Role-play in science teaching and learning

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An overview of the educational importance of role-play, acknowledging its difficulties, advocating its possibilities, and encouraging its potential in science education

What is role-play?

The Concise Oxford English Dictionary (1978 edition) definition of role-playing is: *'behaving in accordance with specified function'*. This is accurate but a working definition of role-play is more difficult to arrive at largely because it is associated with 'dramatic' activity in the minds of teachers, and also because of confusion in the literature arising from its relatedness to play, games and simulation (Jones, 1985).

Role-play is a product of 'play', 'games' and 'simulation', and definitions of these are provided in Box 1. In science education role-play may be seen as an interaction between these three components – either in combination or by themselves – and the child who 'performs' the activity, resulting in learning outcomes (Figure 1). It is suggested in this model that there is progressively increasing intellectual rigour involved as you move from play to games to simulations. Again, in this model, all aspects of role-play are derived from 'play'. Since the initiation and design of role-play is driven by the teacher, play takes on an educational function. Some types of role-play use techniques derived from drama, which may be adapted for use in teaching science. Role-play in science, therefore, is a product of the use of drama, games and simulations. Since, properly designed, it involves children in physical and intellectual activity, it has a potential to elucidate scientific concepts.

ABSTRACT
Role-play in science lessons is underrated and underused, often because of misconceptions about what role-play is and how it can be put to use in science education. This article provides a theoretical basis for the use of role-play, along with some ideas that science teachers may find helpful in further developing the experiential side of their lessons.

Why use role-play in science?

The theory behind the use of role-play in science teaching and learning – as with 'active', 'experiential' or 'child-centred' learning – is that children are encouraged to be physically and intellectually involved in their lessons to allow them to both express themselves in a scientific context and develop an understanding of difficult concepts (Taylor, 1987). The key to role-play, and the reason why role-play can help to make science relevant to many children, is that it is based upon 'play'.

By the time that children begin to be educated in science, they are already very experienced at play, having had their whole lifetime to practise. This play activity is naturally used by children to develop their knowledge and intelligence (Piaget, 1951). The desire to play, and therefore to learn, is a fundamental part of human psychology and is a potentially powerful resource residing in the children themselves.

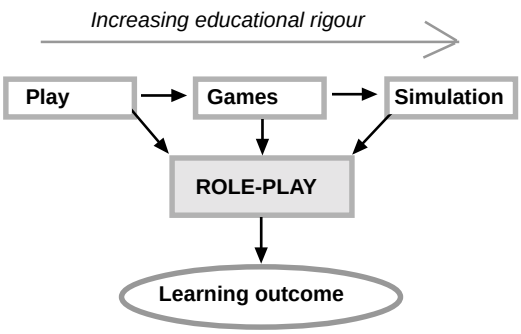


Figure 1 Role-play as the medium of interactive/experiential learning.

BOX 1	Working definitions of role-play's relatives
Play	A behaviour used during the development of children to learn about their environment which produces enjoyment (Piaget, 1951). The 'environment' includes physical objects, interactions and societal rules of conduct.
Games	*Games are like play except that they usually have an end, a payoff'* (Adams, 1973). Games have conserved rules which can be used in competition with the hope of winning (Piaget, 1932).
Simulation	is the *'imitation of conditions, pretending to have or be something'* (Concise Oxford English Dictionary, 1978). In education, simulation is often referred to as 'simulation games', which are usually more controlled than being mere extensions of games, and are *'detailed models intended to reflect a situation found in the real world'* (Adams, 1973).

There are other reasons why role-play may be a valuable educational tool:

- It gives science teachers another option that can be used to link their work with *'the more feeling, creative side of education and as a method of increasing the manipulation of factual material by children'* (Watson, 1985), a good example of which would be asking children to describe the water cycle to their peers in the role of television weather presenters.
- It gives children a feeling of 'ownership' of their education (Danby and Upitis, 1988). 'Ownership' refers to the way a child facilitates their own learning by creating their own role-plays through either scripted or improvised work, for example to explain the way the planets orbit the Sun.
- It can be used effectively to teach about moral or ethical issues arising from the curriculum (Colby, 1987), for example debates about genetically manipulated food production or the arguments for and against the opening of a new quarry in the school's playing field.
- It can help children across the full spectrum of educational needs to *'interpret their place in the world'* (Cayton, 1989). Merely explaining to children about their environment in the course of a theory lesson may not be the best method for helping them to gain an understanding of why it is there or how the processes at work in the environment have formed it. Role-plays, such as those describing predator–prey relationships or why day and night occur, give children a chance to experience these events in a physical way, which may be more appropriate to their personal learning style.
- Many role-plays are based upon analogy, which helps children to conceptualise and greatly increases learning (Lawson, 1993) about, for example, kinetic theory, electrical currents and antibody–antigen interactions.

So what's wrong with role-play?

Some teachers tend to prefer children to watch and listen during their lessons, rather than taking part in the physical and intellectual activity engendered by role-play (Lawrence, 1997). This could be because teachers are used to watching and listening, having themselves been taught like that, or perhaps they find it difficult to understand the educational needs of children because they have actually passed through the Piagetian stages of development which they are trying to encourage in their pupils. Lawrence (1997) says that *'unless the teaching methodology embraces ... a wide variety of techniques, any pupil/student whose style does not match is likely to be disadvantaged'*. Perhaps this mismatch of teaching/learning styles could be why children's motivation in science lessons has become difficult to maintain. The lack of enthusiasm for the sciences amongst children may have also served to proliferate the widespread public opinion that science is at best irrelevant, and actually boring and/or difficult to study (Osborne, Millar and Collins, 1999).

Other agencies have already realised the effectiveness of role-play for use in staff training, from health care, management and administration to urban planning and neighbourhood development schemes (Saunders, Percival and Vartiainen, 1996). It would be ironic if commercial enterprise took the lead from education in the race to reform and rehabilitate education by using techniques which *mean* something to the taught.

However, role-play *is* used in teachers' in-service training (INSET), often to address topics perceived as

BOX 2 Examples of uses of role-play in sex education related to the science curriculum

Sex education is a notoriously difficult area of the curriculum to teach, largely because the topic is so emotive to different teachers and wider areas of society. However, role-play provides many different techniques that may overcome any perceived difficulties because the activities are child-centred and also because any discussion that may arise from them is generated by the children. It is valuable to encourage role-reversals to give girls the opportunity to role-play being boys, and vice versa.

In the case of 'the facts' simple analogy role-plays can be employed:

- **Parts of the reproductive systems:** children form themselves into physical representations of the female and male sex organs.
- **Fertilisation and the 'sex' of the zygote:** one child – female, representing the ovum containing an 'X' chromosome – stands at one end of the playground; the rest of the class, boys representing spermatozoa containing a 'Y' chromosome, girls representing spermatozoa containing an 'X' chromosome, stand in a line at the opposite end of the playground. The teacher says, 'Go!', and all the spermatozoa take 'fairy-steps' (heel-to-toe, heel-to-toe, etc.) as quickly as possible to get to the ovum. Any children who cheat or fall over are pronounced 'dead' and are removed from the race. The first spermatozoon to reach the ovum is the winner and receives a prize to represent fertilisation. Many discussion points arise; for example, what is the sex of the zygote?, what happens to the spermatozoa in real life?, how does the zygote go on to develop?

In the case of the more emotive issues in the curriculum, such as the types and use of contraception, or the use of fertility treatments, simulation is best employed:

- **Contraception:** children act-out case studies, e.g. 'Mary' is 16, she meets a boy of 18 who wants to have sex, what does she do?; or, debate the pros and cons of particular types of contraception using information from textbooks.
- **Fertility treatments:** children act-out real-life scenarios of couples who cannot have children and ways of trying to rectify the problem; or, debates and/or public meetings about the moral/ethical issues surrounding these treatments using a scenario such as the proposed building of a specialist clinic at the local hospital.

Using simulation in this respect is bound to promote cross-curricular ties with, in particular, PSE, since support and advice may be gained from other members of staff while also addressing issues such as relationships, parenting, family and responsibility for oneself and others.

being emotionally 'difficult' to handle; for example, sex and drugs education, child-protection, and bereavement. Examples of the use of role-play in sex education are described in Box 2. Having been on such INSET, there is always a feeling from teachers that the role-plays have been an enjoyable, and even 'good', experience. If teachers are able to see the benefits of role-play, then why wouldn't children?

Categorising role-play

Role-play falls into seven broadly overlapping categories (Table 1). Of these, games, described in Table 2, are often the easiest for children to understand since they are used to playing them and quickly learn any new rules. For teachers who may be new to role-play, these activities would form an ideal platform from which to move on to the more complicated or abstract categories of role-play. The next step from games would be to develop presentations and metaphorical role-play, examples of which are given in Table 3.

The categories of role-play shown in Table 1 which science teachers may previously have referred to as 'role-play' are: metaphorical role-play, analogy role-play and simulation. Of these three, analogy role-play and simulation are perhaps the most useful to science teachers because they can be used to teach the more difficult scientific concepts (Table 4) – those which, for reasons of size or logistics, cannot be demonstrated easily in the laboratory; for example, atomic structure or the circulatory system. Most areas of the science curriculum can be adapted for the purposes of analogy role-play, though simulations are often more difficult to design and should only be attempted when the use of analogy role-play has been mastered. Simulation can be very difficult to attempt because it is based upon the requirement of the participants to 'play' roles described by the teacher, who also produces a scenario designed to represent real events. Children may have difficulty taking on these roles because they have had

Table 1 Categories of role-play with examples of exercises.

Category of role-play	*Example of role-play exercise*
Experiments/investigations	Any practical experiment
Games	Cut-and-stick; card games; board games; dice games; memory game
Presentations	Child-in-role; make a radio or TV commentary; short or extended science plays
Metaphorical role-play	Human sculpture; mimes
Analogy role-play	Using children as objects or elements of scientific theory
Simulation (or moral/ethical role-play)	Organised debates; simulated meetings; simulated court cases
Theatre in education	'Outside' drama companies which encourage audience participation

Table 2 Some examples of the uses of games in the science curriculum.

Examples of role-play exercise	*Suggested activity*	*Examples of curriculum applications*
Cut-and-stick	Worksheets containing jumbled words, phrases or pictures which children cut out and stick in the correct order.	All aspects of the science curriculum, e.g. names of planets; bones and organs of the body; Periodic Table; electrical symbols; etc.
Card cycle	Children work in groups to organise prepared information cards into a loop.	Cyclic aspects of science, e.g. water cycle; carbon cycle; nitrogen cycle; blood circulation; decay cycle; rock cycle; food webs.
Matching cards	Prepared cards of words and pictures; words and definitions or word associations are arranged face-down on a table. Only two cards can be picked-up at a time. The child keeps the matching pair. The child with most cards at the end wins.	Aspects of science that lend themselves to being matched, e.g. terms and definitions; type of radiation and its source; machines and how they work; devices and energy changes; organs and function; diagrams and descriptions of electrical circuits; sound and source.
20 questions	Stick a word or picture label on children's backs. Children can ask up to 20 questions to guess what is written on the label. Answers are limited to yes or no. Children work in pairs.	Elements, compounds and mixtures; the Periodic Table; metals and non-metals; the skeleton; cells and their function; classification; energy resources; types of forces; chemical equations; electromagnetic spectrum; planets in the solar system.
Board games	Question and chance cards; trivial pursuits; ludo; snakes and ladders; blockbusters; bingo.	All aspects of the science curriculum, e.g. growth and development; sex education; properties of chemicals; habitats; forces; etc.
Dice game	Children throw a dice to assemble a scientific diagram which has had numbers assigned to various parts of it.	Skeletal system; organs of the body; parts of a flower; parts of the Periodic Table; electrical circuits.
Memory game	Ask pupils to remember everything that was on a table or tray after looking at it for one minute.	Biology, chemistry and physics apparatus or terms; metals and non-metals; toy animals; various fuels.

no experience of them in their lives. In these cases a good deal of background knowledge needs to be supplied, through textbooks or information sheets and detailed 'character cards' that give information about any character's opinions and arguments. SATIS material is often excellent for this type of information (e.g. SATIS, 1987, 1988, 1991). The beauty of simulation is that it allows children to 'practise' with

Table 3 Some examples of the uses of presentation and metaphorical role-play in the science curriculum.

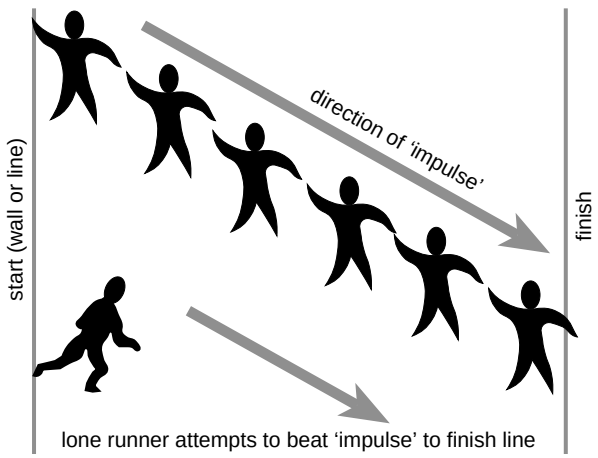
Category of role-play	*Examples of role-play exercise*	*Suggested activity*	*Examples of curriculum applications*
Presentations	Learning and presenting science	Individuals or groups of children read, analyse and report back on scientific text.	All aspects of the science curriculum, e.g. the qualities which different animals possess in order to survive in different environments; sources and properties of alpha, beta and gamma radiation; earthquakes and volcanism.
	Child-in-role	Delivery of part of a lesson.	Any aspect of the science curriculum that the teacher feels is suitable.
	Make a radio or TV commentary	Individuals or groups of children plan and deliver a talk using scientific skills, knowledge and understanding for radio or TV. The talk may be recorded on audio-cassette or camcorder and played back to the whole class.	Outline how an investigation was carried out to arrive at a conclusion or a solution; the importance of energy resources for the future; pollution and how it is destroying the planet's future; healthy eating and what it means.
	Science plays	Groups prepare short or extended plays to describe a suitable area of the curriculum to be performed in front of the class or the wider school audience.	Life histories of scientific figures, e.g. Curie, Darwin, Faraday; the history of science; histories of inventions; the many effects of science on society; ethical considerations of the use of science.
Metaphorical role-play	Human sculpture	Individuals or groups form themselves, or are formed by the class, into shapes or attitudes which represent feelings or physical properties.	Properties of metals and non-metals; life processes; rock types; cell structure and function; types of drugs and their effects; colour.
	Mime	Individuals mime a scenario. The rest of the class guess the content (charades).	Any aspect of the science curriculum, e.g. safety in the laboratory; types of equipment; classification; the planets and other types of astronomical bodies.

potentially difficult emotional or behavioural real-life events in a safe way.

Table 4 (overleaf) gives some examples of areas of the science curriculum where use of analogy role-play and simulation might be helpful. Specific examples of analogy role-play methodology are given in Figures 2, 3 and 4 (overleaf) and of a simulation in Box 3 (page 80), which it is hoped will be of practical help for setting up similar activities in the other areas of the science curriculum shown in Table 4.

Table 4 Some examples of the uses of analogy role-play and simulation in the science curriculum.

Type of role-play	*Area of curriculum that can be described*		
	Biology	*Chemistry*	*Physics*
Analogy	Circulatory system Structure and function of cells (Figure 2) Enzyme action Phagocytosis Transpiration Antibody/antigen interaction Predation	Atomic structure (Figure 3) Valency Concentration effects Surface area effects Gas laws Diffusion Sea-floor spreading	Kinetic theory States of matter Expansion (Figure 4) Electricity/electrical circuits Absorption of colour (see Batts, 1999) Refraction and reflection Movement of the planets and moons
Simulation	Environmental issues (SATIS no. 1206) Drug use Sex education debates Ethics of genetic manipulation	Environmental issues Ethics of oil extraction Ethics of raw material extraction Industrial hazards (SATIS no. 1002)	Use of fuels/renewable energy Use of nuclear fuel (SATIS no. 109) Noise pollution



Explanation

1 Choose a fast runner from the class. Line the rest of the class up, with arms outstretched so that they are just able to touch hands.

2 The idea is for the 'nerve cell' to pass-on an impulse from one to the next by touching the next person's hand, while the runner tries to beat them to the finish.

3 After a few practices, say 'Go!'

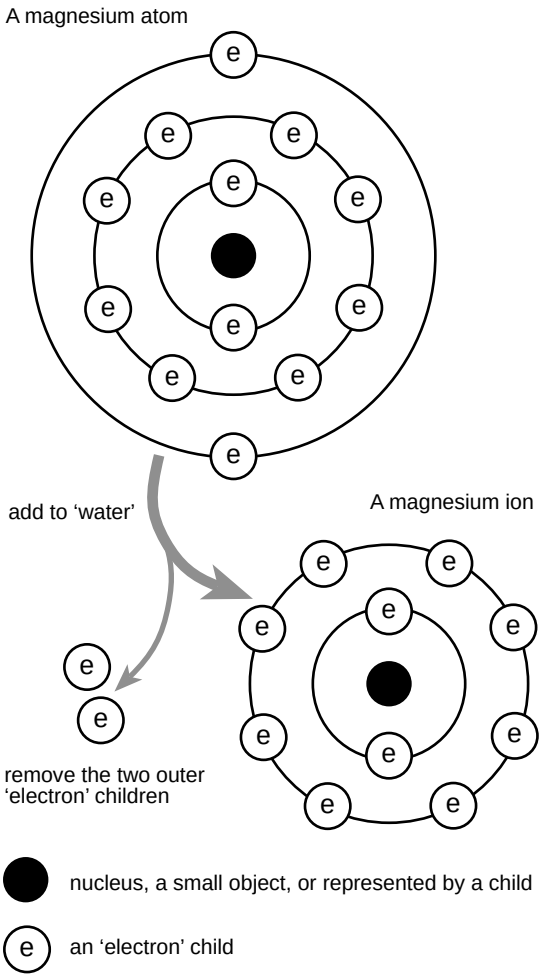
This role-play shows that nerve cells can pass on messages quicker than an isolated, moveable cell because they are long – and have a fixed position. Comparisons can also be made between nerve and hormone action.

Figure 2 A role-play to describe the structure and function of a nerve cell.

Using role-play

Many teachers may fear teaching in an 'active' way because of a perceived loss of control. Control in 'creative' situations is derived from the structure that the teacher applies to classroom management, in much the same way as in traditional lessons; for example, the application of good planning, fair and clear class rules, stringent timing, clear instructions and a calm, positive delivery. Anything that happens within that structure remains under the teacher's control, and is not normally due to any chaotic willfulness on the part of the taught.

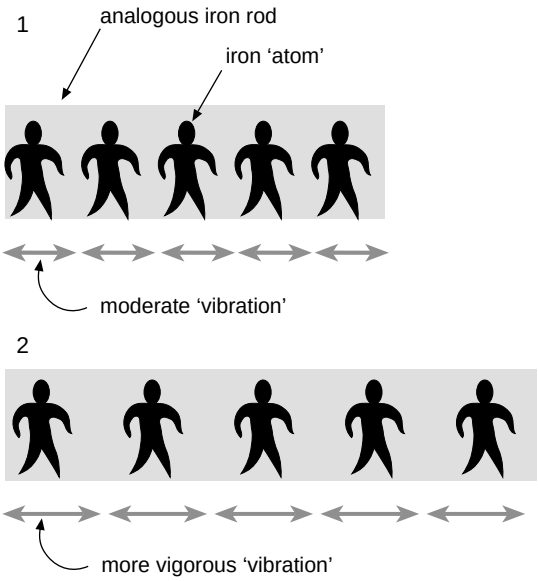
However, role-play is, of course, open to the potential of unruly behaviour, because in some cases it is actually quite difficult to teach (simulations in particular), demanding a great deal of judgement, skill and sensitivity to group dynamics. And sometimes the



Explanation

Based on their previous knowledge of atomic structure, children are encouraged to organise themselves in electron 'shells' representative of different elements. They would then be 'added to water' and behave as an atom would when ionising.

Figure 3 'Building' an element's electron structure and demonstrating ionisation.



Explanation

1 Children are asked to form a line which represents atoms in an iron rod, for example. They are asked to move backwards and forwards as if they are vibrating. The maximum length of the 'rod' is measured.

2 'Heat' the rod by telling the children that the temperature is gradually increasing. They 'vibrate' more vigorously, thus increasing the length of the 'rod'.

Figure 4 Expansion role-play.

teacher has to introduce new rules that the children must learn. The very act of learning these rules can lead to confusion. Often the most difficult rules for children to understand are those that require them, for the benefit of the role-play, to behave as a completely different person in, for example, a moral/ethical debate in a community which has recently discovered that it is to be used as an underground nuclear storage facility. No matter what each individual child may think about the issue, it is extremely important that they play the role of the character given to them throughout the exercise. In order to get the best from this type of role-play, it would be good to be able to perform them regularly so that the children come to understand what is required of them.

The role-play must therefore be created in a way that makes it *believable* to the group, and this believability factor will be different with each group, on different days, and at different times of the day (Bolton, 1992). No single role-play will ever be the same twice; thus, adaptability of the teacher is a prerequisite.

Having delivered the role-play and encouraged its 'performance', it is vital to review and evaluate the activity. Often, this can be achieved by a simple question-and-answer session, but it can also easily be done by art or in written work, or as an introduction to a related topic. During the review of the role-play the child's emotional response to the activity should be elicited (which will invariably be extremely positive).

BOX 3 The simulation, 'Nuclear power in my back yard!'

Possibly the easiest way of producing a simulation is by debating a situation. In this example, children form equally sized groups and choose a speaker who will put the groups' views over to the rest of the class in a two- or three-minute speech. The speech is formulated by the whole group according to the section of society they have been asked to represent; each group is briefed by means of an information sheet or card from the following possibilities:

Government officials

Keen to build nuclear power station because:

- the country needs more electricity;
- need to introduce new, safe, technology;
- need more spent fuel for Sellafield to recycle;
- this is an isolated area, so would have less impact than building elsewhere.

Local residents' association

Against building nuclear power station because:

- fear the danger to residents;
- don't want to spoil the lovely countryside;
- fear the loss of tourism income;
- don't want village over-run with transport.

Scientists

Keen to build nuclear power station because:

- need to perform important new research;
- want to work with the new technology;
- keen to show that nuclear power is safe;
- keen to use recyclable forms of energy.

Friends of the Earth

Against building nuclear power station because:

- concerned over nuclear pollution, particularly the effects on wildlife and local residents;
- already enough stations in the country;
- concern about accidents like Chernobyl.

Local Council representatives

Keen to build nuclear power station because:

- will vastly improve local employment;
- will vastly improve income for area;
- able to use money to improve facilities;
- able to use money to invest in housing.

Local Cancer Trust workers

Against building nuclear power station because:

- aware of the devastating effects of cancer on people and their families;
- concerned that no extra money will be used to increase research into cancer treatment;
- concerned that sufferers will not be compensated;
- concerned that there are not enough hospital beds to cope with the projected increase in patients.

Following a sufficient amount of time to plan and write the speech, each group presents their arguments through their 'speaker', with the teacher presiding as chairperson. There is then a question-and-answer session resulting in votes 'for' and 'against' the building of the nuclear power station. Finally, it is valuable to evaluate the exercise.

It is important to start small in order to gain confidence in using role-play and to get used to the different classroom dynamics. Only with a degree of aptitude, confidence and comfort is it prudent to move up to more complicated and longer role-plays. Role-play may feel strange to any teacher who is new to the techniques, but the majority of children, particularly younger children, find role-play exercises quite easy and derive a great deal of enjoyment and satisfaction from them.

Go on – give it a go!

Much has been made of the problems besetting science education. Reform has been suggested in order to make science more approachable to children (Hodson and Reid, 1988 – and many others!). Perhaps an understanding of the driving force of play behind education would be a good, practical start. At the very least, role-play is available now, and can be used as an additional teaching method in the science laboratory. If done correctly, role-play is an extremely enjoyable

Performing the nerve-cell role-play.

experience both for the children and the teacher, and has a great potential for making science interesting for the disaffected or disinterested child, as well as the interested.

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