Interactive and Collaborative Teaching Methods in the Science Classroom

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One of the biggest challenges in modern education is to actively engage your students in the learning process. This workshop outlines three different examples of interactive or collaborative teaching methods the presenter is currently developing in his classrooms. These methods are peer instruction, interactive lecture demonstrations (ILD’s) and collaborative digital workspaces. All these techniques focus on enhancing the quality of the learning experience by promoting deeper understanding, asking students to teach each other and encouraging them to work together. This workshop includes practical examples, demonstrations and associated resources.
Peer Instruction based on Think-Pair-Share

Outline
Traditional instruction, especially in physics, involves students learning by rote how to plug numbers in equations to solve problems. One alternative to this is instruction that focuses on developing conceptual understanding through active engagement and social interaction. This has been shown to lead to significant gains over traditional methods and is more applicable with today’s physics syllabus and the modern learner.

The teaching strategy used in peer instruction (PI) is based on the process of think-pair-share. The process is outlined in the flowchart below and encourages students to be actively involved in their learning. Students retain more of what they have learned and especially retain the key concepts that were targeted in the questions.
Outline of the Peer Instruction Process (think, pair, share)

The steps shown on the flow chart above are outlined below.

1. Questions used for PI are typically multiple choice questions (often called ConcepTests) that are written to test conceptual knowledge. These can easily be slotted into a lesson when a desirable amount of material or activities has been completed. These can also be used where course material has been covered by the student as set prior reading. It is important to give students enough time to recognise the key parts of the question and think about their answer.

2. Students can record their answers to questions to formalise the process or these could be collected to gain an understanding of students’ initial understanding.

3. Students can indicate their answers in a variety of ways. Flashcards are a simple and low cost way of getting students to show you their answers. A set of cards with A to D in different colours seems to work best as this allows you to easily gauge the proportion of correct and incorrect responses at a glance. It is important to devise a way for students to vote anonymously as they will be more willing to share their answers and cannot be influenced by the responses of others. Electronic devices can also be used commonly known as clickers. They allow you to record and display the responses to questions although they are expensive. Note: It has been recently shown that there is no educational advantage of using clickers over flashcards.

4. If the overwhelming majority of students answer correctly it is clear that further time on this concept is not needed. You can now move through steps 5 and 6 and on to the next activity.

5. Selected students could provide the class with their reasoning for their answer or the steps they went through to arrive at their answer. These provide valuable modelling of thought processes and could also assist those who did not answer correctly.

6. A brief explanation could be useful, especially for those who did not answer correctly.

7. If the number of correct responses lies somewhere between 50 and 80% do not tell students the correct answer. They can then be asked to work in groups of 2 or 3 and convince their group why their answer is correct (step 8). It would be most beneficial if students who gave different answers worked together at this stage. If significantly less than 50% of students indicate the incorrect answer then it may be wise to skip to step 10 as their may not be enough students who can lead the discussion for step 8 to be beneficial.

8. This stage is where students pair and share their ideas. In this step students work in groups of 2 or 3 and try to convince the group their response is correct. This is the process at the heart of peer instruction.

9. Students are asked again to indicate their answer as in step 3. If the majority of students now indicate the correct answer then you can proceed through steps 4, 5 and 6. If there is still a large proportion of incorrect responses then proceed to step 10 and spend some time going over the concept in question.

References
Interactive Lecture Demonstrations (ILDs) for Motion and Newton’s Laws

Supplied by the Centre for Science and Maths Teaching (CSMT) at Tufts University and adapted by Jeff Stanger.

Outline

Educational research indicates that there are significant gains in understanding physics concepts using this method over traditional instruction. Research also says that these concepts are so difficult for students to master because students bring their own strongly held beliefs about the world around them into your classroom. These preconceptions often do not agree with accepted scientific understanding and it is only by letting students challenge their own beliefs that they can correct them.

The teaching strategy used for these activities is predict, observe and explain. This involves students writing a prediction of what they think will happen in a demonstration, then observing the demonstration and record their observation and finally correcting their prediction to explain their observations.

Resources

The movies and flash files can be downloaded from the webpage http://csmt.research.tufts.edu/ildvideos/


The webpage SGHSilds.htm links all the files in order with extra explanation and is available from the science teaching section of www.jeffstanger.net

Instructional Modes

Student Centred and Online.

Completely student centred with students on separate computers working in pairs. When I tried these activities totally student centred many students had difficulties in some of the demonstrations where the sound was a bit low or more explanation was required. The web page (SGHSilds.htm) addresses the issues of more explanation required.

Whole Class and Guided.

When the class was guided by a teacher this gave instant access to clarification. The webpage (SGHSilds.htm) was used to play the files and overheads of the students’ worksheet were used to illustrate the answers (the overheads were very valuable). I showed the video outlining each situation and clarified the situation where needed. I then showed the results once they had made their predictions. If needed I then showed the analysis video but many times it was sufficient to discuss the results myself.

Outline of the ILD Process (predict, observe, explain)

1. The instructor describes the demonstration and performs the demonstration without showing graphical results.
2. Students are encouraged to discuss their predictions in small groups.
3. Students record their predictions on their worksheet (This can be collected as a separate sheet to assess student initial understanding or it can be retained by the student and refined using a different colour as their result if needed).
4. The instructor can use questioning at this stage to gain an idea of student predictions.
5. The instructor now carries out the demonstration and displays the results generated.
6. Students fill in the results on their sheets.
7. The instructor discusses / explains the results or asks the students to explain them.
8. Students can be encouraged to discuss the results within their group and make notes if required to consolidate and explanation for the observed results.

References

Using a Wiki or Word document as a collaborative work space

Introduction

On several occasions I have used a Wiki activity in Moodle or a Word document in a shared drive as a collaborative work space. I ask students to take turns adding information and images to a document and the end result is a small article that summarises information or explains a concept.

Application

Some possible applications for this activity could be when a class is in a computer room doing another task, as homework over an extended period so many students have time to contribute or as an extension activity for students who finish early on a computer within the science lab.

Resources

- Computer(s).
- Moodle with Wiki added or simply using MS Word and a shared network drive.
- If student(s) take turns during a lesson a hat or other object can signify who is editing the document as they can only do it one at a time.

Example

One example of where I have used this activity is during a year 10 topic on radioactivity and nuclear energy. Students spent several lessons researching material for a public hearing in which they would represent various parties with interests in a proposed nuclear power station in Sydney. During this research period they were asked to collaboratively construct two documents. The basic instructions given were:

1. Work together to summarise the positive and negative effects of nuclear energy including issues relating to waste storage, terrorism and weapons.

2. Work together to identify medical and industrial uses of radioactivity and discuss the benefits and problems associated with these uses.

These two activities were designed to address the stage 5 knowledge and understanding content:

5.12 (e) Give examples of medical and industrial uses of nuclear energy and discuss the problems associated with these uses.

In combination with the public hearing activity mentioned above these activities would allow students to address the prescribed focus area:

5.4 (d) Analyse reasons why different cultures or groups within a society may have different views in relation to scientific issues.

While conducting their research the students who were wearing the hat assigned to a particular task were allowed to edit the document and add their contribution. Students were asked to colour code their contribution and indicate the owners of each colour in a key at the end of the document. This activity was seen to be very motivating for the students. The hats used to signify who could edit the document added a theatrical aspect to the class and appealed to many students who otherwise showed less enthusiasm.