An Active Approach to Plate Tectonics

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Abstract: The article outlines an introduction to plate tectonics for younger students. It highlights a number of active methodologies such as visualisation, practical classroom demonstrations and mapwork, which can be used to teach in an interesting way ideas which are often considered to be difficult for them to understand.

INTRODUCTION

Plate tectonics is an amalgam of complex concepts and processes which students of all ages and levels often find difficult to understand. I believe the reasons for this are many and varied, but I feel the amount of difficult jargon and the need to be able to imagine and visualise the three dimensional movement of plates is asking too much of students who often have not yet fully grasped the concept of a continent never mind the possibility that they can move. I would argue that plate tectonics is not a suitable topic for most first years but it is often the first topic dealt with in second level geography courses. To compound the difficulty student teachers are frequently given first year geography classes with which they are expected to cover this topic and often as the first topic they have to cover. It is in this context and in the context of the average or special needs student that I hope some or all of the approach outlined below may be of use.

Stage 1: Introducing Plate Tectonics

Since the concept of plate tectonics is quite a difficult one for students to understand, it is probably a good thing that its meaning is seldom explained clearly in text books at the start of the work. It is much better left until the students have some knowledge of the theory. The suggested introduction to this topic would be to look at the very obvious effects of plate movements such as earthquakes, volcanoes and fold mountains and only to introduce the term 'plate tectonics' when students understand these.

1. Earthquakes

Instruct students to listen carefully and possibly even to close their eyes. The following account should then be read as dramatically as possible.

> "Suddenly there was a rumbling sound. First I thought it was a passing truck then it was all around me. The glasses in the press began to tinkle. Very quickly the whole room and everything in it was quaking or shaking. I saw the glass in the window bending in and out, then it shattered sending pieces of glass everywhere. The kitchen table came sliding across the room at me and I had to jump quickly out of the way. I was stuck to the floor with fright. Then I heard Mary shouting: 'Get into the doorway, it's the safest place'."

The passage might be read a second time (or a few times even, if necessary). Then students should be asked a variety of questions based on it. These should be structured to lead from recall and comprehension to questions which involve students reasoning about the causes of the events. The students should always have to justify their answers with evidence from the passage. Examples of introductory questions might be:

- What room was the person in?
- What tinkled?
- What had the person to move quickly to avoid?
- Why might the doorway be the safest place?

With some classes it might be possible to simulate an earthquake by getting half the class to stand up on their chairs while the other half stands on the floor. On the command 'go' the students on the chairs jump with all their might onto the floor to make the earth "quake" beneath their feet. If conditions are right, the other students will feel the vibrations running through the floor and maybe something will rattle in the press or a piece of furniture will move. Needless to say, it is very important that this activity is well supervised.

Another way to simulate an earthquake is for the students to stand around the teacher's table with both their hands resting on the table then let a heavy book such as a telephone directory fall on the middle of the table. The students around the table will all feel the vibrations.

Once the idea of an earthquake had been grasped then a photograph activity may be used to show the amount of damage caused by earthquakes. Most Junior Certificate textbooks have good photographs which can be used for this. Another way to examine this is using accounts of earthquake damage taken from newspapers. Students can be asked to answer questions based on these and may be asked to write an account of what it would be like to have been there at the time. A word of caution here though - the reading ability required for extracts taken directly from newspapers such as the Irish Times may be beyond that of younger and/or less able students. In this case either the extract must be simplified or the material explained carefully.

Once an earthquake has been described, experienced through play and the damage that often results observed, then it is possible to attempt a simple definition of such as:

'An earthquake is a sudden movement or shaking of the earth's surface. When the movement is large enough damage to buildings and other problems will result.'

Finally one might talk about any recent or famous

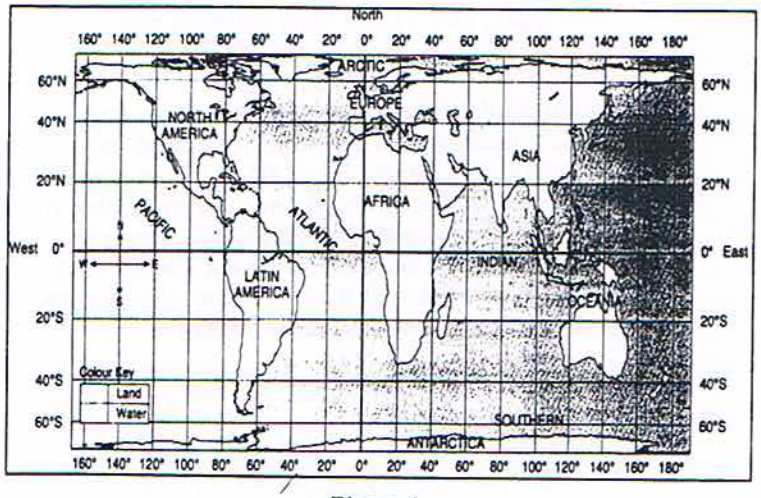

Figure 1.

earthquakes and plot these on a map of the world. This would enable students to practise the skill of location using latitude and longitude (which I feel should be taught early in second level education) and to develop their place knowledge. For example, they can be given latitude and longitude references for the locations of famous earthquakes, such as those in Table 1 and these may then be plotted onto a world map [Figure 1].

Table 1: Locations of ~~Earthquakes~~ VOLCANOES

	Latitude	Longitude
Cotopaxi	1° S	78° W
Krakatoa	6° S	105° E
Etna	38° N	15° E
Fuji	35° N	138° E
Mt Pelee	15° N	61° W

2. Volcanoes

A similar approach to that used for earthquakes can be adopted for the teaching of the concept of a volcano, beginning by reading the following aloud with as much gusto as possible.

> 'I was taking photographs of Mt. Saint Helens in the Rocky Mountains when I noticed the side of the mountain beginning to swell out. Suddenly there was a deafening explosion and the side of the mountain blew out. A cloud of steaming ash and red hot lava came racing in my direction. I dropped the camera and ran to my car. In the rush I fumbled with the keys and could not get the door open. Eventually I got into the car, started it up and drove off at break neck speed away from the approaching cloud. I drove faster than ever I had before. I passed cars travelling at 90 mph, I know, because I was doing over 100 mph. I avoided that deadly cloud but many people in those cars didn't.'

Some questions on this passage might include the following:

- Where was the photographer?
- Why did he let his camera drop?
- What was the photographer trying to avoid?
- How do you know the deadly cloud was travelling fast?
- What was the cloud made from?
- Was the cloud hot or cold?

At this point a clip of an erupting volcano from one of the many excellent videos available on this subject, such 'Born of Fire' (National Geographic, 1983) could be usefully viewed as these show the process of an eruption better than any description.

As a practical demonstration of an eruption, a juicy orange may be used to represent the earth. A compass point or a needle should be stuck into the surface [representing the vent in the surface of the earth]. When the orange is then squeezed firmly, juice will 'erupt' from the surface.

A simple definition of a volcano can be drawn up such as the one below:

A volcano forms where a hole develops in the earth's surface and lava flows or explodes out of this.

Once again the sites of recent eruptions and the locations of famous volcanoes should be plotted onto the same map as was used to plot the earthquakes. The locations of some well known volcanoes are given in Table 2.

Table 2: Locations of volcanoes EARTHQUAKES

	Latitude	*Longitude*
Valparaiso	33° S	72° W
Anchorage	61° N	150° W
Lisbon	39° N	9° W
North Assam	27° N	91° E
Tokyo	36° N	140°

3. Fold Mountains

Following the same strategy as before the following passage should be read aloud:

> 'On our expedition to Mt. Everest we had to rest often to get used to the altitude. We were above 7,000 metres above sea level in the Himalayan Mountains and there was little oxygen. On one of these stops for rest I sat on something sharp. When I pulled it out from under me I found it was a large fossil sea shell. Another evening when we were pitching our tent I found a large piece of sandstone which had the fossil of a fish in it. I remembered from my geography classes of long ago that fossils and sandstones were usually formed in the sea. I wondered to myself how things made in the sea could now be 7,000 metres above sea level.'

Some examples of questions one might use with the above passage are as follows:

- Where is Mt Everest?
- How high above sea-level was the person?
- What did she/he find?
- Why was he/she puzzled by what they found?
- Can you suggest an answer to the problem?

To demonstrate folding a text book can be 'compressed' by holding it horizontally with both hands and moving them together. A video clip of folding which uses computer graphics, for example that shown in 'Essential stone (CRH, 1997) or 'The Shaping of Dun Laoghaire' (Blackrock Education Centre, 1984), would be very useful here. There may also be pieces of folded rock in the school's geography department, which could be used to illustrate folds. All of these should be accompanied by questions which would stimulate pupils to begin thinking about what might cause such distortion of solid rock.

A simple definition of fold mountains should then be given, such as the one below:

'A fold mountain is where the surface of the earth has been buckled upwards.'

Finally major fold mountains such as the Himalayas, the Rocky Mountains, the Andes, the Alps etc. should be plotted on the map on which the earthquakes and volcanoes have already been plotted.

Stage 2: Establishing that continents move

For this activity students need to know the locations of the continents. This may be done by a simple exercise in which students are required to

a) shade the land area on a simple map of the world [Fig. 2]. (The level of knowledge can be quickly checked by walking around the room and observing the students' work.)
b) name the continents (using an atlas if necessary).

How continents have moved

a) Distribute copies of the map of the world as it was 200 million years ago [Fig. 3] - before the break up of Pangaea.
b) Students should be asked to compare this map with the one on which they have named the continents [Fig. 2].
c) Questions such as those below would be helpful to focus their thinking:
   (i) Was Africa closer to South America 200 million years ago than it is today?
   (ii) Where is Antarctica located today?
   (iii) What happened to the positions of the continents over the last 200 million years?
d) The movements of the continents can be shown on the overhead projector by photocopying Figure 3 onto card and then cut out the shape of each of the continents. These can be 'drifted apart' by moving the cut out shapes from Pangaea to their present positions.
e) Students can cut out the continents on Figure 2 and make a jig saw of the map of the world. They can then try to fit together both as they did 200 million years ago and as they do today. This jigsaw activity develops a knowledge of the continents their names, locations and how they have moved through time.

Now that the above activities have hopefully established that continents can and have moved it is possible to begin to look at, in very simplistic terms, the reasons for these movements.

Stage 3: How Continents Move

Students must have some knowledge of the interior of the earth before they can begin to comprehend the mechanism for the movements of the continents.

a) An apple cut in half can be used to demonstrate the three parts of the earth's interior:- the core (part with pips), the mantle (the flesh), and the crust (the skin). The use of an apple to introduce the earth's interior is helpful because it has a 'core' and so students are likely to remember this term in relation to the earth.
b) An orange should then be used and cut in half in a similar way to the apple. Again the core (with pips), the mantle(fleshy part) and the crust(the skin)

are easily demonstrated. An orange has two advantages over an apple in this context: (i) the skin is thicker and easier to work with and (ii) the flesh is juicy and can be made to flow like the mantle. Thus, it can demonstrate how the crust (lithosphere) is floating on the mantle.

c) By peeling the orange carefully so that one has a few large pieces of skin one can demonstrate that the crust of the earth is divided up into large pieces called plates[Fig. 4]. These pieces can be laid out on the table (or the board) and the 'map' compared with the similar diagram of the earth's plates found in most Junior Certificate text books. They can then be replaced on the orange, to represent the plates on the globe. (If a large piece of the orange is left unpeeled at both of its 'poles', it will rest easily on a table while one reassembles the pieces of peel.)

d) It is also possible to illustrate how the plates can move against or away from one another by moving pieces of the peel towards or away from one another.

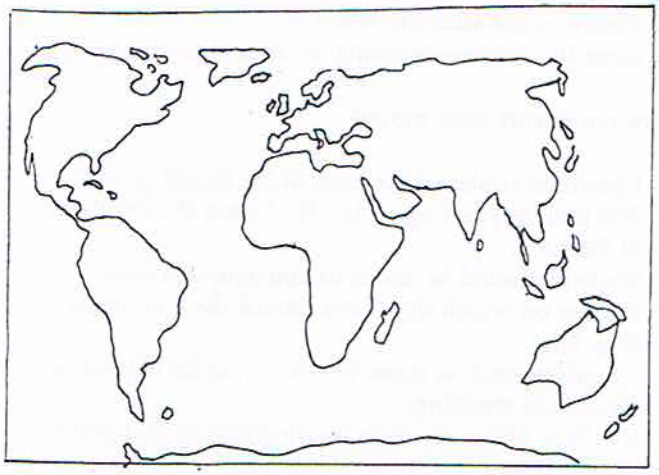

Figure 2

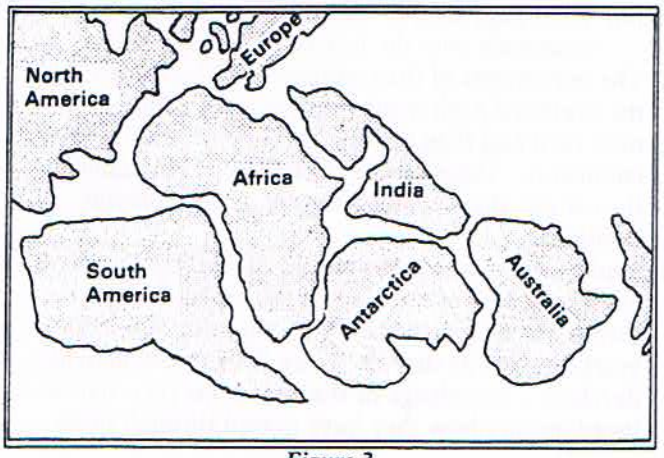

Figure 3

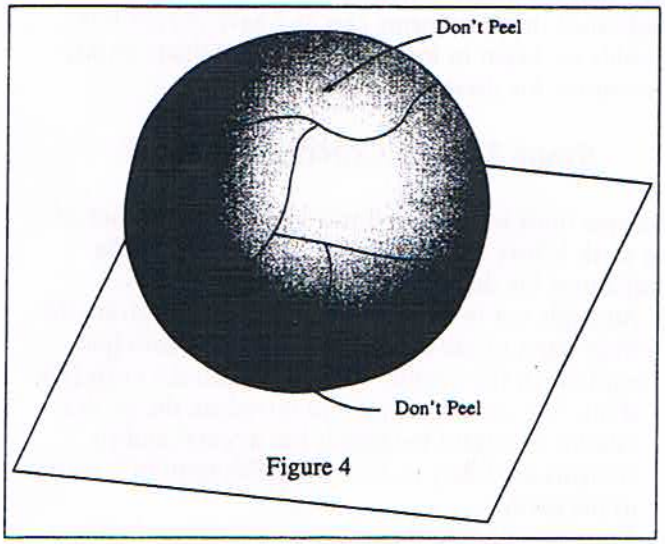

Figure 4

Figure 4

A video clip is very useful to demonstrate the movement of plates, e.g. 'Born of Fire' (National Geographic). If the work suggested in this section is undertaken prior to showing the video this will be likely to facilitate the understanding of these complex processes.

Stage 4: An explanation of the relationship between earthquakes, volcanoes, fold mountains and plate tectonics

A copy on acetate of the map which was used to plot the locations of earthquakes, volcanoes and folds should be placed on the overhead projector. An overlay showing the locations of the plate boundaries should be superimposed on this and students encouraged to identify the relationship between these boundaries and the various phenomena. It is probably best both for simplicity and because of Junior Certificate syllabus requirements to concentrate on the 'Ring of Fire'. Once students have noted that earthquakes, etc. generally occur at plate boundaries it must be made clear that this is because they are all caused by plate movements. Finally, students should be told that the name of the theory which explains these movements (and the earthquakes, volcanoes and fold mountains) is called 'Plate Tectonics'.

Conclusion

Plate tectonics is one of the most difficult topics to teach effectively. Ideally younger students and less able students should not have to grapple with the complex abstract concepts which underlie the theory. I feel that they should be introduced to the theory in stages. What is outlined above is essentially an active and, hopefully, an interesting introduction which will be the foundation for further, deeper study in the senior years of second level education.

Videos

Blackrock Education Centre (1984) *The Shaping of Dun Laoghaire*
C.R.H (1997) *Essential Stone*
National Geographic (1983) *Born of Fire*