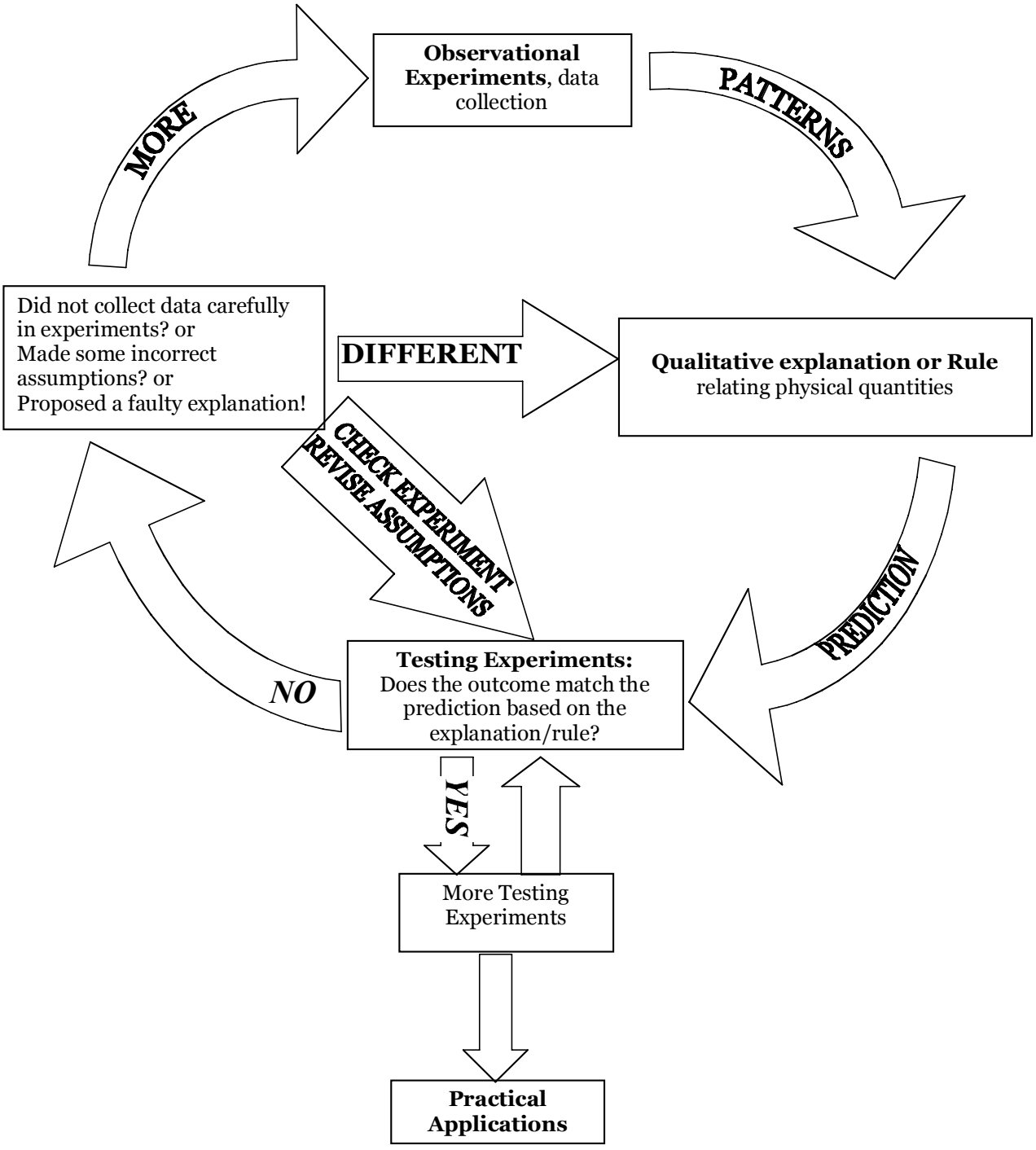
General Strategies

Overall game strategy (Investigative Science Learning Environment)



This is in some sense a distillation of what scientists do and especially physicists. The real process of learning about the world may not be so linear. A word summary of the process is given below:

- A physicist observes a physical phenomenon.
- She thinks of several possible qualitative explanations of the phenomenon and constructs analogies or different representations. Explanations are often built on prior knowledge and experience.
- She devises experiments to test predictions that different qualitative explanations make with regards to particular experiments.
- She may invent physical quantities to describe what is seen. She will look for patterns in the data.
- If some interesting patterns are seen, she may propose several alternative models that fit the patterns. She might find mathematical relations between the physical quantities.
- Different mathematical models may then be used to predict the results of new (unobserved) phenomena. Or a real world application may be devised.
- She will then devise experiments to test the predictions of the model or try out the application.
- If the prediction of a particular model was not verified, one of possible reasons is that the model is flawed. However, a physicist should also consider other models that were used to make a particular prediction before discarding the model. If the model is discarded, other models should be considered and tested in the same way as above. Alternatively she may revise the initial model asking such questions as: What simplifying assumptions did I make? Is there a different model which would adequately describe the initial observations? Can I make a more accurate calculation? And so on. If the prediction of a model was verified or the application worked as expected, the physicist has gathered evidence that the model is successful in describing some physical phenomena.

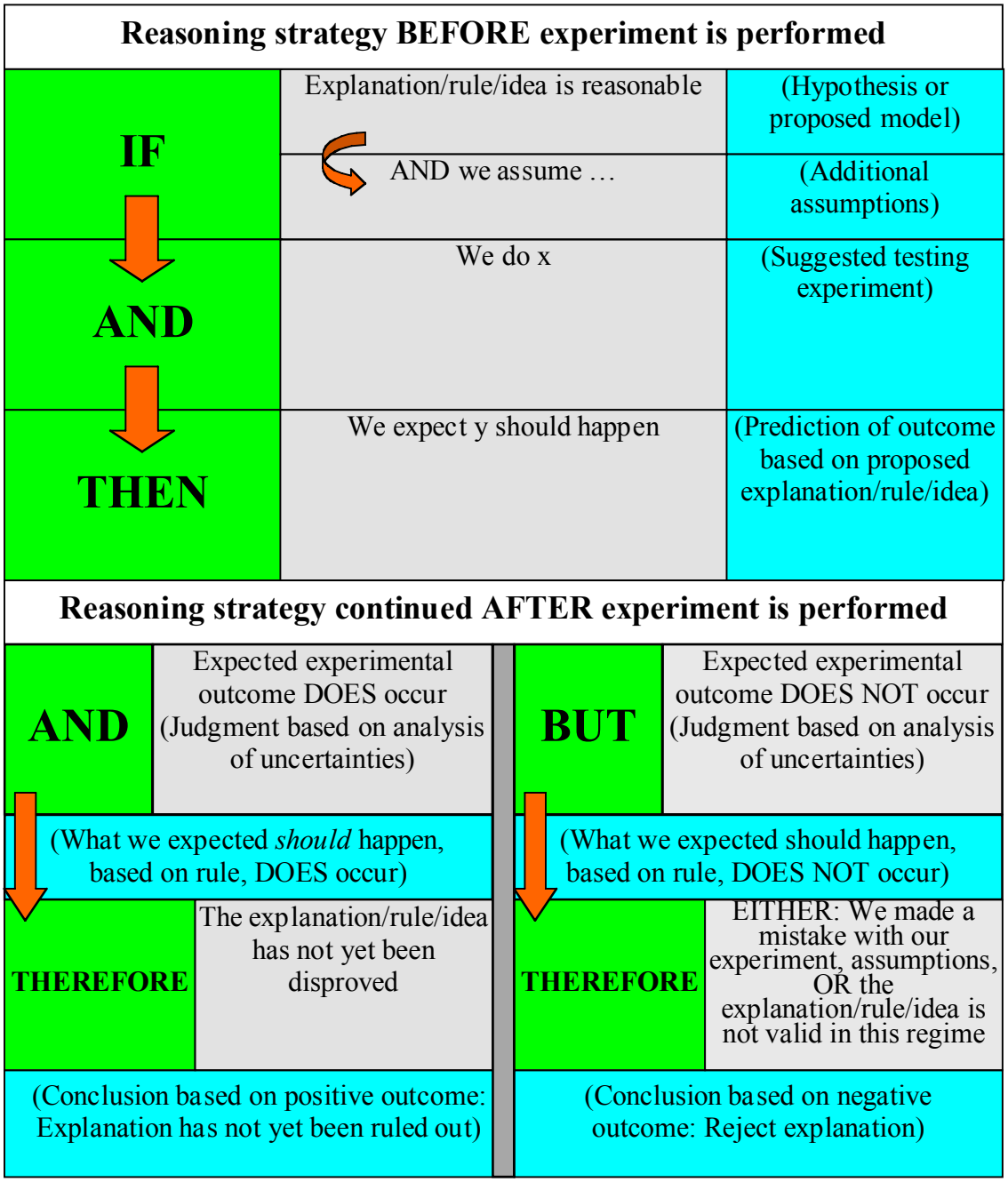
The process is summarized in the diagram above.

This ISLE strategy will serve as the overall structure of the course. Every activity that you engage in should appear as one or more steps in the cycle. Each topic in the course will be learned by moving through this cycle from observation to testing and then application.

Hypothetico-deductive Reasoning:

Basic hypothetico-deductive reasoning		
IF	…explanation/rule/idea is **reasonable**	(**proposed** explanation/rule/idea this is **NOT** a prediction)
AND	…we **do** x	(Suggested **action** or **testing** experiment)
THEN	…we **expect** y **should** happen	(**Predicted** outcome of **action/test** based on proposed explanation/rule/idea)

In the testing/application stage, the following reasoning strategy can be used. It is sometimes called "hypothetico-deductive reasoning". This reasoning strategy also appears in many other contexts. You will use it when you evaluate your answer to a problem with a limiting case or when you do a thought experiment, or when you evaluate the effects of certain assumptions on the outcome of your experiment. A more detailed and complete version of this reasoning strategy is given in the picture below:


Reasoning strategy BEFORE experiment is performed
IF
Explanation/rule/idea is reasonable
(Hypothesis or proposed model)
AND we assume …
(Additional assumptions)
AND
We do x
(Suggested testing experiment)
THEN
We expect y should happen
(Prediction of outcome based on proposed explanation/rule/idea)
Reasoning strategy continued AFTER experiment is performed
AND
Expected experimental outcome DOES occur (Judgment based on analysis of uncertainties)
BUT
Expected experimental outcome DOES NOT occur (Judgment based on analysis of uncertainties)
(What we expected *should* happen, based on rule, DOES occur)
(What we expected should happen, based on rule, DOES NOT occur)
THEREFORE
The explanation/rule/idea has not yet been disproved
THEREFORE
EITHER: We made a mistake with our experiment, assumptions, OR the explanation/rule/idea is not valid in this regime
(Conclusion based on positive outcome: Explanation has not yet been ruled out)
(Conclusion based on negative outcome: Reject explanation)