TEACHING AND LEARNING PHYSICS
A PHYSICS HONOURS COURSE OF TEN LECTURES - 2009

SUPER group

Introduction
The module is based on three broad areas: (1) understanding some elements of learning, (2) teaching and communicating with others, (3) linking learning and teaching through physics education research (PER).

Learning goals and content
The broad learning goals include
• developing skills in analysing the teaching and learning of physics,
• developing skills in the use of quantitative data analysis for educational research,
• understanding of evidence-based practice in physics education.

The module includes a critical analysis of a physics topic using PER literature. The analysis will be embedded in knowledge and tools learnt in lectures on relevant theories and methods.

Organisation and Learning Activities
• Students work in pairs on a chosen topic from a list.
• Each pair analyses the teaching and learning of their topic, probing the difficulties involved, reviewing and evaluating the literature and reflecting on their experiences.
• Individual students will prepare and deliver a presentation on an aspect of their group work.
• Individual students will write an essay on their own interpretations based on the group work.
• A series of lectures will cover relevant theories and methods, and explore evidence-based practice in physics education.
• The SUPER group will be a reference group.

Assessment
15% Presentation
45% Individual essay
40% Exam

Lecture Schedule: All lectures are in LT4.
L1: 9 March, Mon 11 am: Introduction to module & topics, introduction to memory and cognition: Manju
L2: 13 March, Fri 11 am: Theories relevant to learning physics: Dr Richard Walker
L3: 16 March, Mon 11 am: Methods relevant to analysing physics teaching & learning: Dr Derek Muller
L4: 20 March, Fri 11 am: Workshop - analysing PER publications
L5: 23 March, Mon 11 am: Statistical data analysis: Manju Sharma and Ian Sefton
L6: 27 March, Fri 11 am: Statistical data analysis: Christine Lindstrom
L7: 30 March, Mon 11 am: Case studies on evidence-based practice in physics education I: Ian Johnston
L8: 3 April, Fri 11 am: Tutorial on statistical data analysis: Christine Lindstrom and Manju Sharma
L9: X April, XXX 11 am: Student talks
Mid-semester break
L10: 20 April, Mon 11 am: Student talks
Lecture Schedule and reading assignments

L1: *Introduction to module & topics, introduction to memory and cognition*
   Read pages 1 to 10 of Redish and Wikipedia description of constructivism.

L2: *Theories relevant to learning physics: Dr Richard Walker*
   Choose topic for essay.
   Read diSessa, Neuman, Libarkin & Kurdziel.

L3: *Methods relevant to analysing physics teaching and learning: Derek Muller*
   Confirm essay topic.
   Read paper to be analysed in L4. Different groups will have different papers that are not yet in the folder.

L4: *Workshop - analysing PER publications*
   Read Klahr & Li, Sharma.

L5: *Statistical data analysis*
   Read Lindstrom, pp 1 to 9.

L6: *Statistical data analysis*
   Read Lindstrom, pp 10 to 16.

L7: *Case studies on evidence based practice in physics education I*
   Complete reading Redish.

L8: *Tutorial on statistical data analysis*
   Submit essay in L9. Indicate if it is final or if feedback is required. Feedback will be provided largely in it terms of which criteria have not been adequately addressed.

L9?: *Student talks*
   Prepare for talks.
   Mid-semester break

L10: *Student talks*

Exam
The exam will consist of 4 questions. A specimen outline is provided.

Talks
The talks may be modelled on the presentations on evidence-based practices.
Criteria for assessment of the essay

Your essay should be 2000 words and no more than 6 pages long, including figures and diagrams.

For a High Distinction, you will need to

• discuss in depth the scientifically accepted physics for the selected topic, addressing why it is conceptually difficult, using supporting physics education literature. Conceptual development of the topic will need to be explored, for example: historically, or with age or in terms of abstractness;
• evaluate how this physics topic is, and can be, taught using a variety of teaching resources, computer simulations, laboratory experiments, demonstrations and real life examples;
• use substantial research literature to explain alternative conceptions associated with this physics topic, including relations and patterns amongst the conceptions. You should include a short case study of a research study exploring alternative conceptions;
• evaluate and explain how the alternative conceptions can be addressed when teaching, using examples from the literature.

For a Distinction, you will need to

• explain in-depth the scientifically accepted physics for the selected topic, addressing why it is conceptually difficult, using supporting physics-education literature;
• evaluate how this physics topic is, and can be, taught using different teaching aids;
• use the research literature to explain alternative conceptions associated with this physics topic, including relations and patterns amongst the conceptions;
• use examples from the literature and your own experiences to explain how the alternative conceptions can be addressed when teaching.

For a Credit, you will need to

• explain in-depth the scientifically accepted physics for the selected topic addressing why it is conceptually difficult;
• evaluate how this physics topic is, and can be, taught;
• use research literature to explain alternative conceptions associated with this physics topic;
• describe examples of how the alternative conceptions can be addressed when teaching.

For a Pass, you will need to

• Explain in-depth the scientifically accepted physics for the selected topic;
• Explain how this physics topic is, and can be, taught;
• Use research literature to explain alternative conceptions associated with this physics topic;
• Describe an example of how an alternative conception can be addressed when teaching.
**Outline of Exam**

Q1 on learning theory (10 marks)
Use memory as described in Redish’s framework OR cognitive load theory to explore/model how a Fundamentals student may attempt to answer the following exam question under exam conditions.

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**Question 3**

![Image of two people sitting on chairs with wheels](Image)

Christopher (left) and Jayne (right)

Christopher and Jayne were sitting on computer chairs with wheels, facing each other, initially at rest on a horizontal floor. Christopher had a larger mass than Jayne. They pushed against each other. (Assume that the floor was frictionless).

Answer the following questions using the principles of physics and assuming the floor was frictionless.

(a) While they were pushing each other, who experienced the greater magnitude of pushing force?

(b) At some time \( t \) after they finished pushing each other, who will have travelled further from their initial position?

(c) After they finished pushing each other, whose momentum was larger in magnitude?

(5 marks)

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Q2 on learning theory and evidence based practice (10 marks)
Describe an instructional setting for the Fundamentals class based on constructivist guidelines where the above question can be used. Explain which features are underpinned by constructivist guidelines and explore how these features help students learn the necessary physics.

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Q3 on methods (10 marks)
You have been given a paper. Please answer the following questions. (Questions to be provided)
Assess if the methods employed are adequate for answering the research question.

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Q4 on statistics (10 marks)
You will need to interpret statistical output OR given a data set in a study suggest analysis.