Action Research

On

"Improvement of physics numerical problem solving skills of students in Bhutan".

Dorji Tenzin

Dorjitenzin273@gmail.com

Contents

Abstract

The students feel challenged by the numerical questions asked in Physics. They face series of troubles in solving the questions despite their admirable attitudes towards learning the subject. Hence, the improvement in Physics problem solving skills was prioritized. The researchers had suggested that Problem solving has been observed to be one of the principal causes of academic failure in areas of science such as Mathematics, Chemistry and Physics. This is so because pupils do not learn how to solve problems but merely memorize solutions explained by teachers. However, to support this finding the data were collected using observations, class test and questionnaire from students of 9th grade of Drukgyel Higher Secondary School. The quantitative findings are interpreted through bar graph and pie chart. Most of the students performed very well after the interventions as an indication of improvement. Teachers could further help students to develop their problem solving skill in Physics by demonstrating different strategies and techniques and guiding them in solving many numerical questions.

Key words: academic failure, improvement, Physics problem solving, attitudes, merely memorize.

Introduction

The academic performance of students in Physics (solving numerical) in examinations and classroom provide an evidence of poor attitude and poor problem solving skills. Numbers of factor had been recognized by many researchers responsible for the poor achievement of students in solving the numerical questions in Physics such poor instruction, lack of mathematical background, role of teachers, and interest of the students in learning the subject. Moreover, include lack of motivation and poor self-image (self-concept) of primary school teachers, lack of innovative teaching methods, lack of teaching facilities, poor school climate, lack of incentives and motivation, poor remuneration, poor condition of service and students' poor problem-solving abilities (James & Adewale, n.d).

Problem solving has been observed to be one of the principal causes of academic failure in areas of science such as Mathematics, Chemistry and Physics (Perez & Torregrosa, 1983). This is so because pupils do not learn how to solve problems but merely memorize solutions explained by teachers in line with the traditional method of teaching.

Ausubel (1968) defines problem solving as a form of discovery learning which bridges the gap between a learner's existing knowledge and solution to problem. Here problem solving will draw heavily on previous/existing knowledge of the learner which must be brought to bear on the situation at hand. Duffield & Rumbaugh (1989) on his part defined problem solving as a goal directed cognitive learning process that makes use of previously learned knowledge and cognitive strategies. Whereas (Padgette, 1991) defined as 'problem solving is an art, which consists of understanding all the rules and that means all of them, not just the point –by-number type-and then understanding which ones to break in any given problem.

No matter how simple or hard a problem may be, a beginner in problem solving required significant procedural and conceptual knowledge. Conceptual and mathematical knowledge are not enough to determine the success of students in Physics problem solving but also the attitude of students towards Physics is a good predictor in solving problems. So, the following work consists of findings towards the improvement of Physics problem solving skill of the class 9 students through different interventions and methodologies supported by the literatures.

Topic: *Improvement of Physics numerical problem solving skills of students in Bhutan*

Reconnaissance

Reconnaissance is derived from a French word 'reconnaitre' which means to look at (Rinchen, 2008). Basically it has three components or parts namely Situational Analysis, Competences and Literature Review. These are three areas we need to look at when we are going to undertake any action research.

Situational analysis

Country

Bhutan is a small landlocked country located in South Asia, south of India and north of China. It lies between latitudes 26° and 29°N, and longitudes 88° and 93°E. Elevation rises from 200 m (660 ft) in the southern foothills to more than 7,000 m (23,000 ft).Bhutan held its first democratic elections in March 2008. Bhutan is a member of the United Nations and the South Asian Association for Regional Cooperation (SAARC); it hosted the sixteenth SAARC summit in April 2010. The total area of the country is currently 38,394 square kilometers. As of now the literacy rate of Bhutan is 59.5% (NSB, 2010) and poverty rate of 23.2% (NSB, 2010). According to NSB report release of 2010, the unemployment rate of our country is 3.3%. So there is need to upgrade the student's level so as to improve literacy rate and reduce unemployment rate. More importantly Bhutan is identified globally for its policy of gross national happiness.

Education system of Bhutan:

Prior to 1960s there were virtually no modern education facilities in Bhutan. It was introduced with the initiation of economic development in 1961. However, the monastic education was existed and continued to exist even today. At present there is an extensive network of schools throughout the country. In the present formal educational system, we have hierarchical structure and chronological graded learning, which requires certification for the learners to progress through the grades to go to higher levels (National Statistics Bureu,

2010). The system consists of one year in pre-primary (PP), six years in primary, two years in lower secondary schools (LSS), two years in middle secondary schools (MSS), two years in higher secondary schools (HSS), and three years in tertiary education.

My class

The class I chose to conduct my research was class 9A students of Drukgyel Higher Secondary School. These students learn all the three branches of science (Physics, Chemistry & Biology) regardless of the integrated science they have learned in lower classes and came from most of lower secondary schools of Paro dzongkhag. So, what can I expect from those students who were taught integrated science in the lower classes? The class had 24 members ranging from 14 to 16 years of which 13 of them were females. That year was their first year experiencing higher secondary school life when I undertook the action research with them during my teaching practice in 2014. Most of them would be completing their twelfth grade from this school however, for some students their time in school could be their last formal education after class ten. Even then, how I work for the improvement of skills of solving numerical problems in Physics of class 9 would be more important in future.

Competence:

The researcher has completed class twelve taking science stream and I am student teacher in the Samtse College of Education undergoing a Bachelor degree in Physics and Chemistry. I have completed a research module as Introduction to Educational Research as separate module. And has an experience of doing a mini-research as major assignment at College. In fact, I can say that I am equipped with research strategies and related issues so that I will be able to collect adequate, good and reliable data. In order to ensure authenticity of my research I will use participants with the support from my critical friend and here my critical friend will be someone who have undergone research module with adequate and good research knowledge so that s/he will guide and show me the right direction whenever I am stuck with the process and more over s/he will direct and certifying my works at all time.

The most important and information giving participants would be the students of class 9 B of Drukgyel Higher Secondary school. They could assist me in gathering information through participating in class test and sharing the fact about the solving numerical problems through attempting questionnaire although, they don't have any idea and knowledge related to the

topic “research”. Moreover, I am anticipating having heartfelt cooperation from the students’ side as it would be an opportunity to broaden their conceptual content through solving the numerical problems.

Literature review

Here I would like to present the views expressed by various researchers and my own analysis on “improvement of problem solving skills in Physics classroom” that would enrich the learning style and ability of the learners.

Physics by its very nature is exceptionally quantitative. It teaches students to try to reduce problems to exercise (basically the calculations) already in memory or available from outside sources (Beiser, Mahajan, & Choudhury, 2009). In fact, the numerical problems in Physics play a vital role in the clarification of theoretical concept of Physics.

Successful Physics students are those students who understand complex Physics formulae in basic terms for solving numerical problems (Sherin, 2001). He further stated that understanding the fundamental building blocks of Physics and if they are able to transfer that understanding to understand complex formulas, then it helps students to gain the understanding and give necessary for transfer of knowledge to other problems in Physics. Moreover, according to (Martinez, 1998), the capacity to solve complex problems is considered as an essential skill for citizens of today’s changing technological society. (As cited in Zewdie, 2014).

Research on Newtonian mechanics problem solving suggests that students can be adept at solving traditional quantitative Physics numerical problems while still having an extremely poor conceptual or qualitative understanding of the principles involved (Halloun & Hestenes, 1985). This clearly shows that students have learnt the calculation part without clear idea about the respective concept which would ultimately hamper the students to master that particular skill.

Almost all the topics in Physics include numerical problems/calculations for better understanding of theoretical part. Early chapters in almost all textbooks for first level higher education courses start with topics like measurement and formulae, equations and calculations. This is the 'grammar and syntax’ of Physics but is daunting for the student

(Mick & Jenkens, 1998). Moreover in connection to this some of the researchers have found out that most Physics instructors agree that students who are introduced to this subject for the first time are poorly prepared to solve calculations (Frederick & Joan, 1984)

And according to Zewdie (2014), there are different factors for students' failure in solving Physics problems: These were anxiety, instructors' way of problem solving, mismatch between problems they solve in class and those prepared for tests, conceiving that Physics problems are difficult, lose of interest, lack of appropriate mathematical skills, and inappropriate method of instruction. He had further stated that when student had successfully completed the numerical solutions, teachers mostly rushed out to the next problem rather than interpreting the numeric answer. Accordingly, instructors' approach to problem solving could be one of the factors that contributed to students' failure to follow scientific approach in solving Physics problems"

Further, the performance of students in solving Physics numerical problems usually seems to be poor and characterized by having poor numeracy and problem solving skills coupled with poor attitudes towards learning Physics. Their secondary education experience of Physics has left them with little fondness or appreciation for the subject, which they perceive as a purely formula-driven, mathematical discipline with little or no connection to either their everyday experiences or their future careers (Leigh, Developing multi-representational problem solving in Physics classes, 2003).

There are two distinct reasons for the poor performance of the students in solving Physics numerical. Students lack the requisite mathematical knowledge, and students that have the needed mathematical skills are unable to apply them in physics Problems. Mathematics is the language of Physics (Valiotis, 2008). Thus, it is imperative for students to have a solid mathematical background in order to succeed in Physics courses.

It was determined by Duit et al., (2007) that in order to become a successful problem solver in Physics, the problem solver was required to have both a conceptual understanding of the Physics concepts, in addition to an understanding of the specific processes of how to solve the problem. However, many students who have taken Physics do not have basic conceptual understanding, nor do they have an adequate set of technical problem solving skills (Dufreshne, 1997).

According to the Callahan et al., (2009), excellence in high school physics depends on the role of the teacher, however, is the most important. Without a well-educated, strongly motivated, skilled, well-supported teacher, the arch of excellence in high school physics collapses. The teacher is the keystone of quality. It is of course due to the lack of competent Physics teacher and interest of learners. To solve the Physics numerical problems effectively, both the teacher and students must contribute equally; it must be both student and teacher-centered which is hardly found in Physics classes of Bhutanese school. This is indeed the main factor beside the poor performance of students in solving Physics numerical problems.

Many of the researchers had suggested many ways to improve the numerical problems solving skills. They recommend instructional strategies such as authentic cases, simulations, modeling, coaching and scaffolding (Jonassen, 2000). Different problem solving models have emerged in the last thirty years in a bid to explain the processes involved for the betterment of problem–solving. However, the most popularity gained model is the information processing and solution construction model e.g. IDEAL which focuses on identifying potential problems, defining and representing the problem, exploring possible strategies, acting on these strategies and looking back and evaluating the effects of these activities (Bransford & Stein, 1984)

Additionally, researchers (Rose, 1988) and (Alan, 1995) suggested the following steps in problem solving: (i) Defining the problem, (ii) Planning a solution, (iii) Solving the individual part which involves sketches, diagram and grouping, (iv) Putting it all together, and (v) Evaluation. These steps are the easiest to follow no matter how difficult the numerical questions may be since it involves planning and sorting out what the questions really demands.

Many of the research-based approaches to teaching Physics rely on a significant amount of small group work, both in conducting experiments and discussing questions and ideas. Springer, Stanne, and Donovan (1999), reviewing research performed across the disciplines of science, technology, engineering, and mathematics, revealed that small-group work is effective in improving both student learning in courses and student attitudes across the various disciplines. Heller et al., (1992) also stated that Physics students solve problems better when doing so in groups and the experience raises the proficiency of all group members.

In addition, Czuk & Henderson (2005) also stated that students deal and resolve their individual misconceptions through discussion and also each student in a group brings unique set of skills and experiences. It is obvious that students are more comfortable exposing their misunderstandings to a small group than to the whole class.

Cooperative Problem Solving is also the other way to improve the problem solving skills in Physics. However, it remained as ineffective in lower classes but can be used in combination with other teaching tools (Kenneth & Patricia, 2010). It can be combined with group problem solving skills and called as Cooperative Group Problem solving (Valiotis, 2008).

Despite some of the strategies being known, Keller (2010) mentioned the simplest few strategies to improve the numerical problem solving skills such as a) Watching experts solving problems b) developing expert problem solving skills by repeated practice c) practicing problem solving in different contexts that are meaningful d) working with others while solving problems and e) getting coached after you have tried your best and failed.

Action Research Question

How to improve physics numerical problems solving skills of class nine students Bhutan?

General aims

The main aim of this action research will be, to find the ways to improve my student's skills in solving numerical problems in physics.

Methodology or Data Collection Tools

I have used the same data collection tools for base line/ pre- data collection and post data collection. But the questions for class test will differ depending upon the content coverage. During the post-data collection, more content

Following are the data collection tools that have used to collect data for my action research;

1. **Observation**

The students were observed while solving the Physics numerical questions based on the following areas;

- ✓ How my students are solving the numerical problems following the procedures/steps given.
- ✓ The problems they face while solving the numerical problems.
- ✓ Their competence in solving the numerical problems.

However, this method was used only once, neither as baseline nor as post intervention, to support the adequate findings through class test and questionnaire. Moreover, the findings through observation had really helped in relating and drawing conclusions from the data gathered from other two methods.

2. Class test

The test questions were prepared during my teaching practice in Drukgyel Higher Secondary School, based on the level of the students and the content. The questions will be mainly based on the numerical problems. According to their proceedings and answers, I have evaluated each and every one of them. Through this, I came to know the number of students facing difficulties in solving that particular numerical problem and the problems that they face which ultimately hinders the effectiveness of learning physics.

3. Questionnaire

The questionnaires are framed based on the assistance students receive from their teachers while solving the numerical and their attitudes and interests in solving the physics questions.

After collecting the data, I have used the bar graphs and pie charts to represent the respective collected data as follows, for analyzing and interpreting the collected data;

- ✓ **Four bar graphs**; Data collected through class test and questionnaire will have one bar graph each for both base line and post data collected.
- ✓ **One pie charts**; showing the percentage of students' performance during observation after the presentation of interventions.

Baseline data

Most of the students in Bhutanese schools struggle in solving the numerical problems. Among all, they have been facing challenges in solving Physics numericals. So, the following data are gathered based on "improvement of problem solving skills in Physics of class nine". However, it is inappropriate to collect the data without having followed any proper procedures no matter how good the researcher is in analyzing it. Therefore, the following three methods (observation, test and questionnaires) were being used to gather the data during my stay at Drukgyel Higher Secondary School from class nine students. The methods were used both in baseline and post intervention data except observation. Despite the differences in diverse learning abilities, most of the students had improved their problem solving skills after the presentation of interventions.

Observation

Observation was only the method that I used just the once to observe students' problem solving skills providing few questions based on the Physics lesson taught. However, the students were already familiar with the topic and the task they were supposed to do. Moreover, the students were presented adequate examples with problem solving skills and procedures. To further strengthen their problem solving ability, competency and confidence, I made them to solve a few problems on the board. It also helped to examine their understanding on the lesson discussed.

Later, students were asked to solve five word problems in the class after the lesson in order to examine and evaluate them in three areas: a) how students solve the numerical problems following procedures/steps presented b) the challenges they faced while solving problems and c) their competence in solving the numerical questions.

It is not that they are not able to solve the numerical problems, but how they solve the problems with proper steps and procedures matters. There were 24 students ranging from 14 to 16 years and 13 of them were female. Irrespective of their abilities and intelligence, everybody was given equal opportunity to solve the set of Physics word problems. It was observed that more than half (approximately 60%, 15 students) of them have understood the concept and were found solving the problems with appropriate procedures/steps taught. And 25%, 6 students presented the partial performance. However, rest of the students were unable to solve like them (approx. 15%, 3 students) as they could not understand the questions.

Moreover, they could not identify and segregate the given values. They were not aware of when and where to apply the given formula. Despite of their poor ability, most of them were confident and interested enough to solve the questions since it enhances their conceptual understanding.

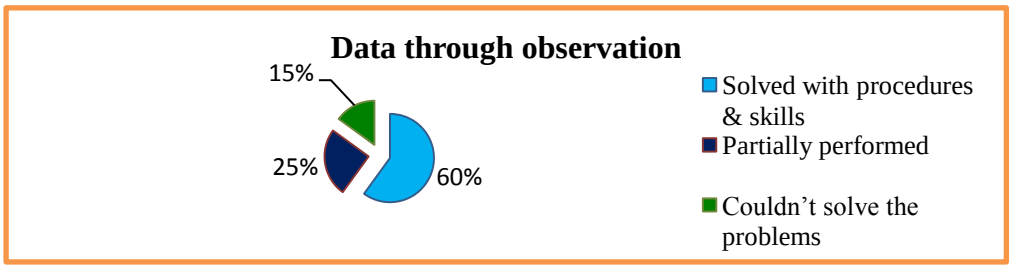


Figure 1.1

Class test (baseline data)

The following (figure 1.2) information were collected based upon their skills and strength before the interventions. The questions were developed based on numerical word problems. Moreover, the test questions were understandable. The class test was conducted in the classroom itself to avoid mal practices. The maximum mark obtained was six by one students. Most of them scored between two and five except for two students who scored one and zero. The results showed that almost 65% of the students scored good marks. However, one student left the paper blank without even trying to solve it, resulting in zero mark.

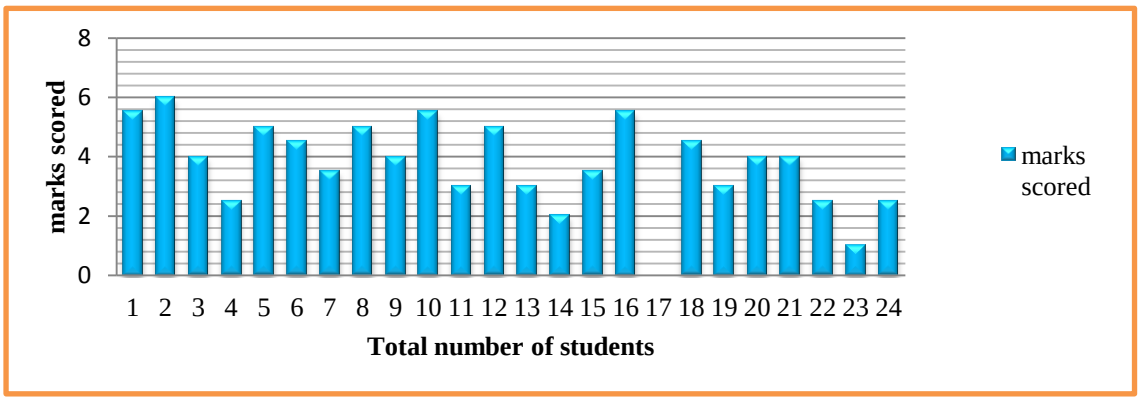
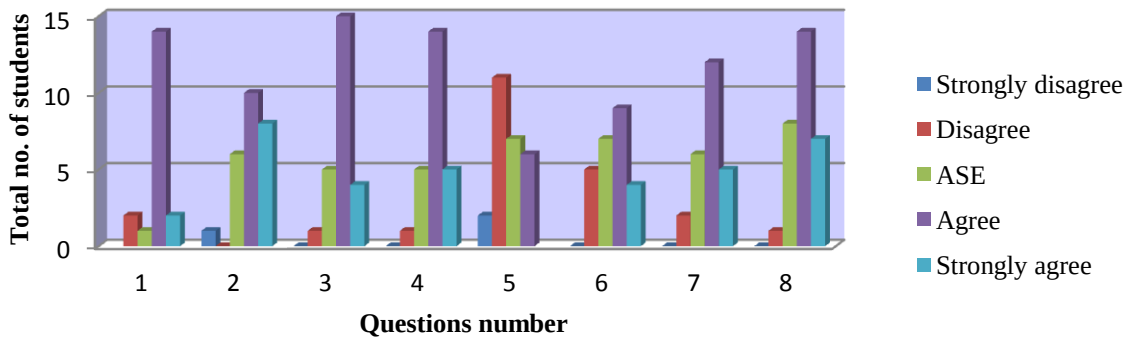


Figure 1.2

Baseline data (questionnaire)

The following (figure 1.3) graph is based upon the students' responses through questionnaire. There were eight questions framed based upon the numerical problems they solve and the help they acquire from their respected teachers. Almost all the students agree with the questions except for question 5 as most of them disagree with it. The question says, "*We can solve all the numerical problems with the help of hints given in the text".* Similarly, most the class 9 students strongly agree with the questions but very few of them strongly disagree with question 2 and 5. In the nutshell, maximum of the students were aware of the assistance they get from teachers and other respected people and they agree upon the questions forwarded.

Figure 1.3: Baseline data through questionnaire



Intervention

My interventions which would entirely help my students to improve their skills in solving physics numerical problem effectively are as follows;

1. **Teacher explains the steps involved before proceeding with calculation.**

Before the students proceed with the calculations, teacher must explain each and every step clearly and assure that all the students have understood the steps clearly so that the students will be able to proceed with the calculation systematically without much problem.

2. **Familiarize the students with the formula to be used and specific units**

Teachers must make sure that their students are aware of the formula to be used for that particular calculations and specific units beforehand.

3. **Demonstration by teachers**

Majority of the numerical problems in physics requires the critical thinking. There will be hardly any direct questions. Therefore, it is must for the teacher to demonstrate how to solve that particular numerical problem before letting the students to proceed. Demonstration provides students a clear idea of how a particular calculation is to be done so that the particular skill will be mastered.

4. **Follow the teaching strategy "Problem Solving Method"**

To solve the numerical problems in physics, the students must have creative and critical thinking skills. So, problem solving method is one of the best strategies which will help the student to develop the creative and critical thinking skills. While using this strategy, the following steps must be involved;

- ✓ Identify the problem
- ✓ Define and represent the problem
- ✓ Explore the possible strategies
- ✓ Act on the strategies
- ✓ Look back

By following this strategy, the understanding skill of students will be promoted; it will help students to remember the formulas for particular numerical problem and follow the steps involved systematically. While solving a problem, everyone is involved and of course everyone get an opportunity to solve the problem individually. Hence, there will be a development of dependent learner.

5. **Involve students' participation**

To understand the concept clearly in physics, particularly in calculation, student-centered is must. Unlike the other subject, the idea of calculation cannot be imparted fully through lecture and of course the mere demonstration and explanation by the teacher is not enough to master the skill. It is only through the active participation of the students that the effective learning will take place.

6. **Give feedback as quickly as possible**

To have improvement in students learning, teacher must give immediate feedback after every activities or their participation. Teacher should monitor and observe carefully when students

are solving the given problem. Never forget to reinforce them depending upon their performance. Always give immediate feedback for their weakness without hurting their sentiments.

7. **Be enthusiastic about one's subject**

To make students develop their interest in one's subject, first teacher should have interest in their subject. Well if the teacher lacks interest, how teacher can expect interest of students towards that subject. For instance, if a teacher is not interested in solving the particular numerical problem, he/she will fail to convey the clear ideas to the students. As and when the students fail to grab the ideas clearly, their interest to learn that particular skill will reduce. Ultimately, the effective learning will not take place.

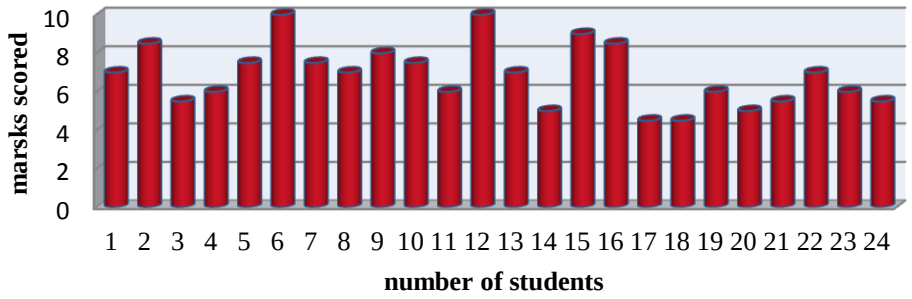
Post interventions data

The findings presented below are the results of successful interventions.

Class test

The following data (figure 1.4) was collected after the interventions and there were equal number of participations as in the baseline data collection. However, the questions were different but with same standard and set in such a way that their skills and acquired knowledge after the interventions in solving problems could be easily determined. Expectedly, unlike in the baseline data, two students could score full marks and rest of the students scored between four and nine which revealed their improvement in solving the Physics numerical problems. I was motivated and encouraged to work hard in presenting interventions in every possible way to bring some improvement in children's learning irrespective of their diverse learning abilities when none of them could scored less than four.

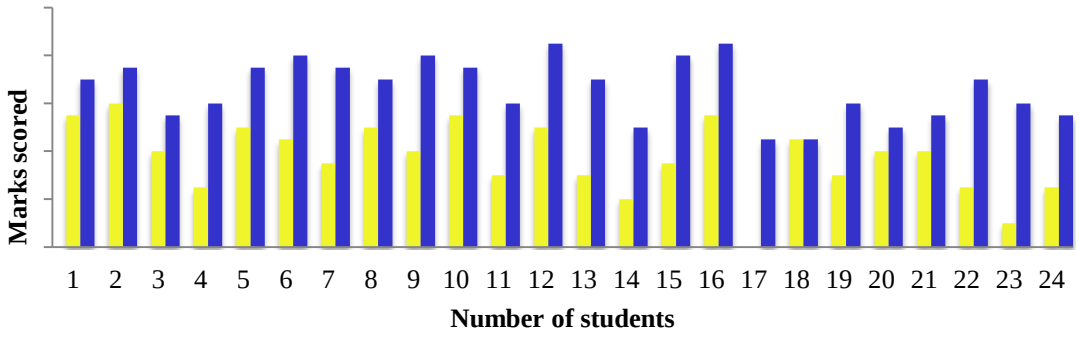
Figure 1.4: Post intervention data (test)



Comparison of class test 1 & 2

The students' performance in the baseline and post intervention can be easily understood from the graph itself. It is very comprehensible that students performed very well in post intervention than baseline data collection. There was not even a single student who had not changed or improved in the post intervention excluding one whose marks remained same with baseline. However, there was good improvement in those students who scored less mark in the baseline which revealed the importance of interventions and interest in learning Physics especially through solving problems. It was also an indication of how students are interested in learning physics despite of their intelligence and diverse learning abilities.

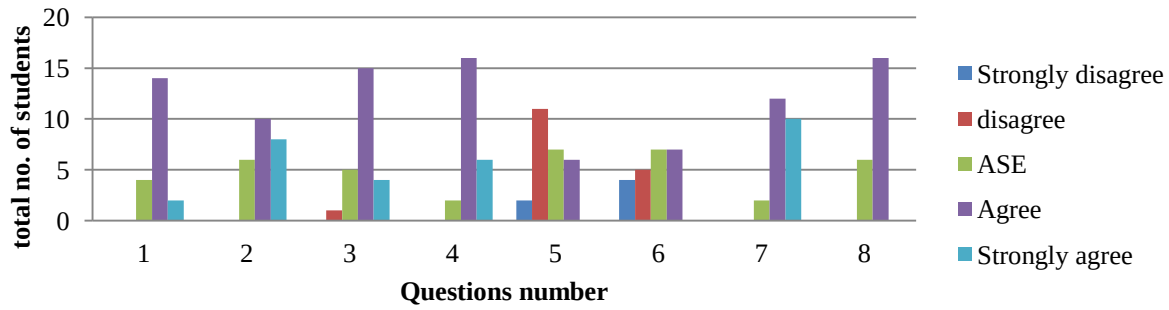
Figure 1.5: Comparson of test 1 & 2



Questionnaire

The information given in second graph is collected with the same questionnaire after the interventions. The number of students who agreed on most of the questions increased as anticipated and also little improvement in question five was observed indeed. However, most of them still disagree with question five and none of the students could strongly agree with question six and eight. It is not surprising to see few students who strongly disagree with question five however; the number has increased in question six as compared to the baseline intervention. Even though, no students were found strongly disagreeing with rest of the questions asked which a clear indication of improvement was after the successful interventions.

Figure 1.6 : Post intervention data through questionaire



Comparison of Questionnaire (pre & post)

Generally, most the students agreed with what the questions says in both the baseline and post intervention. Moreover, the figures also get increased in the post intervention as a clear indication of improvement. Simultaneously, the class 9 students strongly disagreed with none of the questions and disagreed with only question 3, 5 and 6 unlike the baseline intervention where students disagreed in almost all the questions. It is quite contradictory to strongly agree with the question when it is strongly disagreed (question 5) however; it was noted that not a single student strongly agreed with question 6 and 8. There was decrease in the number of students who strongly agreed in the post intervention data despite the interventions were presented. Even with the hardship in implementing the interventions, the number of students who strongly disagree with question number 6 increased.

Figure 1.3: Baseline data through questionnaire

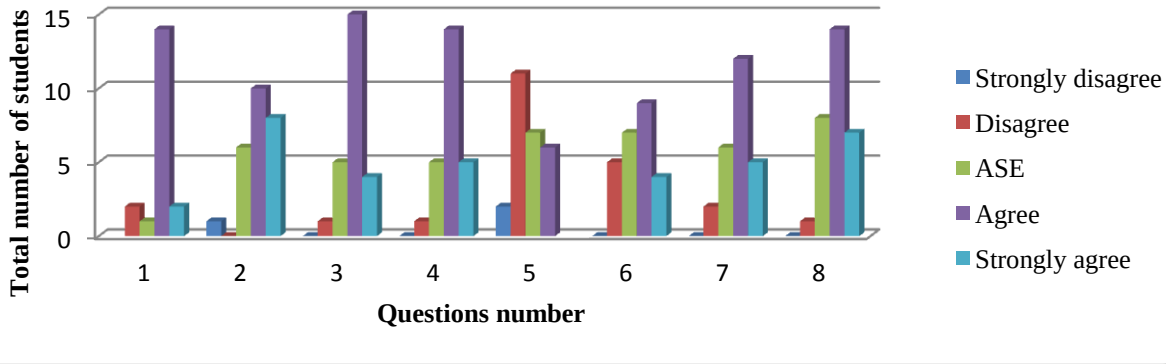
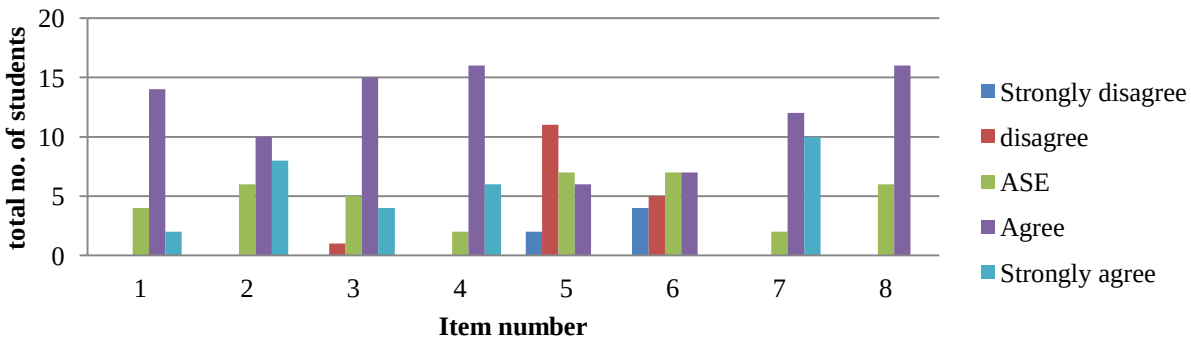


Figure 1.6: Post intervention data through questionnaire



Discussion

The cognitive, analytical skills and the understanding abilities are the keystones for the development of strength and courage of the individual in solving the numerical problems. Moreover, the primary understanding of the subject is necessary in solving the questions. In line with it, Duet et al. (2007) claimed that it is necessary to have understanding of the Physics concept with necessary understanding of specific processes of how to solve the problems to become a better Physics numerical solver. So, here are the presentations of how the literature and findings matches and some possible reasons for the findings.

It was observed that the previous knowledge of individuals entirely determines the future learning. Problems they had been solving in lower classes and arithmetic background are the reasons for their hard work in trying to solve the word problems although the scores were not up to the expectations. These findings agreed with the literature that mathematics is the language of Physics (Valiotis, 2008). Thus, it is imperative for students to have a sound mathematical background in order to succeed in Physics courses. However, it is contradictory to the literature that students are poorly prepared to solve numerical when introduced to the topic for the first time (Frederick, 1984). It is acceptable at some point yet, neither of my students came up with excellent result nor have they poorly performed because of the previous knowledge they possessed. Regardless of the diverse learning abilities and intelligence, students however exhibited average performance except one student who scored zero. The poor basic conceptual understanding or inadequate set of technical problem solving skills and intellectual abilities (Dufreshne, 1997) might be the reasons for his poor

performance. Conceptual and mathematical background are not enough to determine the success of students Physics problem solving but attitudes of students towards learning Physics is a good predictor of problem solving that would weigh down the performance of the students.

In comparison to the baseline data collected, the proper presentation of interventions and transformation in teaching ways with interventions such as giving immediate feedback encouraging active participations had really aided in the improvement of skills in solving the Physics word problems. Moreover, their analytical skills whenever necessary had been geometrically improved. The pass percentage had increased from 54% to 99% in class test. However, during the observation, 60% of the students were found solving numerical correctly with proper steps and skills. The observation was made right after the teaching session. Following the fact, carelessness, time rigidity, unconscious, immediate feedback and encouragement from the teacher were the reasons discovered for their difference in performance.

And repeated practice and readiness of the students might also be the key factors for the better performance in the post intervention of test than baseline and observations. The encouragement from the teachers in terms of evaluating and assessing their work were found other approaches to help students in learning. It is obvious that students would better solve Physics problems when assigned in small groups as stated by Heller et al., (1992) and it is beyond question to assure that these students would perform far better in groups since each student in a group brings up with unique set of skills and experiences.

Due to negative thoughts and attitudes towards learning Physics and their experience of Physics in integrated science has left them with little fondness or appreciation for the subject, which they perceive as a purely formula-driven, mathematical discipline with little or no connection to either their everyday experiences or their future careers (Leigh, 2003). Due to this poor perception and attitudes students came up with average performance in the baseline data collection. However, student were able to take hold of the clear concept of the questions and develop possible strategies and solutions to the problem which supports the literature that students should be however able to follow information processing and solution construction model (IDEAL), that are a) identifying the potential problems, b) defining and representing the problem, c) exploring possible strategies, d) acting on these strategies and e) looking back and evaluating the effects of these activities (Bransford & Stein, 1984).

Teachers play a critical role in learning of students. Moreover, a teacher should be sensitive enough with the students. Frequently, when working with problems, students are unsure of themselves. This lack of confidence may hamper their learning. It is important to know their weaknesses and give immediate positive reinforcement/feedback to let students know the value of self-confidence. However, the findings had convinced me that teachers play active role in educating, and leaning of students especially in solving Physics numericals in presenting appropriate steps and procedures, guiding, giving immediate feedback and encouraging active participation from students. Moreover, the students were more or less, familiar with the kind of support, initiatives and responsibilities shouldered by the teachers for their learning. These findings really supports the literature (Callahan et al, 2009) that arch of excellence in high school Physics depends upon strongly motivated, skilled, dedicated and well supported teacher. Teacher is the keystone of the quality. Most of the students disagreed with the item, "*We can solve all the numerical problems with the help of hints given in the text"* which ultimately revealed the importance of teachers. And also, these findings relates that the role of teachers in instructions giving and presenting appropriate mathematical skills entirely determines the learning (Zewdie, 2014).

The marks obtained by the students in the post interventions had shown some improvement in their learning. However, one of the students could unintentionally have managed the same marks (i.e., 4.5) both in baseline and post interventions. The person might have only practiced the baseline numerical problems rather than practice solving from different context. This finding supports the literature that no matter how long you have been practicing over and over the same context until it becomes automatic; it would not help in learning how to solve problems (Ken, 2010). "Practice does not make perfect, only perfect practice makes perfect", as said by Vince Lombardy.

Possible second round of research

After reflecting on the first action research cycle it is evident from the result that this study has brought improvement in students' ability to be reflective and analytical in solving Physics numerical questions. However, the work sample of students continues to have problem in understanding the questions to solve correctly. Throughout my study period, I tried to redeem their mistakes by guiding and helping them proper explanation of the questions with correct solving and other assistance required. Having known the weaknesses of the students, I consider students not being able to understand the questions as a grave problem and if this

trend continues, the consequences will be dire in the learning of students as well as their attitudes towards the subject be hampered eventually. If a second action research cycle had to be developed as an extension to the first, it would be on how to help class 9 students understand the Physics numerical questions to solve appropriately.

Conclusion

Based on the findings of this study, it is suggested that teachers should take into consideration the significant intellectual abilities that would improve the teaching/learning of Physics in the secondary schools. Hence, teachers should provide opportunities for students to improve their intellectual abilities of verbal, induction and other abilities. Moreover, they should focus on the improvement of problem solving skills in Physics. This could be done by enriching the learning environment with different instructional materials and methods and providing numerical solving activities which requires analytical skills and intellectual abilities. Teachers should group students in such a manner that they are able to generate ideas and solutions and brings unique set of skills and experiences through active participation. In this way, students would improve learning and the attitudes towards the subject. Similarly, government should encourage and motivate the teachers by giving them incentives and remunerations that will in turn propel them to put in their best. Finally, teachers should be exposed to constant and continuous workshop and seminars to learn new strategies in problem solving to meet the demand of the subjects and encourage professionals' Physics educators to write books which emphasize the use of different strategies of Physics problem solving.

Acknowledgement

I would like to extend my gratitude to Dr. Tashi Gyelsthen and Mr. Kinley for their efforts, insights, skills, and persistence for making the programme on Action Research an enriching one. I owe my deepest appreciation to Madam Tshering Choden (mentor) and Mr. Sangay Phuentsho for their leadership, wisdom, and guidance rendered.

Special thanks are also extended to my 24 class 9 ‘D’ students of Drukgyel Higher Secondary School for bearing with me during my study. My study would not have come this far without your cooperation and patience

Bibliography

Alan, V. H. (1995). Experimental problems for mechanics. *Physics Teacher. 33 (3)*, 176-180.

Ausubel, D. P. (1968). Educational Psychology: A cognitive view, New York: Holt, Rinehart & Winston.

Beiser, A., Mahajan, S., & Choudhury, S. R. (2009). *Concepts of Modern Physics*.

Bransford, J., & Stein, B. S. (1984). The ideal problem solver: A guide for improving thinking,.

Callahan, P., Beverly, C., Elizabeth, C., Joan, M., Shannon, M., & Carl, W. (2009). The Role, Education, Qualifications, and Professional Development of Secondary School Physics Teachers. *AAPT - Secondary School Physics Teachers*, pg. 9.

Chand, S. (1996). *Rfresher course in Physics; for B.Sc of all indian universities*.

Czuk, C., & Henderson, C. (2005). Strategies for the Development of Student Problem Solving Skills in the High schools Physics classroom. Retrieved from http://homepages.wmich.edu/~chenders/Publications/Czuk2005.pdf

Duffield, G. M., & Rumbaugh, J. O. (1989). AQTESOLY aquifer test solver documentation. *Geraghty & Miller Modeling Group*.

Dufreshne, R. J. (1997). Solving Physics problems with Multiple representations. *Physics Teacher*.

Duit, R., Niedderer, H., & Scheker, H. (2007). Teaching Physics. In S. K. Abel, & N. G. Lederman (Eds.). *Handbook of research on science education*, 599-629.

Frederick, R., & Joan, H. (1984). Prescribing effective Human Problem solving processes: Problem description in Physics.

Halloun, I., & Hestenes, D. (1985). Common sense concepts about motion. *American Journal of Physics* .

Heller, K. (2010). Strategies for Learning to Solve Physics Problems. *School of Physics and Astronomy University of Minnesota*. Retrieved from https://www.aapm.org/meetings/2010SS/documents/Heller.pdf

Heller, P., Keith, R., & Anderson, S. (1992). "Teaching problem solving through cooperative grouping. Part 1:Group versus individual problem solving," Am. J. Phys.

James, A. O., & Adewale, O. A. (n.d). Relationship between senior secondary schools students' achievement in mathematical problem-solving and intellectual abilities tests. *European Scientific Journal*.

Jonassen, D. H. (2000). Towards a design theory of problem solving. *Educational Technology Research and Development*, 37 - 42.

Kenneth, H., & Patricia, H. (2010). Cooperative Problem Solving in Physics. Retrieved from https://www.aapt.org/Conferences/newfaculty/upload/Coop-Problem-Solving-Guide.pdf

Leigh, G. (2003). Developing multi-representational problem solving in Physics classes. *University of Cape Town, Department of Physics*.

Martinez, M. E. (1998). "What is problem soliving?". *Phi Delta Kappan*, 79, (605-609).

Mick, H., & Jenkens, A. (1998). Learning cycles and learning styles: Kolb's experimental learning theory and its application in geography in higher education.

Morgan, J. T. (2012). What Constitutes Effective Physics Instruction? Surveying the Views of Iowa High School Physics Teachers. *Electronic Journal of Science Education, Vol. 16, No. 2* .

National Statistics Bureu, R. G. (2010). Statistical Yearbook of Bhutan.

Padgette, W. T. (1991). The long list and the art of solving physics problem. *Physics teacher*.

Perez, D. G., & Torregrosa, J. M. (1983). A model for problem solving in accordance with scientific methodology. *European Journal of Science Education*.

Rinchen, D. (2008). Exploring Disability and inclusive education in the context of Bhutanese Education. *Bhutan Journal of Research & Development*.

Rose, J. A. (1988). Improving social environmental studies problem-solving through cooperative learning. *American Educational Research. 25 (4)*, 573-591.

Sherin, B. (2001). How Students Understand Physics Equations. Cognition and Instruction. 479-541.

Springer, L., Stanne, E. M., & Donovan, S. (1999). Effects of Small-group Learning on undergraduates in science, mathematics, engineering and technology: A meta analysis. *Review of Educational Research*.

Valiotis, C. (2008). Improving Conceptual Understanding and Problem Solving Skills in Introductory Physics courses . *Proceedings of the 2008 American Society for Engineering Education Pacific Southwest Annual Conference*, 1-2.

Zewdie, Z. M. (2014). An investigation of students' approaches to problem solving in Physics courses. *International Journal of Chemical and Natural Science*.