

Using the Tuckshop applet with learners

The aim of the Tuckshop applet is to help learners carry out subtraction successfully and to understand when and why the process of decomposition applies. As the name suggests, the underlying imagery is a tuck shop containing chews that are stored singly, in tubes of ten, in trays (composed of ten tubes) and in boxes (composed of ten trays). Learners are invited to sell chews to customers, a task that requires them to 'unpack' tubes, trays and boxes, as appropriate.

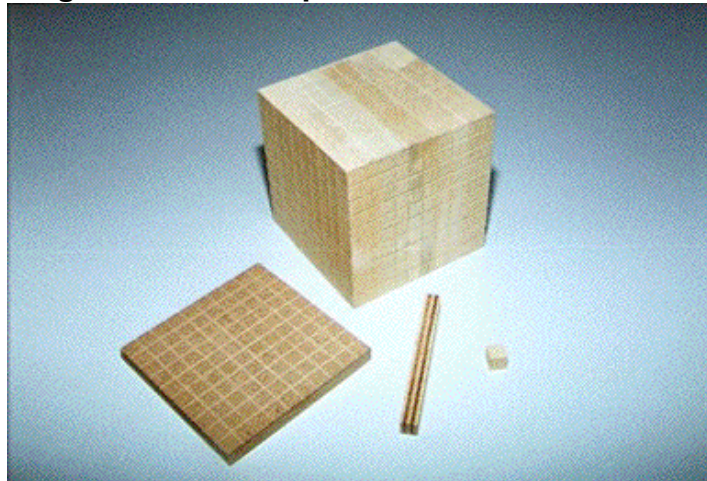
As with all the software that forms part of the 'EIS' project, the Tuckshop applet can be used as a free-standing tool. However, it has been particularly designed for use in a wider teaching context, consisting of the following three stages:

- Stage 1 The Enactive (E) stage, involving *physical handling*.
- Stage 2 The Iconic (I) stage, involving pictures and developing *imagery*.
- Stage 3 The Symbolic (E) stage, involving using conventional mathematical notation and *symbols*.

These stages are described in more detail below.

Stage 1 The Enactive (E) stage: the tuck shop scenario

Learners are given base ten equipment and are asked to imagine that they are selling chews in a tuck shop. The chews are available in different packs – singly, in 'tubes' of 10, in 'trays' of 100 and in boxes of 1000. Customers will present orders for different numbers of chews and, where necessary, the learners will need to unpack tubes, trays or boxes by trading.



Base ten apparatus, with single cubes, 'ten' rods, 'hundred' squares and 'thousand' cubes.

A suitable starting task might be to provide learners with, say, two tubes and three singles – a total of 23 chews. Then ask if they can give you two chews, eleven chews, seven chews. The first two are easy, but in order to hand over seven, they will quickly see that it can't be done without trading one of the tubes for ten singles. Trading can be carried out at an agreed trading location in the room. This is not a difficult concept and one that builds naturally on children's common sense awareness that they need to open up packets of sweets in order to handle them singly. After trying to meet several 'customer orders' from the tuck

shop, a useful discussion can take place about *unpacking* – why and when is unpacking necessary?

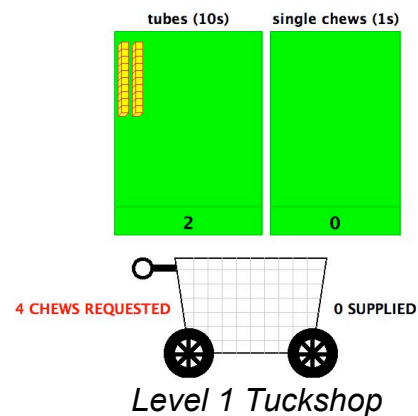
For older learners, the discussion is easily extended into trading trays for tubes and boxes for trays. You could also offer more complicated tasks where two levels of trading are required – for example, suppose there are just two trays and three singles in the tuck shop and the customer wants eight chews. This requires that a tray must be traded for ten tubes and then one of these tubes is traded for ten singles. Another important discussion concerns what connects the various tradings – i.e. the idea that they are all linked by TEN (ten singles in a tube, ten tubes in a tray, and so on).

Stage 2 The Iconic (I) stage: using the Tuckshop applet

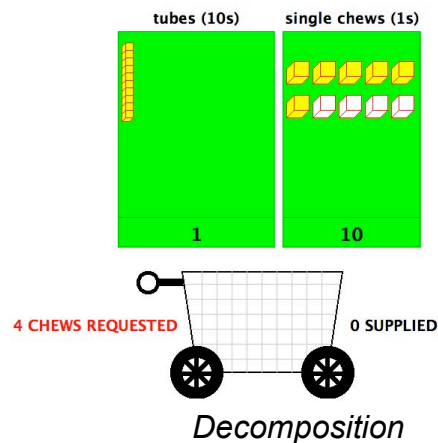
Stage 2 involves using the applet 'Tuckshop'. This builds on the tuck shop metaphor introduced at the enactive stage and provides pictures and tools for handling the various exchanges. An important element at the 'I' stage is that it uses and exploits the imagery introduced at the 'E' stage.

Overview of the Tuckshop applet.

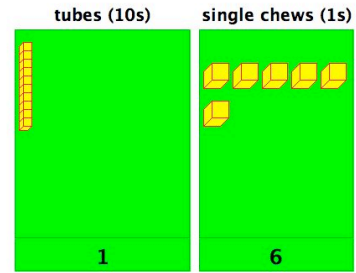
Like all the software designed in the EIS project, Tuckshop can be set at varying levels of difficulty. The most basic level starts with 20 chews (i.e. two tubes) and customer orders are of single digit numbers of chews. In the example opposite, five chews are requested, so the user must break up one of the tubes into ten singles.



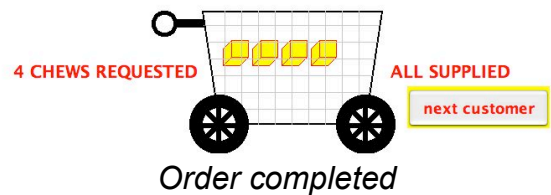
This is achieved with a single click of the mouse in the 'tubes' section (to select a tube) and then a click in the 'single chews' section (to decompose the tube into ten singles and place them in the single chews section). Five further clicks in this section select the five chews, as shown here (represented by the five white cubes).



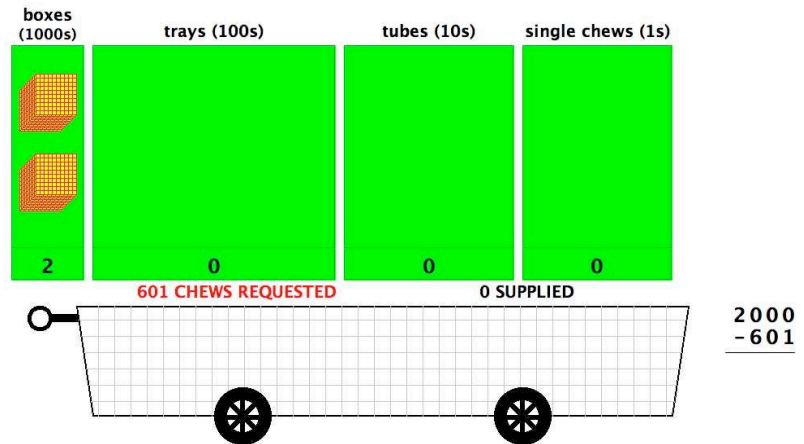
Finally, the chews must be placed in the shopping trolley below (a click in the trolley transfers the selected chews) and the transaction is completed by clicking 'next customer', at which point the trolley rolls off screen to the right, to be replaced by a new, empty trolley arriving from the left.



In addition to the images displayed above, the screen has a number of extra buttons such as 'Restock' which adds to the number of chews in stock.



At level 3, Tuckshop displays boxes and trays (as well as tubes and singles). So, calculations can also involve thousands and hundreds. Note that the conventional subtraction algorithm is displayed alongside the trolley.



Level 3 Tuckshop including hundreds and thousands

Note that, when the correct number of chews is placed in the trolley, this is signalled by the message giving the number of chews in the trolley changing to red and displaying "ALL SUPPLIED". The "next customer" button also appears. At the same time, the symbolic version of the calculation to the right of the trolley is completed, showing the remainder (in this case, 1399 chews still in stock).

Stage 3 The Symbolic (E) stage: the shift to symbols

As with the other applets in the EIS suite, the top level of the software represents the shift to the symbolic form of representation. In the Tuckshop applet, this option is called 'Numbers'. The aim here is to mimic, as closely as possible, the physical and pictorial stages so that the conventional subtraction algorithm is seen to grow out of what the student has already done at the 'E' and 'I' stages.

This is illustrated below with the calculation $910 - 788$.

At the start, the black arrow points to the units column. If the user clicks the 'subtract 1s' button (on the right), they are informed that '1s column not ready'.

1000s 100s 10s 1s

$$\begin{array}{r} 910 \\ - 788 \\ \hline \end{array}$$

unpack one 10s into ten 1s do it subtract 1s

The top level – Numbers

They must now 'unpack' one of the tens using the related tools on the left. After unpacking one of the 10s, the screen looks like this. Now the 'subtract 1s' button will be able to operate.

1000s 100s 10s 1s

$$\begin{array}{r} 9010 \\ - 788 \\ \hline \end{array}$$

unpack one 10s into ten 1s do it subtract 1s

After decomposing the tens

The user progresses through the subtraction procedure in this manner, unpacking 10s, 100s and 1000s, where necessary, and then subtracting, column by column by clicking the button on the right.

Note that if, at any stage, the learner is stuck, they can click the '<Tuckshop' button on the screen and they will be provided with the same problem represented in pictures, with the Tuckshop toolkit available to them. This movement, toggling back and forth between the 'I' and the 'S' forms of representation, offers an invaluable way of building up learner confidence, helping them to understand what they are doing when performing a subtraction calculation using conventional notation.

Pencil and paper. The final part of the 'S' stage in the 'EIS' sequence is for the learner to move to symbols using pencil and paper. So, unsupported by the applet, learners will be asked to tackle conventional subtraction calculations.