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The Theme Park Experience of Teaching Science from the Constructivist Paradigm

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Abstract

Using Theme park rides to teach science/physics is one of the possible authentic experience one can offer to the science students. The physics of the rides as an alternative way of teaching forces, such as, G-force, centrefugal /centrepetal, free fall, acceleration, and conservation of kinetic and potential energy, is definitely an innovation students love to have in their learning experience. And, allowing students to actually experiencing the forces in action and enabling students to actually measuring the forces using a gravitometer that they designed are grand examples of not only meaningful learning can be established but learning with enjoyment can be made achievable too in the students’ learning outcomes. As, students by their youthful nature enjoy the rides such as the roller coasters and the freefall towers that deliver white-knuckle thrills in a safe environment.

In our UiTM science education program, among the courses included is a course named SCE553- Creativity and Creative Teaching in Science and Theme Park is one of the major units of the course. This paper shares the course experience in general and in particular pertaining to the unit of Theme Park as an alternative way of teaching science/physics. The unit of Theme Park organized around three main innovative activities, there are, 1. Designing a gravitometer, 2. The theme park rides, and 3. A class presentation/discussion of the science/physics of the rides. The SCE553 course structure is designed using the constructivist framework emphasizing inquiry approaches in teaching, highlighting among others, the creative dimension in the learning outcome. The paper also offers a brief description of the course philosophy and its outlines. Learning outcomes as seen from the eyes of student-teachers as appeared in their reflective essays will be shared in order for the reader to capture the true essence of a constructivist approach in teaching that not only nurturing the creative and innovative elements in the student-teachers but also the soft skills, such as, leadership, communication, and presentation.

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1. Introduction

From the constructivist paradigm of teaching science, authentic experience is greatly emphasized as experiential learning enables students to appreciate science and a sure way of getting students interested in science. But, how to get this message across to the student-teachers in a science teacher preparation program such that this constructivist paradigm can be translated into a reality in their classroom practices with confidence when they are in schools in the later years? Isn’t it the best effective way is by showing the student-teachers the practical approach by means of experiencing the constructivist paradigm that encompasses authentic experience by themselves? The above conception form the guiding principle in designing the SCE courses in the UiTM science teacher preparation programme.

This paper shares the course experience of SCE553-Creativity and Creative Teaching in Science in general and in particular pertaining to the unit of Theme Park as an alternative way of teaching science/physics. The unit of Theme Park is organized around three main innovative activities, there are, 1. Designing a gravitometer, 2. The theme park rides, and 3. A class presentation/description of the science/physics of the rides.

The SCE553 course structure is designed using the constructivist framework emphasizing inquiry approaches in teaching, highlighting among others, the creative dimension in the learning outcome. The paper also offers a brief description of the course philosophy and its outlines. Learning outcomes as seen from the eyes of student-teachers as appeared in their reflective essays will be shared in order for the reader to capture the true essence of a constructivist approach in teaching that not only nurturing the creative and innovative elements in the student-teachers but also the soft skills, such as, leadership, communication, and presentation.

2. A creative curriculum

The short coming in the learning outcome of science students in general pertaining to thinking and interest have been acknowledged by science educators. How to enhance scientific thinking in students? How to get students to see science in action and excited about science other than bring them to a good Science Centre? It is to address these noble questions that science education reform suggests the possible use of some non-traditional method of approach in science instruction such as those that are based on the constructivist paradigm that emphasize on student center, hands-on mind-on, group work, and etc. In terms of research, focus has been on the emphasis of out of class room activity, such as science museum visit, field trip, and playground/amusement park. Cartoon movie such as Tom and Jelly has been used often in the teaching related to mechanic. However, using science fiction movies has been suggested but rarely applied in practice.

In the SCE553- creativity and creative teaching in Science course for the in-service program we have introduced several innovative approaches in teaching targeting the nurturing of creativity to a higher level. The topic outline of the course is as followed (Table 1):

<table>
<thead>
<tr>
<th>Table 1. Course Outline</th>
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<tbody>
<tr>
<td><strong>Content</strong></td>
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<tr>
<td>Course Induction: Game Participation: Students take turn to demonstrate a unique way of crossing a path/Creative puzzle</td>
</tr>
<tr>
<td>Torrance’s Creative Thinking</td>
</tr>
<tr>
<td>The Unnatural Thoughts in Science</td>
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<tr>
<td>Creativity in Science</td>
</tr>
<tr>
<td>Baroque music in learning</td>
</tr>
<tr>
<td>Fostering Creativity in Science</td>
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The objective of the course as stated in the learning outcomes is to enable students to acquire the following academic abilities:

- Demonstrate higher order thinking skills such as creative and critical thinking skills;
- Display the confidence and skills to implement alternative methods in science teaching which are largely based on creativity; and
- Construct and internalize a comprehensive theoretical frameworks of creativity.

The teaching approach is based on the student-centered constructivist paradigm. The general guidelines are in brief as followed:

- Students are divided into a group of not more than five.
- Every week each group is responsible for sharing its research finding regarding the content of each week lesson during the 3-hour session class.
- Instructor executes as facilitator.
- Use inquiry method that emphasizing the student-centre mode of instruction.
- Students experience cooperative, reflective, and experiential learning,
- Creative learning with critical thinking are among the focus.

From the course outline, it can be conceived that there are three mains parts in the course program.

- Students are exposed to creativity in general and in science specifically.
- Students are guided through the various innovative methods of teaching.
- Students demonstrate their creative and critical thinking skills via presentation, project and assignment.

For this article author would like to share the experience of the unit - the Theme Park.

3. Theme park

The unit of Theme Park is organized around three main innovative activities, there are, 1. Designing a gravitometer, 2. The theme park rides, and 3. A class presentation/discussion of the science/physics of the rides. The activities will be deliberate in details in the following discussions.
3.1. Designing a gravitometer

In this subunit, students are required to design a gravitometer. Before embarking on the building of this meter for measuring G-force and centripetal/centrifugal for of the theme park rides during the visit, students are encouraged to do research and come out a good design. Figure 1. show an example of gravitometer that students have designed. In designing the gravitometer, the following learning outcomes are apparent:

- Students learn the techniques of calibration,
- Students have to acknowledge the important of reducing the effect of friction, and,
- Students learn that the basic principle of gravitometer is the same as spring balance and the theory of extension is proportion to the force applied.

Fig. 1. Gravitometer

Fig. 2. Centripetal Toy
3.2. The theme park rides

The visit to the Sunway Lagoon has been proven to be the high light of this unit. Students are excited not only with the fun students can have but to measure the forces using an instrument-gravitometer that they themselves designed and actually produced. Students are to measure the G-force of 1. Buffalo Bill Coaster, 2. Pirate’s revenge, and 3. Tomahawk, and the centrepetal force of 1. Tiger Adventure, 2. Butch Cassidy Trail, 3. Chief Crazy Horse Carousel, 4. Vultures, 5. Wagon Wheel, and 6. Apache pots.

3.3. A class presentation/discussion

The group which is responsible for the unit of Theme Park is required to plan the 3-hour class discussion. The group is guided to come out with the activities for this classroom session. The focus of this class session are the followings.

- In the discussion of the physics of the rides, such as the roller coaster, the focus is on the design that take into consideration of the energy exchange between the potential and kinetic energy and the G-force during the free fall and the looping of the rides. For the rides that involved centripetal/centrifugal, other than introducing the formula \( F = \frac{mv^2}{r} \), students are made to aware that in the measurement they are actually measure centrifugal as they have to place the gravitometer horizontally with the weight pointed outwards. Centrifugal force is more apparent than centripetal in the rides. The reaction force from the back of the seat forms the centripetal. Definitely in the discussion, included is the discussion of the maximum G-force that human can withstand and the biological effect the rides have on our body such as how our adrenaline glands reacts with the motions of the rides with the secretion of adrenaline hormone. Included in the discussion are the rides not available in Sunway Lagoon, such as, Silly Silo (Figure 3), and the Swing Chair (Figure 4). The discussion is aided by video clips where students found using youtube search.

The concept of centripetal and centrifugal forces have been proven very challenging to most students. Apparently students uses these two conceptual terms interchangeably. But most students will use the term centripetal first as this is the term being emphasized under the topic of circular motion. To make a distinction between these conceptual term students are asked to play with a centripetal toy that they can construct as shown in Figure 2. Students are asked to play with the toy by setting the blue ball into an orbital swing and state the obvious observation they have made - the radius of the circular motion of the blue ball increases as the speed of the swing increases. Students are required to explain the phenomena based on the centripetal force equation \( F = \frac{mv^2}{r} \) and come out the notion that the tension of the string as the source of centripetal force. Mind you, most of the student teachers including the physics majors find this task a very challenging one although the physics majors have studied circular motion in their Physics per se course of Mechanics. An interesting event that followed is getting students to put the green and the red ball into orbital swing instead of the blue. Students need to provide the ‘why’ this task is a difficult one.

- The physics of collision form also the topic of discussion since the student-teachers have the experience of the Bumper Car ride. This ride illuminates the three laws of motion formulated by Sir Issac Newton in the following ways:

Newton's third law of motion says that if one body exerts a force on a second body, the second body exerts a force equal in magnitude and opposite in direction on the first body. It's the law of action-reaction, and it helps to explain why the student-teachers feel a jolt when they collide with another bumper car.
Newton’s second law is brought in to explain how does the Bumper car rides are designed so that the cars can collide without much danger to the riders. The role of the large rubber bumper all around the car which prolongs the duration of impact and diffuses the force of the collision is then highlighted.

The concept of inertia in Newton’s first law has been brought in to explain the experience when the bumper cars collide. During the impact of the collision, as the drivers the student-teachers feel a change in their motion and become aware of their inertia. Though the cars themselves may stop or change direction, the drivers continue in the direction they were moving before the collision. This brings in the explanation of why it's important to wear a seat belt while driving a real car, since otherwise one could suffer injury being thrown forward in a collision.

The law of conservation of momentum - an extension of the Third Law, form the premise of discussion of the effect of the masses of the drivers on collisions. A difference in mass between two bumper car riders will mean that one rider experiences more jolt due to change in motion than the other. The type of collision, velocity of the cars, and mass of the individual drivers all come into play in bumper car collisions.

4. The Findings

Have we been successful in meeting the objectives of the class? These are what students have commented in their feedbacks with reference to creative teaching, thinking, development of soft skills and leadership:

“Experience is the best teacher. I am sure that everyone must have listen to this before. When we experience, we learn better and we will remember it for the rest of our life. We had a visit to sunway lagoon. This visit really gives benefit to us. We experience when there is zero gravity. We experience how if there is a day without gravity. Actually it is like we have no weight at all or weightlessness. In class before we learn that when there is no gravity we will be floating in the air, we never thought the other concept that occur. We never thought that there is such thing as G-force. So, this visit shows us the importance of science in our daily life. We can see what is really we learn through application. After the visit, we know the concept behind the rides”

“For this class, I have gone to Sunway Lagoon to learn about gravity, study how much gravity is exerts when we ride roller coaster, pirate carrabean and others. Besides learn, I can feel it and it make me very excited to learn and do more research on it”

“This class helps me a lot. In term of soft skill, by doing presentation it helps developing self-confidence and increase classroom management. The presentations also test my ability in solving unexpected problems such as dealing with the technology. In term of creativity the trip to Sunway Lagoon helps on developing the “gravitational meter”. Lot to solve with this device such as how to measure the G-force, how to make sure it does work smoothly and how to make as simple as possible.”

“Creativity is the ability to think and do extraordinary things beyond our normal thinking such that we are thinking of doing something different and impossible. Having the chance to be in the class of Creativity in Teaching Science (SCE 553) and to be one of the students of Dr Beh in the SCE 553 class is more than just a requirement for passing the final term. Frankly admitted, our group members really love for being in the class of SCE 553 and we find that this course is a good way in cultivating creativity among science students.

For the course requirement, each group is required to do presentation and lots of ideas come out. From Torrance’s creativity to gravitational force, each group comes up with creativity and crazy ideas of conducting the presentation. This makes the course totally different from any course as for normal presentation, students just read from the slide show and give explanation based on the information they have but for the SCE553, the presenters prepared activities and let the audience to carry out the activity based on the presented topic. In addition, we have the chance to argue on any information and Dr Beh will ask questions like ‘what do you think?’, ‘why this happens?’ or ‘what is the application in your daily life?’ So this kind of question triggers our inquiry of reasoning and finding the answer by our own.
The idea of constructivism is one hundred percent integrated into the class of SCE 553. Why do we say so? From A to Z, you name it, each of the students involves actively in the class and Dr Beh is just the monitor and just guides us on how to conduct the activity. Unlike normal classroom condition, we are free to do anything we like as long as that thing related to the class or related to the presentation. So, it is too common if the presenters prepare activity and reward the winners of the activity just for the reason everyone has fun of doing the activity.

If we look back to the time when each one of us is a student, we have to follow all the teacher’s orders and we do not have the chance to demonstrate our creativity. We go to school just for the sake of examination oriented where the letter ‘A’ has the power over anything. During school time, our physics teachers explain about gravitational force and our biology teachers do mention about adrenaline hormone (ADH) but do we really experience gravitational force and ADH? For the SCE 553 class, we have the chance to experience a force called as gravity and the secretion of ADH while riding the pirate revenge at the Sunway Lagoon. Constructivism leads us to enhance our soft skills. Three years ago, almost all of us have the anxiety to stand and speak on the front but now as being of the students of SCE we have changed and our English language has been improved consistently.”

5. Conclusion

Using Theme park rides to teach science/physics is one of the possible authentic experience one can offer to the science students. The physics of the rides as an alternative way of teaching forces, such as, G-force, centrifugal /centripetal, free fall, acceleration, and conservation of kinetic and potential energy, is definitely an innovation students love to have in their learning experience. And, allowing students to actually experiencing the forces in action and enabling students to actually measuring the forces using a gravitometer that they designed are grand examples of not only meaningful learning can be established but learning with enjoyment can be made achievable too in the students’ learning outcomes. As, students by their youthful nature enjoy the rides such as the roller coasters and the freefall towers that deliver white-knuckle thrills in a safe environment. If we can translate this approach in teaching science/physics at schools from the constructivist paradigm where students intrinsic motivation is aroused, may be our Malaysian target of getting 60% of students doing science will be realized sooner. However, reform is easy said than done. To begin with, we have to reform the instruction in our Malaysian teacher training programs. How to get pre service teachers to have the confidence of carrying out this type of authentic science teaching when they are in schools in the later years? Isn’t the best way is having them actually experience this constructivist way of teaching themselves? This authentic experience from the constructivist paradigm form the guiding principle in designing this SCE 553 course as well as other SCE courses in our Science education program at UiTM.
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References