Modelling weights in an educational environment using Empirical Modelling (Key Stage 1)

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Abstract

In this paper Empirical Modelling is used alongside Key Stage 1 specifications, to allow the modelling of weights within a learning environment. The aim of this study is to discuss current teaching methods for modelling weights within the classroom. Currently modelling weights is taught by physically getting the students to hold weights either side of their bodies with arms outstretched and by using scales within a classroom with students asked to provide estimates. Although this method may be very practical, I was interested in trying to model weights in a more Empirical Modelling way. In this study I will discuss how it is best to model weights in this way, and how this can be applied to Key Stage 1 of teaching.

1 Introduction

Empirical Modelling (EM) is a very flexible method, when used with modelling concepts and principles. The creation of dependencies between each aspect of a model particularly suits EM to modelling real life, physical situations. Within this paper, I will be discussing modelling weights, by using EM practices, for use in the classroom.

1.1 Teaching Weights

All teachers at Primary School level follow the National Numeracy Strategy that defines exactly what should be taught to the students along with learning outcomes and example exercises. Different levels are used, and are broken up into two tiers[1], Years 1-3 and Years 4-6.

1.1.1 Years 1-3

During years 1-3, students should 'Suggest and use simple measuring equipment, reading and interpreting number scales with some accuracy' (National Numeracy Strategy, 2007)

Year 1: Use a balance with two pans, to compare two objects directly.

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[1] Note that there is also a reception year tier, however for the purpose of this study, will not be considered.

Year 2: Record estimates and measurements to the nearest kilogram, using own notation: for example 'nearly three kilograms heavy'.
Year 3: Read a scale to the nearest marked division. Read estimates and measurements using a mix of units: for example, 'three kilograms and five hundred grams or three and a half kilograms'.

1.1.2 Years 4-6

During years 4-6, students should 'Use vocabulary related to measures' and also 'Know and use relationships between familiar units'. (National Numeracy Strategy, 2007)

Year 4: Know names of standard metric/imperial units. Understand mass and weight. Understand that 500g is half of 1kg, 1kg is 1000g.
Year 5: Use correct abbreviations, such as kg, g. Know the equivalent of one half, one quarter, three quarters. For example, know that: 10g is one hundredth of 1kg.
Year 6: Know the equivalent of one thousandth of 1kg in grams. Begin to convert to larger units. For example: write 750 grams in kilograms (0.75kg).

1.2 Modelling Weights

Ideally this model would help primary school teachers in helping to teach weights to students effectively, however it was important to consult the National Numeracy Strategy to get an idea of what was required during each school year. The model ideally would have the option of adjustment to the different

school years in order to teach the students the correct material, and ultimately, to meet the demands of the National Numeracy Strategy.

1.3 Why Empirical Modelling?

Empirical Modelling can be used in a similar way to traditional software development, however, Empirical Modelling allows dependencies to be created between objects in the model, and the code used to create the model can be changed if needed at runtime, without the need for re-compiling.

After having a conversation with a Primary School teacher, it became apparent that the most useful model that I could create would be modelling weights. This concept, however basic it may seem, is a fundamental learning curve for students during Years 1-6.

2 Models for Education

To enable students to learn effectively with a created model, the model must simulate the effects similar to that in real life, and must simulate the real life scenario.

2.1 Learning with Educational Models

The first stage of the learning process is based around interaction with artefacts, leading to recognition of correlations between artefacts and in turn the identification of dependencies in a given system or situation [1]. It is important that the user can have input, and receive a relevant output. This will help to further increase the learning and ultimately an understanding of the model, for the student.

2.2 Benefits of Educational Models

There are many benefits to modelling education models. Significant cost savings can be had in primary school, where funds for equipment are limited. Within schools, many pupils work at a different pace to each other, making it hard for the class teacher to teach effectively without students becoming frustrated, and waiting for other students to finish. By using EM in this way we can eliminate the problems by allowing students to work at their own pace, and change the difficulty levels as they progress. This will allow for students to improve on their own learning skills, at a comfortable pace.

EM can simulate the effects of an environment, and allow it to accurately produce the same effects as in real life situations. For example, the train simulation [2] allows the modelling of a train track and can simulate what can go wrong with the signals and analyse user error when controlling the signals.

2.3 Features required for Educational Models

In order to create a successful model, especially within an Educational Environment it is important to adhere to the following three A's:

- Accuracy – The model must simulate objects accurately and the model must allow the user to act in a similar manner to real life objects.
- Aesthetics – To enable interest to be generated in the model, the model must look aesthetically pleasing to the student, this will also help to generate interest in the model, which is important for primary school students, as it will not only maintain a satisfactory interest level, but will also make learning enjoyable.
- Accessibility – The model should be easy to use, especially as this model will be aimed at primary school level, it is important that the target user can use the model effectively. The model is primarily aimed at developing students learning experiences, exploring concepts and helping to build a solid foundation of essential knowledge.

3 Description of the model

3.1 Research on previous models

Other models have been researched to understand how interaction takes place between the user and the model. The Jugs model [3] is a good example of how user interaction is simulated. This simple problem consists of two beakers, each of which can be filled and decanted into the other. This model accurately simulates a similar real life scenario. The user is able to fill either jug, empty and pour. User interaction is done through the Scout programming interface whereby users are able to click on the desired button. However, it is important to note that overfilling of the jugs is not possible, much like real life, if the liquid is not to be spilt.

3.2 Model Expectations

The overall expectations of this model, it to create an interactive model that will allow students to understand weight, how scales can balance and how weight can be measured and approximated. The model must accurately simulate a real life scenario,

and maintain integrity by not confusing the student with an impossible scenario.

3.3 Overview of the model

This model has been developed using Donald, Scout and Eden languages.

The Scout window interface manages components located in the active window and provides a simple graphical user interface. When combined with Eden script, other functionality can be added, such as buttons, text boxes and many other useful features that would be found with many Graphical User Interfaces (GUI).

To construct an original diagram of the scales, Donald was used to allow line drawings to be drawn that would simulate the scales. Donald allows for dependency to be created between two objects, especially useful if an item needs to be resized. Donald also has a nesting feature that is useful in the development phased, and also at runtime, for changing variables within the model. Here is the nesting feature for the main model:
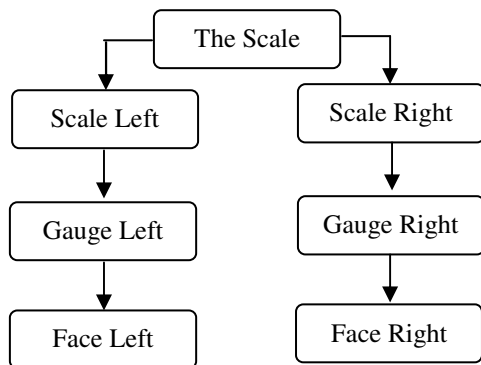

Figure 1: Nesting Feature

This allows for easy access to the underlying variables while the simulation is running. Providing that the user knows the variable names within the model, it is easy to change them whilst the model is running. For example, to change the scale to read 1 kilogram, assuming 200 gram partitions, then the command:

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%eden
thescale/scaleleft/gaugeleft/min=25
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The previous command will allow the model to be changed automatically and at runtime. However, it is important to note that impossible situations can be created when the variables are modified in this way.

For this model it was decided to keep the scales simple, and show two traditional scales side by side. As an additional feature, a different traditional balance scale could be modelled.

With this model, two scales have been created in Donald, and displayed in Scout to show how weight affects either scale. Weight can be added to the scales in 100, 200 and 300 gram quantities. The effect of the weight on either scale is shown graphically within the Scout window. The gauge code was generated from Digital Watch (Fischer, 1999) [4], as it provides the perfect scale needed to represent the measurement gauge.

The only modification done to the Digital Watch code, is that the 12, 3, 6 and 9 hour markers have been changed to create a weight representation in grams, and the second and hour hand have been made redundant. With this basic scale, each marker represents 200 grams, therefore each scale can take 2400 grams worth of weight. Ideally, variable scales could be provided that would allow for greater flexibility.

4 Conclusion

The model currently presents how Empirical Modelling can be used to simulate a real life scenario, at modelling weights, however the model will need a lot more adaption to enable it to be used fully within a primary school. Additional features can be added: the aforementioned tilting scale that will show dynamically how the scale first tilts in one direction, before eventually levelling out. Other attributes that can also be added include additional levels of complexity, with the added addition of a digital scale.

Although additional features can be added, it is important to note that the model must remain as intended, easy to use, aesthetically pleasing, and must simulate a real world example accurately.

EM allows a very versatile and accurate way of modelling in this way. The main benefits over traditional software programming methods, is the added functionality of creating dependencies between the objects contained within, allowing the model to have the functionality as found in a real life model.

References

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