Our body in movement (Ages 8 to 11)

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Summary : This is a module made up with six sequences to discover the human skeleton and understand how muscles are linked to bones and allow us to move our body.

Program content: Human body and education to health, body movements in sports and work.

Issues approached: locomotion, movements

Scientific field : biology

Remarks : This progression is based on a cycle of dance to which the pupils participate and which serves as a starting point. The teacher tries to initiate 8 to 11years old students to the learning process of "solving a problem": alternation of phases of formulation, questioning, investigation and structure. As for writing, whether individually with a diary for example, or reformulated with the teacher during the sequences, it plays an important part to communicate ideas, recenter the debate and structure a knowledge.

Sequence 1: What makes us able to move?

(initial scenario and start of problematization)

Objectives :

- of method:

- To learn to express feelings through drawings.
- To clarify thought, structure ideas and express them in schematic form so as to be able to communicate them to others.

- of attitude

- To put one's imagination to use
- To know how to face criticism

Progress of the sequence :

Subsequent to a dance sequence, the teacher asks the pupils to depict themselves dancing.

- Pooling:

The drawings are compared and it is sought to identify those which best express movement. Pupils' answers are written on the board. It is concluded, after verifying with a few pupils who repeat the movements in front of

the class, that it is when the limbs are bent that movement is best perceived.

- Presentation of own experiment books:

"This experiment book is for you to take notes: everything you think about movement, everything you discover may be noted in this book. You can make drawings. You may take this book home."

- Diagnosis of individual knowledge:

The teacher then asks the children to explain in writing what it is which enables our body to make movements, and suggests that they draw what is happening to their arm as they write. The teacher collects the pupils' work and takes the time to analyse their efforts.

Duration :

Approximately 45 minutes

Material / Preparation :

Per pupil : 1 sheet of paper, felt pens, 1 exercise book

Starting situation :

This progression is based on a cycle of dance to which the pupils participate and which serves as a starting point.

Sequence 2: First statements of fact

(initial concepts giving rise to the problem of bones and their joints)

Objectives :

- **Objectives of notion**

To distinguish the parts of the body which move (limbs or parts of limbs, eyes, mouth, ...) organs which make movement possible (joints, muscles, brain).

- **Objectives of method**

To know how to focus on a scientific issue.

To classify ideas, categorize, reformulate questions.

To formulate hypotheses.

To argue.

- **Objectives of attitude**

To learn to place one's ideas in doubt, and the ideas of others.

To show inquisitiveness.

Progress of the sequence

- Pooling:

After a quick review of the work done in the previous sequence, the teacher lists the body parts cited by pupils in their written work and asks them to classify these answers. This joint classification will lead to pupils to making a distinction between:

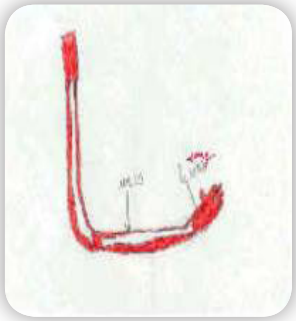
- Parts of the body which can move (limbs or parts of limbs, eyes, mouth...)

- The places where movement occurs which they know under the term of a joint without exactly understanding its meaning; the pupils agree that some parts of the body can be bent, or can turn at the site of the joints (notions introduced during the age 5 to 7 key stage).

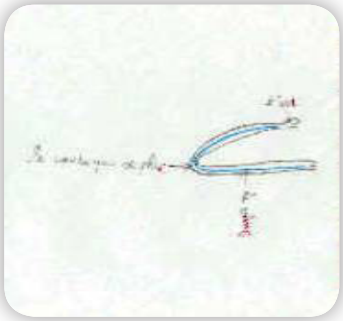
- What causes movement (perhaps the bones, or the muscles or the brain)

- Work in groups

The teacher distributes the five drawings (numbered A to E) chosen from among those pictures drawn individually and asks pupils to compare them and to say whether they agree or do not agree, explaining why. the replies must be entered into a group chart.



A



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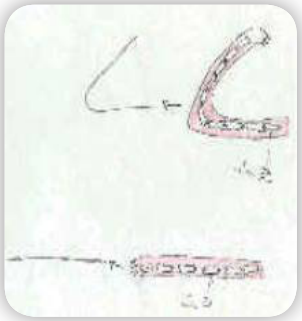

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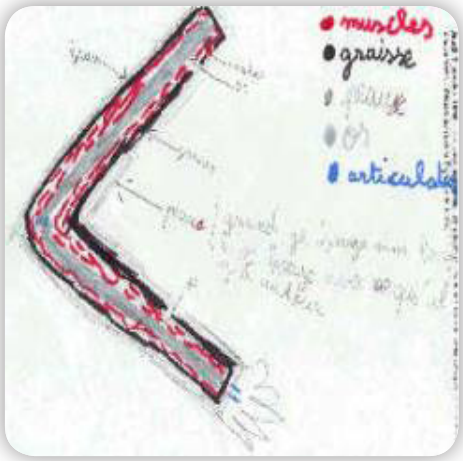

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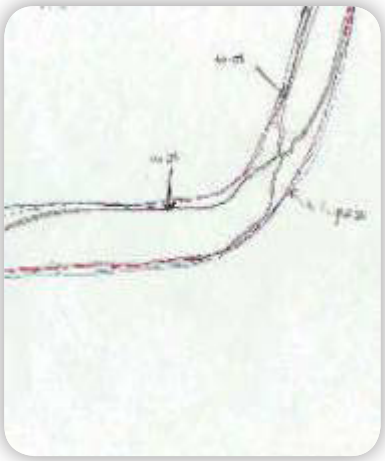

E

Examples of answers given by one group :

B : there are more bones than in A,C,D,E

C : it is not possible for a bone to be completely bent and the vein is not in the bone

D : the key makes it clear

A : the bones are attached

E : the bone of the forearm is not twisted

Duration:

Approximately 45 minutes

Material / Preparation :

Per group of 4: 1 copy of 5 chosen drawings (previous sequence)

Remarks :

Before this second sequence, the teacher makes a wall chart listing the body parts or limbs cited by the pupils in their replies to the question" what makes us able to move? ". The teacher will also have chosen five drawings made by pupils (showing the inner arm) which are the most representative of the initial concepts.

A word by the author:

The five drawings used in the work groups and enlarged, and the written work just completed, are posted on the board. Pupils read each group chart in turn and the ideas expressed are discussed as are the formulations used. The teacher uses the opportunity to lead pupils to making the difference between a finding (we have only

described what we have seen) and an opinion (we agree or do not agree). The teacher prompts pupils to argue their opinion. In this manner some sentences come to be reformulated and they are re-entered into the charts.

Sequence 3: Bones and muscles

Formulation of questions and hypotheses

Objectives :

- **Objectives of notion**

- Relationship between the site of the bones and joints.
- Types of connections between bones.

- **Objectives of method**

- To construct or reformulate questions.
- To formulate hypotheses.
- To learn how to represent what is observed.

- **Objectives of attitude**

- To learn to place in doubt
- To show imagination.

Progress of the sequence

Recall of the previous sequence and joint formulation of questions and hypotheses:

After posting up the drawings and group written work from the previous sequence, the teacher invites the pupils to read the charts once again.

The pupils are asked to formulate clearly what they think they know and the queries raised. A certain number of arguments are started concerning the hardness of bones, the way in which they are joined together, the nature of muscles and the role they play.

On a wallchart, as dictated by pupils, the teacher writes down:

What we think is true as of today (date) concerning body movements :	The questions we ask ourselves to better understand how our body makes movements:
The bones must be attached	Are bones glued to one another, or attached or fused or interlocked?
There is one bone in the forearm and one bone in the arm. There is a joint between the two	Do bones grow?
Bones are hard and brittle, they cannot be bent	Do we have many muscles? Are there muscles everywhere?
Bones are used to make movements	How do muscles grow?
Bones are straight, but perhaps not all bones.	What is a muscle? What is its purpose?
There is no space between the bones (at the joints).	How do muscles work?

Duration :

Approximately 45 minutes

Material / Preparation:

For the class: drawings and written work from the previous sequence

Remarks

These lists show that some odd questions remain (b and d) whose importance pupils are unable to relate to the problem raised by the teacher: work on the problem-solution approach no doubt not being achieved by all.

A word by the author :

The teacher asks " How can we know who is right ? ".

Pupils suggest looking up the subject in books, the internet, the radio, the Encarta encyclopaedia, asking someone who knows (a doctor for example) by observing a skeleton but this appears difficult.

Since the teacher has the opportunity of finding a skeleton at the teacher training college, this is the solution that is first chosen

Sequence 4: The skeleton

Verification of hypotheses through observation of a skeleton and new questions

Objectives :

- **Objectives of notion**

To know the main component parts of the skeleton.

To relate bones to joints.

To relate limb parts to bones.

- **Objectives of method**

To know how to observe reality and to subject it to questions and hypotheses.

To know how to draw diagrams

To know how to relate reality, imagery and vocabulary.

To know how to structure one's knowledge

- **Objectives of attitude**

To show inquisitiveness and creativity.

Progress of the sequence

Recall of the previous sequence:

The teacher recalls the problem on which the class is working and has a reading made of the chart which was prepared during the previous sequence (see table **sequence 3**). The pupils remember that they have to observe a skeleton.

- **Observation of the skeleton :**

Pupils observe the skeleton setting out to reply to the questions asked during the previous sequence. Each pupil draws the skeleton in his/her own experiment book and writes down what they think they have understood.

- **Discussion :**

Throughout the discussion, the teacher introduces the names of the main bones: skull, jaw, spine, ribs, humerus, radius, ulna, femur, tibia, fibula, patella, finger bones, toe bones.

With the teacher's help, pupils formulate what they have learnt and their new queries.

A new argument is entered into, in particular concerning relationships between bones at the site of the joints. On the skeleton model the bones are joined together by screws and bolts, but pupils are well aware that this is not the case in a living body.

They do not all agree that the skull bone is always hard, with reference to what they have heard concerning babies' skulls (Children often make general use of the word tibia for the leg and conversely).

The teacher enters into a chart as dictated by pupils:

What we believe to be true:	Our queries :
We all have a pelvis	Are the skull bones soft ?
We all have the same number of bones	Are bones attached or interlocked ?
The skeleton is the assembly of all the bones	Can bones stick out from the arm ?
There are bones in our feet: we use them to stand up	Of what use are our bones ?
	What is cartilage ? What is its purpose ?
The ribs are attached to the spine	What are ligaments ? What is their purpose ?

It is pointed out here that it is not sufficient simply to observe reality in order to changes one's concepts, and that an investigative observation not only leads to answers but also to new questions.

Together with the pupils, the teacher decides that the investigation must be continued.

X-rays are used to see how bones interlock. Encyclopaedias are used to find the answers to the other questions on bones.

- **Final written record:**

The teacher distributes a diagram of a skeleton to each pupil; pupils must enter the keys using a list of words written on the board; they must write the names of the bones and joints on the left side and the names of the parts of the body on the right side

Duration :

Approximately 45 minutes

Material / Preparation :

For the class: written work from the previous sequence, 1 skeleton, 1 diagram of a skeleton per pupil

Remarks :

It is pointed out that since the launch of the hands on operation "La main à la pâte" , some suppliers market small-scale models of the skeleton (Jeulin for example). If no skeleton is available, it is advisable to use photographs of a skeleton before analysing X-rays, an operation which requires prior knowledge and which could be used subsequently as an exercise to apply one's knowledge.

A word by the author :

The written record is the demonstration of the knowledge approached throughout this study, but it is not necessarily a reply to a problem requiring a solution. Replies may be formulated when all necessary verifications have been made and when all elements of reply to intermediate queries have been found; at this point a synthesis could be made.

Sequence 5: A model for simulation

Further clarification and further questions on making a model and dissecting a frog's leg, followed by documentary verification.

1- Objectives :

- **Objectives of notion**

To understand how bones are connected together.

To clearly identify muscles.

To understand how muscles are connected to the bones and how they can actuate the bones.

- **Objectives of method**

To know how to observe, approach reality and subject it to questions, hypotheses even concepts as yet unexpressed.

To know how to build an explanatory model (model, diagram).

To know how to transcribe pertinent elements of reality.

To know how to explain an action or phenomenon.

- **Objectives of attitude**

To show inquisitiveness, creativity.

To integrate into a group by exchanging ideas and dividing work tasks.

Progress of the sequence

- **Recall of unsolved questions:**

Using the charts produced during the previous sequences, the teacher prompts pupils to recall the questions raised and the answers already obtained. It is agreed that it remains to be solved how bones are connected together and what makes the different parts of our body move. Pupils suggest dissecting an animal and conducting experiments (but they are not sure which experiments).

The teacher suggests dissecting frogs' legs and building models so as to try and understand how bones can be connected and actuated.

- **Group work:**

The class is divided into two halves:

- one half divided into groups works on the rear parts of frogs (the flesh has been removed from one of the legs to expose the two bones joined together by ligaments). The children are given a few instruments (tweezers and magnifying glasses).

- the other half divided into groups is to attempt to re-construct an arm (forearm and arm) and to make it work. The pupils are given all kinds of material (wooden sticks, Meccano parts, adhesive tape, elastic bands, string, modelling clay, paper clips ...)

Each group, irrespective of its activity, must be able to represent what it has observed or built and explain what it has understood.

- **Share information:**

In turn, each group explains what it has done and what it has understood with reference to the drawings and written work, and the elements of reply are compared.

The class agrees on what it thinks it has understood at this point and the teacher enters this information into a chart:

- bones are interlocked and joined together by a kind of string which is somewhat elastic (observed on the frogs' legs)

- they can be joined with long strips of adhesive tape (like insulating tape) , there is no need for screws

- muscles are flesh (frog's leg)

- the muscles are attached to the bones

- if you pull on a muscle it is possible to move a bone to which it is attached

- **Remark :**

Frogs' legs, despite the disadvantage of their small size and differences with mammalian limbs, have some advantages: they are easy to find frozen, children are already familiar with them, the muscles are easier to separate. Later a comparison will need to be made with the human body. This may also help towards generalisation, an important step in conceptualisation. It is to be pointed that the groups who built models only managed to reproduce the joints but not to model the muscles.

- **Document search by groups:**

The class decides to look up their key stage manuals to complete their information and check that they have not made a mistake (2 different manuals per group of 4).

After the group work, pupils enter into their experiment books what they have understood.

- **Pooling:**

The teacher writes on the board what each pupil has to say, helping pupils to reformulate when necessary:

- the ligaments which are a little elastic give strong support to the bones
- the muscles when they contract make the bones move
- the muscles when they contract shorten in length and swell, they become hard

Duration :

Approximately 45 minutes

Material / Preparation :

For the class: written work from the previous sequence

Per group of four:

- Dissection workshop: rear half of a frog, tweezers, magnifying glasses

- model workshop: wooden sticks, Meccano parts, adhesive tape, elastic bands, string, modelling clay, paper clips

Remarks :

Through this work, it does not mean that they have understood how muscles function, but they seem to have understood that the muscles are the motors of movement.

Sequence 6: Joint synthesis

Structuring and preparation of an explanatory text in connection with language activities.

Objectives :

This session was in fact conducted as part of language work. The pupils used their questions-problems as starting point and constructed an explanation making a synthesis of all the elements of reply obtained during problem-solving activities in Biology.

Progress of the sequence

Final text proposal

Our **skeleton** is made up of 206 bones. They are hard and brittle. It is at the **joints** that bones are able to move in relation to one another. This enables us to makes **movements**.

The bones are **interlocked** and held opposite one another by **ligaments**.

To protect the tip of the bones at the joint they are covered by **cartilage**.

It is the **muscles** which enable the bones to move in relation to one another. Muscles end in **tendons** which are attached to the bones.

When a muscle contracts, it swells and shortens in length thereby pulling on the bone and causing it to move

Duration :

Approximately 45 minutes

Remarks :

The teacher may ask pupils to either to construct the entire final explanatory text or provide pupils with a text containing blanks, several levels of difficulty being possible; work tasks can then be differentiated and adapted to respective learning levels.

Outings, developments :

Possible variants according to learning level

- The described experience was conducted with a class of 9 year olds, but with more experienced pupils it is possible to guide them towards identifying the points of attachment of the muscles and understanding the relationship between their location and their role in making bones move. Pupils could be led to forming concepts by locating muscles on a diagram and/or on a model choosing a material to represent the muscles (the bones already being assembled or drawn); in this way pupils can be brought to understanding that tendons cannot be attached anywhere.
- To help pupils understand that it is by shortening that muscles pull on the bones, one young trainee teacher provided pupils with a model she had constructed herself and asked pupils to explain what happens when she made it move. This model was made in thick cardboard, the bones being attached by paper fasteners (the pupils were aware that it was only an artefact) and the muscles were lengths of string surrounded by modelling clay ; these muscles were fixed to the bone with the tacky paste used to post up documents on walls. Therefore when the pupils shortened a muscle while holding one of the bones, they could see the muscle becoming bigger and that it pulled on the bone which was not being held. They could also be introduced to the notion of antagonist muscles.

Another trainee suggested an equivalent model with bones made of sticks of wood connected by mortise and tenon systems.