

USING ROLE PLAY IN THE TEACHING AND LEARNING OF KINEMATICS AT SCHOOL CERTIFICATE LEVEL

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Physics is perceived as one of the most difficult subjects in the secondary school curriculum (Colletti, 2010; Mauritius Research Council, 2004; Monk & Osborne, 2000). Cobern (1994) further states that "... even the well educated often know little science". The teaching of physics has till now been very rigid, using very limited resources and without much link with real life experiences (Ramma, Dindyal, Tan & Cyparsade, 2006). Physics teachers have to do their best to make learners understand physics concepts despite the inherent difficulties in its teaching (Lawrenz, Wood, Kirchoff & Kim, 2009). Students are not only unable to understand and apply science concepts, they are also not able to understand the purpose of science in the school curriculum and are regrettably shying away. The hypothesis of this study is that use of role play as an innovative strategy in science classrooms can bring about the desired conceptual and behavioural changes among students at secondary level in Mauritius. Two types of activities were tried in this case study; the setting up of scenes on scientific concepts by the class teacher, then these scenes were explained to students so that they can act accordingly and learn the concepts as they enact. The second type of activity was setting up and acting of some scenes by groups of students, after the concept had been taught by the teacher in some interactive ways other than role play (Cyparsade, Moheeput & Carooppunnen, 2009). Pre-test and post-test, along with classroom observation, teachers' interview and focus group discussions with students show that there is much enthusiasm developed during classroom interactions and this has enabled students to understand concepts in kinematics better through the use of role play.

Keywords: Role play, Teaching and learning of physics, Kinematics, Innovative strategies

INTRODUCTION

This investigation is an effort to apply an innovative strategy such as the role play in the teaching and learning of concepts

in physics, precisely kinematics, at secondary level and evaluate its effectiveness in bringing about the desired conceptual change.

It is very important to trial innovative strategies in the teaching and learning of science for several reasons. One of these is the intention of bringing variety to the classroom practices both for the benefit of the teacher and also the learners (Cyparsade, Moheeput, & Carooppunnen, 2009, p. 679-704).

If the teacher comes into the classroom with the same type of planning, same strategies, same questions, resources and evaluation techniques then it may become boring for learners. Teachers should actually have a huge repertoire of strategies, resources and assessment techniques to choose from, to enable him/her to teach the intended concept. Role play has been chosen as it is a relatively new strategy and has not been implemented so far at the secondary level in the teaching and learning of physics in Mauritius. Actually, learners need focussed and engaging exercises during teaching and learning process. It is also intended to help learners internalise certain abstract concepts through the engagement of more than one sense at a time (Sharma, 2006).

It has been found that learners in Mauritius and worldwide are less at ease with physics concepts than other science subjects because more abstract concepts are probably found in physics than elsewhere. Physics is actually the master of scientific knowledge (Colletti, 2010). Therefore the learning of physics concepts demands more concretisation. Different structures of students' prior knowledge implicate different instructional strategies to help students reorganise those structures (Ozdemir & Clark, 2009). However, the availability of appropriate and up to date resources in schools, especially low achieving and privately run schools, is difficult. In such a situation how do we concretise abstract concepts? Teachers who are dedicated are trying means and ways to make resources available through their own initiatives but others are resorting to 'teaching by

telling', which is detrimental to learning. Teachers need to adopt strategies that translate abstractions into concrete experiences and provide meaningful learning experiences to students, without needing expensive material that is not readily available.

The study has been conducted at school certificate level (14 years old students); it is at this level that students choose to study science further or not. Since there is a growing concern about the shrinking number of students who are choosing to study science (Mauritius Research Council, 2004; Osborne, 2008), means and ways have to be devised to maintain students in the science stream. Kinematics is one of the fields of study that is taught at School Certificate level and also at Higher School Certificate level.

AIM OF THE STUDY

The aim of the investigation is to gauge the usefulness of role play as a novel strategy to bring about conceptual change in learners studying kinematics at School Certificate level.

OBJECTIVES OF THE STUDY

Through this study the researcher intends to

1. Put into practice the use of role play as a novel strategy in the teaching and learning of physics.
2. Evaluate the extent of conceptual change taking place through the use of role play.
3. Gauge the feeling of learners and teachers with regard to the use of role play in teaching.
4. Make certain recommendations on the applicability of this strategy in the teaching and learning of physics at secondary level of education in Mauritius.

Innovative strategies

Various innovations have been brought in the teaching and learning process in the Mauritian Schools. Some of these have shown desirable results but have not been tried out on larger scales to be able to inform policy. Teachers at secondary level have used peer-tutoring (Goomanee, 2003) cooperative learning (Pillay, 2008), jigsaw method (Katwaroo, 2008) and other innovative strategies and all these endeavours were meant for improving practice and therefore producing meaningful learning and better results. Other innovative strategies that have been tried outside Mauritius are the use of 'play-n-learn' approach in the learning of physics (Munirah, 2006), use of magic scientific toys (Hong & Lin, 2006) and these innovations have brought encouraging results in the respective countries. These new methods should be tried across larger areas to reach more learners to bring about the desired changes. One of the new ways of physics teaching is the role play method that can enrich and inform both its audience and those who participate in the performance (Nickerson, 2009).

Role play

Role play has sprung from other common forms of expression such as drama, play, games and simulation (McSharry & Jones, 2000). The author has elaborated on several categories of role play such as experiments/investigations, games, presentations, metaphorical role play, analogy role play, simulation and theatre in education. Of these the analogy role play has been tried in this study as

"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 – those which for reasons of size or logistics, cannot be demonstrated easily in the laboratory" (McSharry & Jones, 2000).

Analogy role play is about using children as objects or elements of scientific theory (Nickerson, 2009). The author is of the opinion that drama, and therefore role play, is an effective means of providing opportunities for deeper understanding of science topics. Though role play has not been used in physics instruction in Mauritius, teachers have tried it in biology and chemistry at secondary education level. For example, Sukhoo-Busawon (2008) has used role play to teach circulatory system at school certificate level. She has used teacher prepared notes as well as reference books to deliver content to learners and then students role played the concepts. Student responses were positive and she recommended that teachers could use this technique for the benefit of our students as it is a fun based strategy leading to meaningful learning.

Pedagogical benefits of role play

Role play has several benefits that should be tapped for the teaching and learning of physics. It gives an opportunity to bring variety through the development of multiple intelligences (2009) of learners where linguistic, bodily-kinesthetic and visual-spatial intelligences of learners can be explored (Sharma, 2006). The philosophy of 'learning by doing' or 'doing is understanding' fits very well with the role play method as Nickerson (2009) and Darlington (2010) put it, "use of drama (and role play) forces deeper understanding of scientific subject matter and it is beneficial to students of all abilities". Role play involves co-operative learning where each member has to contribute towards the success of the activity and learn in the process. It is also observed that learners are physically, emotionally and intellectually involved in their lesson which makes it a memorable experience. Simulating real life situations and learning from them can also make learning a fun-based activity where creativity of learners can develop (Wardle, 2009).

STRUCTURE AND PROCEDURE OF THE STUDY

In this study, the topics that were taught using the role play method were distance, displacement, speed, constant speed, velocity, constant velocity, acceleration and constant acceleration at School Certificate level. Learners are required

to study these topics, understand, them and apply them in interpretation of motion of bodies and in problem solving. Learners are also required to sketch and interpret velocity – time graphs, obtain information from these graphs and use these in problem solving. However, due to the abstract nature of this topic, many learners are not able to understand the concepts and have a tendency to interpret the velocity – time graphs pictorially. For example, a graph representing a motion where the velocity increases and then decreases, may be interpreted by learners as if the body has gone over a hill and has come down a little further away. This type of misconception arises due to the inability of learners to internalise the ideas, having learnt it in an abstract way. One way of handling this situation is by role play where the learner reads and understands the motion of the body and tries to imitate it or another way is to take a toy car and make it move according to what is shown in velocity – time graph.

The researcher ensured that teachers whose students are involved in this study had completed the chapter on kinematics at school certificate level. The strategies that were used by the teachers were questioning, demonstration, problem solving and so on, but not role play. Our study involved conducting a pre-test (diagnostic test) to see how far understanding of concepts in kinematics has been achieved by those learners. Students' responses obtained in the pre-test were analysed to identify misconceptions. The areas which needed reorientation in the teaching were identified. Then the researcher, along with the teachers, planned to teach these concepts through role play.

Tools for gathering data sample and methods

This study was conducted through a case study approach which produces a detailed examination of one setting (Wellington, 2000). Two classes of 20 students were chosen, each from a low achieving privately run school. The learners are of low to middle ability in mathematics, science and languages. Teachers do put additional effort to make learners understand and apply concepts in science and prepare them to enter the next level of the school curriculum. These efforts also include innovations that enable educators to take learners 'on board' by allowing them to take more responsibility in their learning. Multiple sources of evidence have been chosen in this case study (Gillham, 2003a). Data gathering tools used are pre-test and post-test scores (Hewson & Hewson, 2003), observation by the researcher, focus group discussion (Wellington, 2000) with learners and interview (Gillham, 2003b) of the class teachers.

Pre-test

A pre-test was given to the learners to check their understanding of the concepts in kinematics. Questions set were related to what was taught in the class by the class teacher. Basic content and applications of these ideas were assessed. Time allocated was twenty minutes and the questions were of structured type. After the pre-test, the scripts were marked

and scores were kept for comparison with that of post-test.

Teaching of lesson on kinematics

One week after the pre-test, the topics in kinematics were taught through Powerpoint presentation, whole class discussions as well as role play. For each group of students, two sessions of one hour each were conducted. It should also be noted that as these learners have poor linguistic skills, the teaching took place partly with the use of L1 that is 'creole' which all learners are familiar with and through English. This was necessary to be able to keep proximity with the learners and also to be able to bring about meaningful learning of scientific concepts. Learners felt more at ease to express their answers/comments in L1 and then I translated these expressions into English so that they grasp these meanings for assessment purposes.

Using role play in the teaching/learning process

Two types of role play activities were used in this study. Velocity – time graphs were shown to learners and they were required to interpret the type of motion that is depicted. After whole class discussion some students were required to move their own body and demonstrate their understanding of the motion or to move the toy car provided to them to demonstrate the motion. In some cases students were explained on what to do to depict the motion of bodies but in other cases students were required to plan the act on their own and perform it to explain the type of motion shown.

The tasks were related to: 'object at rest', 'object moving with constant velocity', 'object accelerating uniformly from rest', 'object accelerating uniformly but not from rest' and 'object decelerating uniformly till rest'. These are some of the common types of motion that are learnt at school certificate level. The graphical motion depicted by these five situations were first explained by the researcher using both techniques, that is, moving own body and also moving a toy car to create the visual impact required for understanding the abstract situation. The first graph was easy to enact as the object is at rest and no motion is required. The second graph showed constant velocity and the role play shows a motion where the body moves in a straight line and covers equal distances in equal intervals of time. This was shown by the researcher moving in a straight line on the floor and using the markings on the floor tiles to cover same number of squares in same time interval without stopping or slowing. Following this demonstration, one student was asked to role play it using the toy. The same techniques were used, that is, moving along a straight line following markings on the lab bench and covering equal distances in equal intervals of time.

The third graph showed a uniform acceleration from rest. So it means initially the body was not moving and then it started to move slowly and gradually the body moved faster and faster. The idea was to make learners understand that when acceleration is taking place, there should be an increase in speed and the body should go on moving faster and faster along the same

straight line. In this demo we moved the toy car starting from rest and moving with increasing speed in a straight line. Other students were then asked to do the role play.

The next graph showed a body that was moving with a certain initial velocity and then it started to accelerate uniformly. Students were asked to role play this part and it was done well by some while others could not imagine and act the scene. The problem was conceptualisation of the initial velocity; already moving and then moving faster, however, some students were able to do so both with their own motion and the motion of the toy car. The fifth context was an easier one as it showed something moving initially, then slowing down and coming to rest finally. The role play was performed well by most of the learners. The idea of uniform and non-uniform acceleration was a bit more difficult to explain as they involve higher order thinking. The changing slopes of the graphs were used mathematically to explain these abstract ideas; however, an attempt was made to concretise their understanding. In order to make the idea more explicit, role play was again used. We devised a model of the two pedals that are used in cars for acceleration and braking. Using this model, learners were supposed to act as a driver of a car and translate his/her intentions into actions. All the above examples were tried using the developed model.

- Body starting from rest and accelerating uniformly, the role play action showed the initially stationary body moving faster and faster and the accelerator pressed and held at a fixed depth
- Body having initial velocity and accelerating uniformly, the role play action showed the initially moving body, moving faster and faster as the accelerator was pressed and held at a fixed depth
- The uniform deceleration till rest was acted beautifully by some learners and this showed they were at ease with the role play and understanding the concepts. Students showed the brake being pressed and held at a fixed depth as they slowed down to stop
- For increasing acceleration, students were encouraged to come forward and perform the role play. Leading questions were used as to whether the velocity is increasing or decreasing, the accelerator or the brakes should be involved, whether the pedal is pressed slowly, released slowly or held at a particular depth. These prompts were able to draw the right act from some students. It was then shown that for this case we should go on pressing the accelerator to show increasing acceleration
- For decreasing acceleration, some students thought that the brake should be used as the body is slowing down. There was confusion between slowing down (deceleration) and decreasing acceleration. The same leading questions were then used to produce the right answer from students. It was then decided that the accelerator should

be used and it should be released slowly to produce a decreasing acceleration

- It was clear for students that the remaining two graphs dealt with the brakes as velocity was decreasing in both. For increasing deceleration, students went on pressing the brake and slowing down abruptly at the same time
- For decreasing deceleration it was the opposite, students continuously released the brakes and slowed down at the same time. It was seen that the distance in which the body stopped was longer for the decreasing deceleration as compared to that of increasing deceleration

A formative evaluation to check students' understanding of combinations of the motions was conducted. Learners were required to interpret a graph in terms of how the vehicle is behaving and also what the driver must be doing to achieving this motion. Students were able to explain orally the various sections of the graph. After the role play activities and formative assessment, there was a whole class discussion to clarify issues (Sharma, 2006), to find out if the same concept can be enacted in different ways or the reasons for doing it this way. As such talks proceeded, students were able to engage in dialogic process of meaning making (Mortimer & Scott, 2003). This idea is also in line with the three step process comprising the role playing; preparation, presentation and analysis (Bender, 2005).

Post-test

After the 2 one-hour sessions for each class, the post-test was conducted. It contained the same questions, the same number of questions and for the same duration as it intended to assess the extent of conceptual change due to the use of role play. It was an individual task as before.

Focus group discussion

After the post-test, a sample of 6 learners had been called to give their views on the days' lesson and especially the role play as an innovative classroom interaction. The teacher selected the learners who would participate in the focus group discussion (FGD). A set of simple structured questions were set such as: What did you like most in this method of learning physics? What is the advantage of learning physics in this way? Would you like to learn other topics using this method? Why do you think so? How is this method different from other methods used to learn physics? The duration of the FGD was about twenty minutes.

Learners related their experience with this innovative way of learning physics. This was the first time that they had acted to show their understanding of physics and they were enthusiastic about it. Students who did not participate in the role play activities but watched the concepts in action also benefitted. They stated that acting lead to better understanding as compared to reading or listening to the teacher most of the time. Learners also stated that they wished to learn other concepts in similar

innovative ways such as role play and drama. They stated that this type of interactive sessions will help them recall concepts better. Students mentioned that this method is different from other methods as they have to understand the content to be able to act it out. It is also a pictorial way of understanding an idea and it is better retained as a sequence of actions. Since it is easy to recall a movie as a sequence of actions in the same way these concepts can be retained. The idea of understanding the types of motion from the driver's point of view was also commented on. Students recalled that when they were playing as children they were using such expressions as "accelerer" (acceleration), "frein mort" (constant velocity) and "ralenti" (slowing down/deceleration) and now they have studied these ideas scientifically.

Observation of the lessons

During the two lessons learners showed much enthusiasm and participated in the discussions. Their linguistic abilities brought a certain degree of handicap in the way the lesson progressed. They were at first hesitant to answer to my questions but as we increased the use of L1, they were more and more able to join in the discussions and were eager to perform. It was also observed that the role play using the toy car was better performed by students than moving their own body to explain the type of motion. The low ability learners were hesitant to participate in discussions and role play but we made them feel at ease and participate.

Teacher interview

The two physics teachers were present in the class at the time the lessons were being conducted by the researcher but they did not participate in the teaching/discussions. They were asked to give their views on the lessons conducted. They were both very cooperative and stated that the lessons were very interactive. Students participated actively and responded to the queries of the researcher, performed the role play and also asked questions to clear their doubts. Teachers stated that role play is a strategy that can be used in the teaching and learning of many concepts especially if these are abstract ones.

Teachers supported the fact that role play is also in line with the philosophy 'I do, therefore I understand'. This means when students understand a concept and then act it out, or observing others performing the act, helps to understand.

From Figure 1 it is found that on average there has been a positive leap by students in understanding of the concepts related to kinematics. The observation that we had noted while conducting the session, tallies with what students have said in the focus group discussion and it also tallies with the marks obtained in the pre-test and post-test. Students said that they have understood the concept better as they had to act them out, it can be stated that use of role play has benefited them. But to be able to confirm this fact larger scale studies have to be conducted where other concepts have to be taught for extended periods of time. This would provide additional facts to be able to establish the effectiveness of the innovative strategies such as role play and drama in the teaching and learning of physics. However, use of role play in this study has brought certain degree of conceptual change in the learners. It is also true that the positive leap in the conceptual understanding of learners cannot be solely attributed to the use of role play as no control was used.

On closer analysis, it is found that there is a very small number of learners (4/40) who have not had any change in marks obtained in the pre-test and post-test. It could be that they have not been able to undergo any conceptual change through this method of learning and need other strategies. It could also be that the misconceptions that they have are deep rooted. It has also been seen that few students had given the right answer in the pre-test but have given the wrong answer in the post-test i.e., after explicit instruction. It could be that the conception that these learners have are not strong and permanent. Students vacillate between alternative conception and scientific conception (Hewson & Hewson, 2003; Sookrauj, 2006). Sometime they use the right scientific conception to explain an idea and at some other time they switch to naïve ideas to explain the same idea. In such cases, more activities and other strategies are needed to bring about permanent conceptual change.

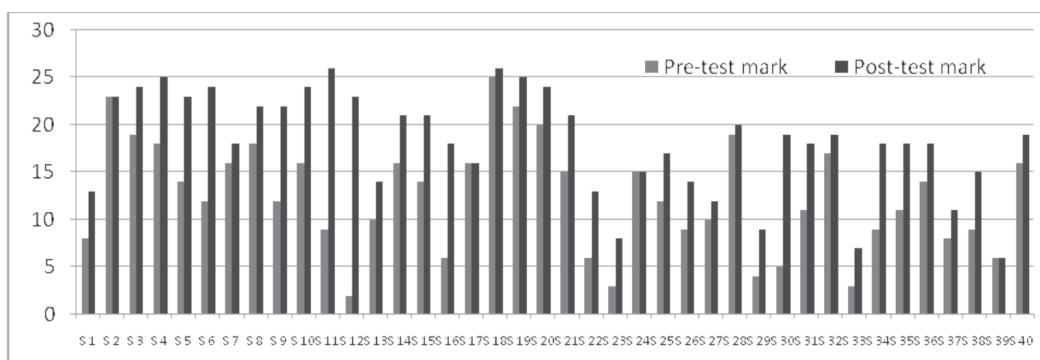


Figure 1: Analysis of marks from pre-test and post-test (total of 30 marks - both classes combined). Average score of pre-test = 12.45 (standard deviation is 5.85); Average score of post-test = 18.23; (standard deviation is 5.49); Increase in average marks = 5.78 (+ 46.4%)

DISCUSSION

Over the years, researchers, curriculum specialists, educators at pre-primary, primary, secondary, pre-vocational, post secondary and tertiary levels as well as other stakeholders have advocated the use of active learning techniques. Many techniques have been applied and their strengths and weaknesses have been identified for implementation on larger scale. Many science education specialists have focussed on the use of role play and have compiled the benefits that this technique brings about in the classroom, apart from a break in monotonous teaching. Practical implementation of this technique also shows that the potential of using drama and role play in science classrooms are enormous (Darlington, 2010). As well as being fun, boosting confidence and self-esteem, it is a way to enable learners to apply concepts they have learnt, in a rich and realistic environment. Role play has also provided a valuable opportunity to learn not only the subject matter but other skills such as communication skills and cooperation.

CONCLUSION

Data obtained through focus group discussion, pre-test and post-test scores, along with our own observations, views from the classroom teachers all show that role play is a useful tool to enhance the teaching and learning process. The advantages provided by this innovative method of instruction should be explored by educators and it can prove to be very beneficial for our students. It is therefore recommended that teachers make use of the range of role play strategies available, to be able to produce the desired conceptual change among learners. The use of LI was beneficial in the classroom interactions and this has to be investigated further. It is also essential to vary teaching and learning strategies to avoid monotonous lessons.

ACKNOWLEDGEMENT

Teachers, students and managers / rectors of the schools where the study was conducted.

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