CREATIVE PEDAGOGY IN ACTION RESEARCH

by

PHANG SIN NAN

Guru Cemerlang (Fizik)

Majlis Guru Cemerlang Sarawak

d/a Sekolah Menengah Kebangsaan Pending,

Kuching, Sarawak.

ABSTRACT

"Creative Pedagogy in Action Research" is based on the teaching and learning of the concept of "Resolving Forces" over the past six years.

It has been observed that students find "Resolving Forces" abstract and difficult to understand . Action research on the teaching-learning of this topic has lead to new approaches, breakthroughs and innovations in pedagogy. The students have found the innovative approach more enjoyable and easier to understand. They have also become more creative and critical in their thinking.

This working paper has the following ***four main features*** **:**

1. 1. ***The students learn to verify*** theoretical concepts. In this case, they learn how to verify that the force acting downwards parallel to the inclined plane, $\boldsymbol{F}$, is given by $F = mg \sin \theta$, where $\boldsymbol{m}$ is the mass of the object, $\boldsymbol{g}$ is the acceleration due to gravity and θ is the angle made by the inclined plane and the horizontal.
2. 2. ***A constructivist approach*** is used as an alternative teaching-learning approach to the conventional method of teaching this concept.
3. 3. ***A research culture*** is inculcated and nurtured.
4. 4. ***A concerted effort to produce inventors and innovators*** among the students.

1. 1. BACKGROUND

In this working paper, “Resolving Forces” is used as a model for ***Creative Pedagogy In Action Research.*** “Resolving Forces” is such an important subject in Physics and Engineering that it is imperative to ascertain that our budding scientists are able to conceptualize and understand it well right from a young age. I have been asking myself why the students have a problem understanding the concept of resolving forces.

2. STATEMENT OF THE PROBLEM

Physics is very practical, interesting and alive as a subject and it should be presented and taught as such. It has been heard among Science Stream students nationwide that Physics is abstract and difficult to grasp. As a Physics educator , I need to address this problem. “Resolving Forces” is a sub-topic in Form Four Physics as well as STPM Mathematics. It has been observed that SPM Physics students find “Resolving Forces” abstract and difficult to understand. There is a need for accompanying experiments for this concept to complement the materials in standard texts and reference books. I have thought through how constructivism and experiential learning will make this concept more palatable and interesting. Why do students have a problem understanding the concept of “Resolving Forces” even though the derivation of the formula is explained systematically ?

This paper has a four-fold objective : The students will

A. A. ***learn to verify*** theoretical concepts through innovation,
B. B. ***use a constructivist approach*** to understand this concept,
C. C. ***be involved in action research directly***, and
D. D. ***have enough opportunities to invent and innovate in a day-to-day classroom situation***.

A. A. ***LEARNING TO VERIFY THEORETICAL CONCEPTS THROUGH INNOVATION***

In this case, they were first introduced to an experiment (called **"Resolving Forces")** which I first invented and designed in early 1995. They learned how to verify that the force acting downwards parallel to the inclined plane, $\boldsymbol{F}$, is given by $\boldsymbol{F} = \boldsymbol{mg} \sin \boldsymbol{\theta}$, where $\boldsymbol{m}$ is the mass of the object, $\boldsymbol{g}$ is the acceleration due to gravity and $\boldsymbol{\theta}$ is the angle made by the inclined plane and the horizontal (Diagram 1).

This experiment enabled the students to :

- · experientially and contextually understand the concept of "Resolving Forces",
- · think more analytically, critically and creatively as they tackle this concept,
- • become innovators themselves after having been shown the way,
- · enjoy Physics much more, and
- · learn more effectively.

-

Apparatus And Experimental Procedure

-

- • Generally, cheap and readily available resources are used. The only additional apparatus is the special runway which costs only RM 7.00. The rest of the apparatus are existing standard apparatus in the laboratory.
- • As shown in *Diagram 1* and *Photograph 1* , the experiment is set up using simple apparatus like the retort stand, boss head and clamps, a large wooden protractor, a smooth runway measuring 65 cm x 20 cm x 1 cm with a screw fixed at one end, a 1-kg dynamic trolley, a forcemeter or spring balance, some plasticine, talcum powder, a large set square and a red brick. The talcum powder reduces the frictional force considerably. The set square ascertains that the protractor is vertical. The brick stabilises the retort stand.

- • The experiment works well with a 1-kg dynamic trolley. Other mass values are not suitable because of the sensitivity and range of the forcmeter used.

-

<u>Experimental Results</u>

The experimental values of ***F*** , the resolved force acting downwards parallel to the inclined plane, are easily read off the forcemeter for values of $\boldsymbol{\theta}$ = 0°, 15°, 30°, 45°, 60°, 75° and 90°.

Table 1 compares a set of the experimental results with the theoretical values of the resolved force, ***F***. For the calculation of the theoretical values of ***F***, 9.81 N kg^{-1} is used for ***g***, the gravitational field strength.

Diagram 1 : "Resolving Forces In Action"

Photograph 1: “Resolving Forces In Action”

Experimental Results

Angle θ / °	**Forcemeter Reading / N (Experimental Values For *F*)**	***mg* sin θ / N (Theoretical Values for *F*)**
0 °	0	0
15 °	2.4	2.5
30 °	4.9	4.9
45 °	6.8	7.0
60 °	8.2	8.5
75 °	9.2	9.5
90 °	9.8	9.8

Table 1

When θ = 90°, the forcemeter shows the exact value of ***mg*** sin **θ**. Interestingly, when θ = 0°, the forcemeter reads ZERO. This is simple yet profound.

Conclusion Of The Experiment

Within limits of experimental errors, the experimental values of ***F*** are very close to the theoretical values of ***F***. This verifies experimentally that the force acting downwards parallel to the inclined plane, ***F***, is given by $F = mg \sin \theta$.

Benefits Of This Innovation

- • This innovation provides a hands-on, minds-on approach (constructivism).

- • This experiment enables the students to understand “Resolving Forces” experientially. This experiment also serves as a memory aid.

- • This experiment serves as an eye-opener that principles in Physics can be verified using our own inventions. The students are encouraged to devise experiments of their own. As such, they develop their creative and critical thinking skills in learning Physics.

- • The students’ response to this innovation is encouraging and positive. They show that they have grasped the concept of “Resolving Forces” and have found it to be tangible and concrete after all.

- • By carrying out the experiment in small groups (of 3 to 4 students), the students come to life because the approach is fun, enjoyable and boost their confidence.

- • By just reading off the values of the resolved force from the forcemeter, the students, especially the weaker ones, are encouraged as they can solve problems the practical way in resolving forces.

B : ***CONSTRUCTIVISM***

As explained in Sections A, C and D, the constructivist approach is given prominence to tap into the genius within each student. The students are encouraged to construct and build their knowledge and understanding based on their present cognitive perception of concepts. They have the opportunity to engage, explore, explain, elaborate and evaluate their work in a constructivist approach. This will also be discussed in details during the presentation of the paper.

C : ***ACTION RESEARCH***

To me, 'The Best Is Yet To Come" succinctly describes Action Research. The following chronology of events shows how elements of action research have made the above innovation inexhaustive and more creative. In fact, the term "*kaizen*", a Japanese word meaning *continuous improvement*, aptly describes the results of the following action research.

May 1995 ***:*** A 1-kg weight and a half-metre rule was used for the experiment.

October 1995 ***:*** The 1-kg weight was replaced with a 1-kg trolley. The specially-made runway was used instead of the narrow half-metre rule.

March 1996 to March 1997 ***:*** The experiment (as described) was prescribed to my students.

March 1998 to March 1999 ***:*** I modified my approach by just giving the students the apparatus without telling them the experimental procedure. They were asked to use the given apparatus to design an experiment to verify that $F = mg \sin \theta$. This was less prescriptive than before.

April 2000 ***:*** The students were not told about the apparatus or experiment at all. They were asked to design an experiment to verify that $F = mg \sin \theta$. After some probing and facilitating from me, the students spent much time thinking and discussing the task. Finally, a few students managed to design similar experiments. I have found that this latest approach (which is not prescriptive at all) is most satisfying as it enabled the students to think really hard to analyse, create, innovate and synthesise. The students enjoyed the experience of thinking and being creative. This approach was most beneficial to all. The students' thinking skills level had gone at least one notch up. Some useful data were obtained from 75 of the students, the details of which will be discussed during the presentation of the working paper.

D: PRODUCING INVENTORS IN THE SCHOOL

I believe that the approach of using creativive pedagogy in action research in the classroom will produce inventors in the school. I think that this practice should be part of the day-to-day routine of the teaching-learning experience. It is not some mystical experience limited to a select few.

CONCLUSION

-

Personally I have found the above experience extremely gratifying and enriching. The students have enjoyed it, too. This will certainly spur me on to greater creativity and inventions in pedagogy in the future.

-
-

-

REFERENCES : HALLIDAY, D., RESNICK, R. & WALKER, J. (1993) *Fundamentals Of Physics, Extended With Modern Physics,* 4th Edition, John Wiley & Sons, INC. (1306 pp)

COPYRIGHT RESERVED © by PHANG SIN NAN, 2001

phangsn@pd.jaring.my

No part of this project paper may be reproduced, copied, or distributed in any form or by any means, or stored in a data base or retrieval system, electronic or otherwise, without the prior written permission of the author.