Brazilian boy

Coleopteran, gthe beetles, for example ladybirds, has one pair of wings working as swings. The first pair has become hardened and forms the hard covering, the wing case, over the second operational pair that actually propel the animal through the air Whedn thdeyh l, and ted xsedcind p; air fvold up and ghe wing case bhakves close over them. This is easily observed when a ladybird flies and lands, or any other beetle. A five-year-old Brazilian boy drew the insect in Figure 3.04, drawn more accurately than is usual, as part of this study. The arrow on the drawing seeming to indicate possibly a location is unknown to us! Interviewing also can elucidate such points.

Inside animals without bones. Internal anatomy

Young children use themselves as the template for other animals. Vetebrate organs are often indicated inside invertbrates. An unpublished study of Tunniclifefe and Reiss asiknbg chjldren of 5, 7, 10, 14 yhrs s and Cambridge educatgikon and b iology undergfradautes to draw the interal organs of a cfrab,. Thwy wer tiaken a fresh crab b oughtg at alocla supermarket to observe, inderted in nealry all dawinsg, even ghje biology and educgtaion undergraduates, boines. The exoskeleon of a carfb tgeh ard ojutger ckvereinbh is very obvious!.

A class of seven-year-old pupils in a primary school in an English town had, in the previous year in their primary school, kept a wormery and observed the earthworm inhabitants in action. They were asked, with the usual instructions, to draw what they thought was inside an earthworm

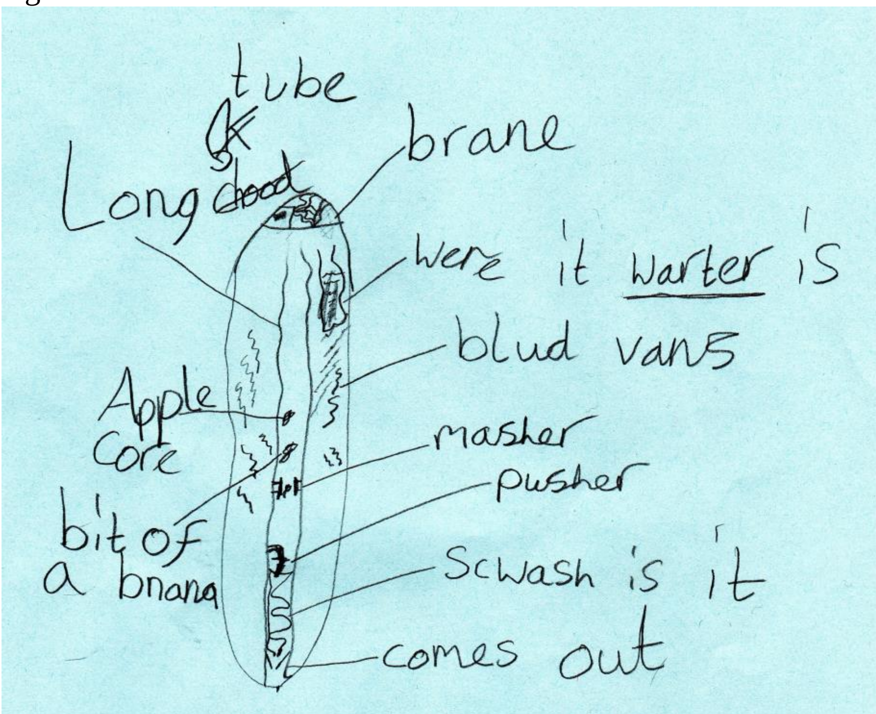


Fig   a drawing by an 8-year-old boy of inside an earthworm.

A class in altogether local school of gteh same age had not ever kept a wormery and had little knowledge of earthworms and did not realise that the animals had a through gut, which the other class nearby all did because they said they had watched the worms eating, pulling leaves into their burrows and the development of worm castes
4 girls drew lungs, this indicates they have an understanding that organism have a respiratory system but no understanding of the mechanisms in these
The views of a class of 28 7-year-old English Children of internal anatomy of an earthworm (14 girls, 14 boys)

These children had kept a wormer the previous school year. Their class teacher cued them in by talking about the wormery and what the worms did.

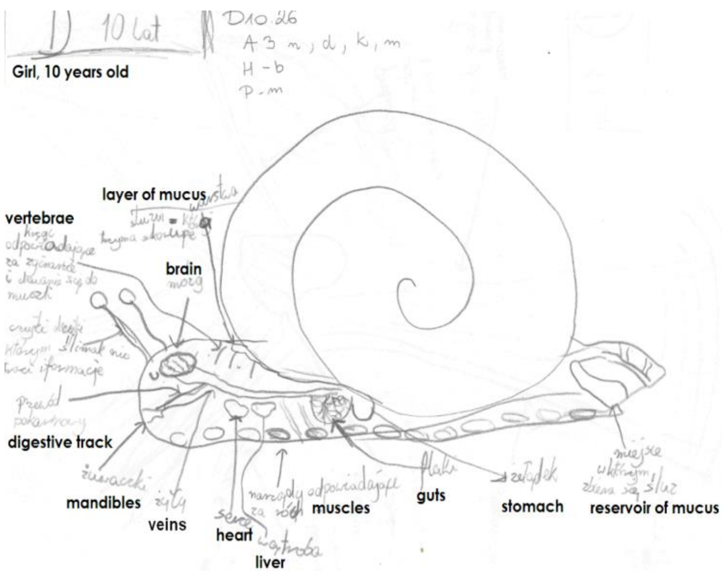
They were asked, with the usual instructions, to draw what they thought was inside an earthworm.
There were 28 children. Two boys 5 girls one of whom also mentioned mouth, others had the gut beginning behind the Central ganglion (counted as brain if that is as it was labelled), but no obvious opening.

4 girls drew lungs; this indicates they have an understanding that organism have a respiratory system but no understanding of the mechanisms in these invertebrates. One girl (no 26) drew and labelled a covering of slime externally. 2 children one boy and one girl drew very similar excretory tubes. 2 children indicate d pores externally. Indicating an awareness of the need for an excretory organ

one child (female) produced an external view showing segmentation. Scored as a level 1 as no internal organza indicated. One dirking indicated a boy) indicated bones, 3 boys and 2 girls labelled DNA in blood.

Blood in the body cavity was indicated in several drawings as was a heart, these were scores as c for circulatory system, one girl drew a gut with an opening and an anus hence was given D for a system. One girl (no 3) indicate then role of different parts of the gut, masher, pusher, squashes it out invertebrates.

Sven year old polish children e were asked to draw the inside of a snail. All children drew any organs in the foot of the snail. Three drew literally a home, as they understood the term, a bedroom whim curtains at window inside the shell. Such understanding is possibly gained from the early children’s literature where the text talks about the snail carrying its home on its back. “Home’ is taken literally by the children as a home, like theirs. They do not learn that animals have homes suitable for them, serving gthe same function as our human homes. It is as it is in other animals a place to live, such as a burrow and is a place of refuge. A snail’s shell is a protection, from attackers and from the dry atmosphere.



Bartozek et al (2016) worked with in a particular Brazilain locality and asked them what thedy knew aboujt the intetnal anatomy of a particlar crab, the subtropical Brazilian crab which lives in near-vertical tunnels in mangrove swamps, or among rocks near rivers and the coast. The crabs may be seen in them borrows close to tree roots, but some climb onto tree branches growing in the swamps. They are food in Brazil and cooked too by local people, the local less affluent families collected them in season and sold gem so we thought as they saw them cooked and eaten at home the children might have more undergirding fo gthe internal anatomy
These drawings were analysed using a modified fabric as follows

Table 1. Organ and organ system scoring rubric scale.

Level 1	No internal recognisable organs.
Level 2	One or more internal organs showed at random.
Level 3	One internal organ (e.g. heart) in appropriate position.
Level 4	Two or more internal organs (stomach, gills) in appropriate position but no extensive relationships indicated between them.
Level 5	One organ system indicated (e.g. gut connecting mouth to anus)
Level 6	Two or three major organ systems indicated (e.g. digestive, circulatory).
Level 7	Four or more organ systems indicated.

(Adapted from Reiss and Tunnicliffe, 2001).

The researchers used an organ g=rubric specific to crabs, an invertebrate belonging got gteh class of Arthropods, Crustacea, with non-vertebrate systems, agreed a definition of organs belonging to a system to complete the rubric scale above. The recording technique of small and capital letters was still employed.

Table 2. Organs belonging to an organ system.

Nervous system	Cornbraid ganglia, supraesophageal ganglion, circumesophageal ganglion, thoracic ganglion, abdominal nerve, optic nerve, nerves
Digestive system	Cardiac stomach, hepatopancreas, middle (small) intestine, posterior (large) intestine, cecum, anus
Circulatory system	Heart, lateral right branch blood vessel, lateral left branch blood vessel
Muscular system	Muscles in the legs and claws,
Excretory system	Bladder, kidney, vas deferens, excretory hole
Respiratory system	Branchial chamber, gills, openings to the outside

Reproductive system	Testis, deferens channel, ejaculator channel, penial papillae, ovary branches right and left, spermathecal

(Adapted from Felgenhauer, 1992).

In summary, the basic statistical approach applied for analysis of these data revealed a modest mean levels growth similar for both age and sex, the one exception being the 10-year-old boys, which was higher than that of the 12-year-old boys.

Most of the drawings of kindergarten children (age 5) achieved level 2 and/or level 4, with girls having higher percentages per the rubric used to allocate a grade to the drawings (Table 1). The most frequently represented organ on the drawings was the heart (85%), followed by the brain (35%), and the least frequently represented organs were the kidney and bladder. Boys and girls represented almost the same percentage for the same organs.

Most the elementary school children (age 10) achieved level 4. The most frequently represented organs on the drawings were the heart and brain and the least represented were the kidney and gills, whereas the 12-year-olds did represent the heart and gills. The most frequently represented organ system was the digestive system and a few represented the respiratory system (see Figure 9).

How crabs 'breathe ' was one of the physiological aspect the children did not understand In most of the drawings of the respiratory system of the crab, pupils included the lung, which is typical of vertebrates and did not draw the plume-like gills that do allow the crab to' breath' Young children an even older ones and adults in our experience assume anikmal breathe air not realising or remembering that vertebrates obtain their 'air' in solution in water but the laces of oxygen entering water occurs in the lungs. Some vertebrate, the amphibians also absorb oxygen through their damp skins live in moist places and. These drawings show again pupils using themselves as a template for what an animal needs to live. However, this did show that they were aware that the organisms needed 'lungs', presumably to breathe. Likewise, the inclusion of bones and other organs, such a s a stomach inside invertebrates shows an awareness that such systems are necessary for life but the drawer is uncertain as to how this is achieved. this same use of the known human template approach is seen in work about inside a fish, too always taken to mean a body fish. The understanding of vertebrate and invertebrate respiration is one of the organ systems of which caldron do not know. Very few children in children in 'fish;' drawings showed gills, most often do show the edge of the operculum as a curved line. Some children in England at the top of primary age range, taking it to cease at 11- 12 years, beginning officially at 5 years, understood respiration of the water living vertebrates the fish and the sequence of gills ad mouth although in countries where am amphibians and their tadpoles stoles are seen and studied they re ware love eternal bills. Many chider's books, faction and non fiction portray gteh tadpole as the young stage when in fact it is the adolescent, The young are the tadpoles with external gills which emerge from the frog spawn. As the gills become covered the young animal is beginning to change to its adult form. As in

Brazil few primary children have the opportunity for making first hand observations on this function.
Insect respiration perplexes children and if skid to draw internal structure do unsift dungs. The outside entry hole for breathing in the insect body, spiracles, small openings, along the animals sides seem unknown as is the internal tracheal system od small tubes taking oxygen to parts of their body. Crustaceans have external gills on their underside and can easily see. They must be kept moist otherwise these animals swill suffocate, such anteed explains their natural habitats, water or damp cool place for land livers such as woodlice. (Chapter). Earthworms live in moist cool places and oxygen is absorbed through their moist skin. Molluscs, on land with a large muscular foot are either lugs or snails, Slugs are like snails but their shell has nearly all gone. Most have no visible shell, but do have a breathing hole or pore on their outside and have a lung inside. Land living slugs and snails have a breathing hole scientifically called a pneumostome, you an see it in snails just below the edge of their shell and just below a bump on their back in a frequently seen slug in the UK. Inside is the snails shell and slugs body as their hell has largely gone, an has developed from the gills. Snails and slugs do have a lung, into which air goes when they open their breathing hole and then e dissolves. Land. n fresh water snails invers this is where the gill is. Some freshwater snails do have a lung, and they can be seen coming to the water surface to breathe and you can see clearly the breathing hole open. They don’t open it underwater, just like we humans and other mammals, do not breathe in under water. Whales and other water living mammals come up to the surface for air like do human divers with out air breathing equipment and have to hold their breath under water,.

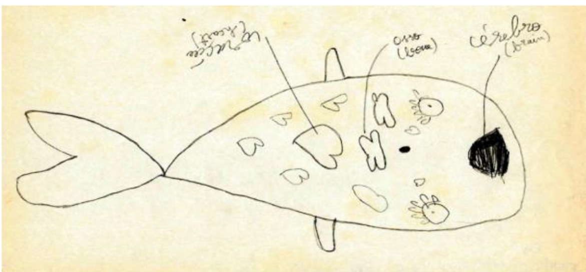


Fig 3 00 A drawing by a preschool Brazilian boy of a fish shows the child knew the anikmal needed a brain, a stomach and bones. Sometimes, rarely, a child draws the iconic fish Skelton that is often depicted in cartoons.

Birds were also drawn using the human template. As in drawings of a mammal, bird drawings by the youngest children, 5 hears, often were portrayed with dog bone shoaled images, very characteristic of early learners, arranged around the inside of the periphery of the drawn body cavity. In Fig 3 00 a heart icon is placed in approximately the appropriate position, but was scared as level 4 The bones were not indicating where gthe are, however a brain was also indicated currency.

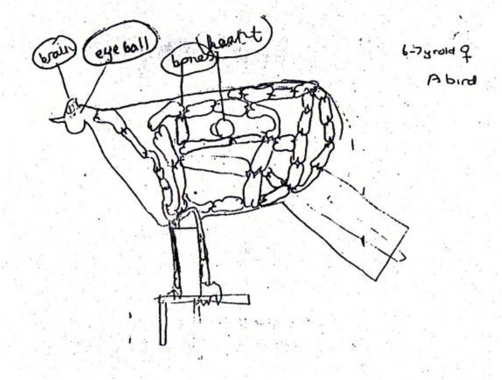


Fig 3 000 Inside a bird drawn by an English girl I class 2 (6 to 7 yrs)

Fug 3 001 shows a drawing made by an eleven old from the same school as the girl who drew figure 3.00 in the same study. They were shown a taxidermically prepared bird, a Starling, borrowed. From a local university zoology museum. The bird exhibit was displayed on a stand , as a museum exhibit. The drawings showed this! Moreover, the children have oriented their drawings to the slanted; posture of the bird readjusting their understanding on the armament of internal organs to fit with this The specific features of the internal organs of a bird are not indicated, unusually has drawn a kidney representation and the liver, thus was level 4, s, d, u, c. These children were not interviewed, thus the meaning of the circles in the body cavity are unknown, together is a possibility this pupil knew about crops and gizzards.

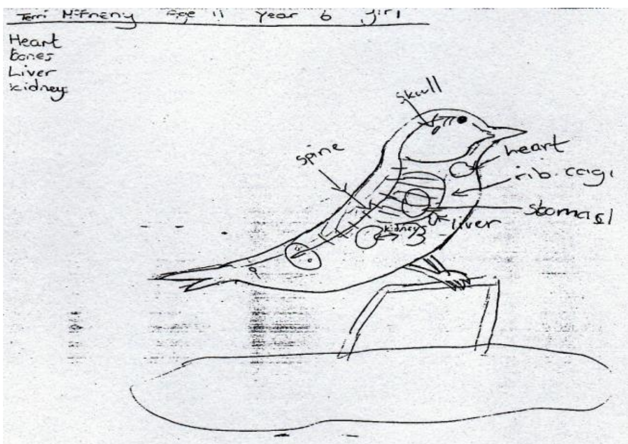
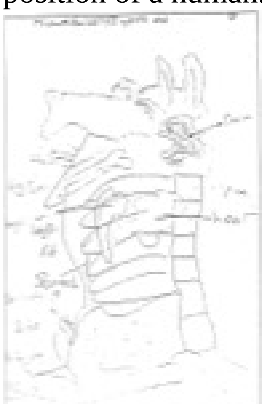


Fig 3 06 and eleven year old pupil's drawing of the internal organs of a bird

Mammals seem the easiest to draw and insert organs for children. The drawing below, from Brazil, is unusual in that it indicates that the child had an understanding of mammalian pregnancy, unless it also indicated that large animals ate smaller ones of their own kind, again illustrating the benefits of interviewing a child after gage have made their drawing. This drawing also shows how children skillfully orientate their knowledge of their internal organs to the axis of the animal of which they are making a drawing. This drawing (Fig 3.?) a, sol shows the anthropomorphic face very often drawn by younger children, the iconic heart shape and the other iconic representation also often seen, drawn by the earliest learners when they have passed through the straight line stage, is the ‘dog bone’, although in this case the image cloud indicate that it had been the dog’s meal. We considered it was probably representative of the child’s understanding that dogs have bones as his way of drawings is often seen in early learners. Hence this drawing could indicate level 3, one organ in approximately correct position, and the ‘baby’ and bone are not. Sometimes a researcher has to make a 'best guess' interpretation, without asking the child we cannot be sure of what they know. Certainly children may often see pregnant dogs, and in more rural communities, other mammals, and the resulting babies and if the family keep a pet dog.

The drawing (Fg 3.7)of the families small dog is interesting because the boy drew the dog siitting up restung on its hind quarters, so could insert the organs as in the position of a human.



The earlier works of Tunnicliffe and Reiss and Reiss and Tunnicliffe (2001) lead to their summarising the development of an understanding off human organs. They

identified a sequence whilst acknowledging that there were exceptions. The following order of growth in knowledge about any organ as being the typical progression of developing understanding of both anatomy and the physiology of an organ: They also stated the limitations of looking at only drains because drawings and the interviews complement each other. For knowledge that cannot or is difficult to verbalise drawings can be especially useful to find the understanding of the pupil. The information can be explained by an interview which is helpful with younger children, especially if there is no label, which is unusual to have on darns of young children. Overall drawings provide a focus for an interview and children will often tell you much more a and can be asked further information with the drawings as a cue to dialogue. Even undergraduates said that they found trying to draw a system you indicate its functions was a challenge not easy to do when trying to indicate mechanisms and functions.
The development sequence suggested is:

1. Awareness of organ
2. Knowledge of name of organ
3. Knowledge of (approximate) correct position of organ
4. Knowledge of one function of organ
5. Appreciation that organ has more than one function
6. Understanding that organ relates to other organs. (Tunnicliffe and Reiss 2006).

Children learn much from directly observing animals in action and making sense of what they see. In school class room this can have problems. However, children observing brine shrimps *(Artemia*) can develop their observation and interpretation skills as well as learning about structure and behaviour, in fact how you can work scientifically. Artemia is a crustacean but has existed since the Triassic period of geological grime, so is a living fossil. Dinosaurs could, had grey looked in tgeh places brine shrimp lived have seen them. Which can be kept in an ecosystem in a bottle, usually 1 litre plastic drinks bottles with a screw top. But require a light (Tunnicliffe 2011), or mealworms (*Tenebrio sp,*) the small ones taht in UK fishermen buy as bait, are excellent animals et to keep in a classroom and children make interesting observations. They are low lost, low maintenance and have no known health hazards (further information and advice ascience.cleapss.org.uk/LogIn.aspx)

Children, particularly girls, may express disgust at first sight but my experience is that they soon become intrigued sand involved One girl I taught and was expressing disgust allowed me to place a mealworm larva ken her open hand and she suddenly stopped grimacing and exclaimed that she could feel the power of the animal as it moved across her hand. She was full of 'awe and wonder' and became involved. Tunnicliffe, (2016.) The more children observe animals the more they notice and begin learning (Tomkins and `Tunnicliffe, if children are to learn accurately and scientifically, not only emotionally only, and realistically about their own human centric world, careful teaching and planned experiences to support the out of school learning and pre school learning of children which happens whatever, are important to both understand and encourage. Such may rise to an understanding of the living world, the issues of sustainability of the planet and conservation of organisms and their habitats.

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