Global Journal of Guidance and Counseling in Schools: Current Perspectives

Volume 10, Issue 1, (2020) 49-63 www.gjgc.eu

The effects of problem-solving teaching methods on elementary school student's physics achievement at Dudmegn full cycle elementary school, Ethiopia

Asrat Dagnew*, Department of Teacher Education and Curriculum Studies College of Education and Behavioral Science, Bahir Dar University, Post Box No: 79, Bahir Dar, Ethiopia https://orcid.org/0000-0002-2804-1715

Gebremedhin Dagnew, Middlebury College, 14 Old Chapel Rd, Middlebury, VT 05753, United States

Suggested Citation:

Dagnew, A. & Dagnew, G (2020). The effects of problem-solving teaching methods on elementary school student's physics achievement at Dudmegn full cycle elementary school, Ethiopia. *Global Journal of Guidance and Counseling in Schools: Current Perspectives. 10*(1), 49–63. https://doi.org/10.18844/gjgc.v10i1.4653

Received January 5,2020; revised February 20, 2020; accepted April 21,2020.

Selection and peer review under responsibility of Prof. Dr. Kobus Maree, University of Pretoria South Africa.

Abstract

This study investigated the effects of problem-solving teaching method on elementary school students' physics achievement at elementary school. In this investigation an experimental research procedure was used. Along with this, a sample of sixty students was drawn from a total of three hundred seventy-eight students using lottery method of sampling technique. Physics achievement test (pre-test and post-test) covering the unit ''Introduction to Electronics'' was used as measuring instrument. Then, based on the pre-test scores, mixed ability groups such as fifteen high and fifteen low scoring 30 students each were assigned as experimental (13Fand17M) and control(15 and15M) groups using lottery method of sampling technique Students in the experimental group were taught using problem solving teaching method while those in the control group were instructed with lecture teaching method. The post-test constructed by the writer in the sample unit taught was administrated to both groups immediately after the treatment was over. Finally, the results of the study revealed that problem-solving teaching method was more effective in teaching physics as compared with lecture method at elementary school level.

Key words: Achievement, Effect, Elementary, Physics, problem

* ADDRESS FOR CORRESPONDENCE: **Asrat Dagnew,** Department of Teacher Education and Curriculum Studies College of Education and Behavioral Science, Bahir Dar University, Post Box No: 79, Bahir Dar, Ethiopia.

E-mail address: asratboza@yahoo.com / Tel.: +1-905-721-8668

1. Introduction

Physics is a science subject that deals with matter, energy, motion and force. Learning Physics is important as it is one of the fields of knowledge that underlies the physical universe and applies constantly to people's everyday lives. For effective Physics education to occur, students have to actively process the knowledge by making sense of the concepts by themselves.

The main objective of education is to prepare an individual for better life through cultivating his/her capacity for problem-solving and adaptability to the environment by developing the necessary knowledge, skills and attitudes. In this case, student-centred method involves students in doing things, interacting, discussing, debating and asking questions, exploring, experimenting and thinking about the things they are doing and observing their own knowledge through active participation. Moreover, the study may contribute to promote an active learning strategy of constructivist approach.

Technology and science have become a benchmark for measuring the rate of economic development and advancement of all countries which are reflected in the various aspects of their national cultures and practices. By now, when technology is thought, the primary thing that comes to mind is physics because its principles applied in information technology have reduced the world into a global village through the use of satellites and computers. Supporting this, scholars agree that physics is and will remain the fundamental science (Weham, Dorlin, Snell & Taylor, 2012). Physics, therefore, is around us everywhere and makes our lives easier from the scientific and technological aspects with the inventions of aeroplanes, automobiles, communication satellites, computers, as well as televisions and the like.

In this case, modern societies need pupils to be equipped with scientific and technological knowledge as well as skills at the highest level. In response to this, Ethiopia is committed to expand its higher education base and focuses on expanding science, technology and engineering (Ministry of Education,2015).To facilitate this, the Federal Government established the Ministry of Science and Technology. This is evident in the 70:30 plans by which 70% entrants to universities are natural science students and 30% of them are into the social and humanities streams. In line with this, Ayalew (2014) indicated that the government's rationale for introducing this professional mix is the belief that science and technology are the engines of development.

Hence, more value is given to science recently to access skilled human capacity easily for rapid industrialisation and sustainable development, as well as economic growth etc., by addressing problem-solving approaches (Ministry of Education, 2013).

Despite these efforts of the teachers, education designers, teacher trainers, English language trainers, supervisors, school principals, teachers etc., grade 8 students scored low in Physics. This seemed that students did not solve Physics problems correctly because the method of teaching physics did not match with the nature of physics and the students as well as ineffective application of planned techniques was also another challenge for the failure of teaching physics out of the tremendous factors.

1.1. Literature review

The researcher concluded that the problem-solving method had significantly increased students' academic achievement overall, compared to the traditional teaching method. Problem-solving approach to eighth graders is used to measure the impact of the method on their achievement in science subjects. A quasi-experimental research design was used in the study. Data collected through the students' achievement test revealed that there was a significant difference on the impact of the problem-solving approach, in favour of the experimental group compared to the control group. Hence, based on the above-mentioned literature review, it can be concluded that problem-solving has the potential to be implemented as an alternative instructional approach in order to improve students' performance

Based on the above reasons, therefore, the researcher became interested in investigating the effects of problem-solving teaching method on elementary school students' physics achievement at Dudmegn full cycle elementary school.

In this respect, physics is one of the natural sciences that the government has given much emphasis on, it is taught independently starting from grade 7 and to enable students to learn it at a high level of proficiency in achieving those goals by seeing, living, creating and relating their previous knowledge and experiences with the new learned information; to breed individuals that can reach, research for information and can produce new information as well as grow individuals that question the problems they face and bring solution using qualitative sketches, diagrams and figures etc. that makes the problem easier to solve. In this case, Vygotsky (2008) described that knowledge is produced or made meaningful through interaction between the learner and the society around him or her. Besides, Piaget (2013) explained, knowledge is acquired from others by means of social interactions in their culture.

Problem is defined as an inquiry starting from a given conditions to investigate or demonstrate facts and principles. Problems typically used in traditional physics teaching are frequently goal-directed, narrow, disconnected as well as simplistic. By goal-directed, it is meant that students are given problems with very specific objectives, such as calculating physical quantities. By narrow, it is meant that problems can be solved by directly applying a single procedure or principle. By disconnected, it is meant that problems do not integrate with the prior knowledge acquired by the learners rather to the topics and worked-out examples newly covered in the lecture or assigned readings. By simplistic, it is meant that those problems pay no attention to most of the complicated physics that are needed to address real-world situations. In this manner, Kim and Pak (2002) suggested, the competence demonstrated in solving such problems reveals no conceptual understanding.

Thus, teaching students to solve problems is based on the hypothesis that knowledge is organised and stored in memory in sequential and logical networks (Anderson, 1992) and is thereby retrieved in a step-by-step and sequential manner to solve problems. This means that for successful solution of a problem, knowledge alone may not be sufficient but the knowledge of how the conceptual knowledge or problem-solving skills must be applied in solving problem is just as important.

1.2. Theoretical framework

Problem-solving method is described as a method which is intended to aid classroom teacher in terms of those specifics that specify the responsibilities of both teacher and student. A first step to helping any teacher in effective use of teaching methods is to develop theoretical framework in which teaching occurs. Let us establish the theoretical framework for the problem-solving method:

Review of literature reveals the problem-solving method as the generally being an arrangement of specific processes or steps, and identified as a scientific method (Mahan, 2015). These steps were described as representing the general method by which the solutions to problems are sought, although there might be deviations from this method, and that these steps need not necessarily be followed in their entirety to provide a problem-solving experience.

According to Mahan (2015), the steps for the problem-solving method obtained by comparison of literature references are as follows:

1. Identification of the problem
2. Analysis of the problem and gathering of information bearing on the problem
3. Selection of one or more hypotheses
4. Testing of the hypotheses
5. Arriving at a conclusion relative to the solution of the problem

In addition to this, many researchers find that their students do not solve problems at the required level of proficiency (Redish, Scherr & Tuminaro,2006).This seemed a similar practice as in the target school that physics has not been taught efficiently since the instruction was teacher-centred. Problem-solving teaching method in physics is viewed by students as a challenging strategy to achieve the desired objective. So, they have faced problems in learning physics as well as physics is considered to be the most challenging subject for them and thereby learning is simply carried out by reading textbooks and writing notes. As Freire (2007) described, the role of the teacher is to fill the minds of students with the contents of his narration regardless of their existing experiences.

In connection to this, physics is in crisis as a number of students studying it at all levels is declining rapidly. Because Semeal (2010) reported the decline rates in physics enrolment and graduation at all levels including advanced countries like USA, UK, Germany and the Netherlands. Likewise, Africa, Kenya and Nigeria have faced similar score decline in physics (Akinlaye, 1998; Kenya National Examinations Council, 2003).

The analysis was made on the results of grade eight regional examinations in the years 2016 and 2017, which revealed that grade eight students' performance in physics was far below the expected in the elementary school-leaving certificate physics examinations in the elementary schools. Surprisingly, at the school, no one had scored 50% and above in the years mentioned. As Kassie (2012) explained, factors for students' failures in the regional examinations are tremendous.

Furthermore, classroom observations and information gathered from physics teachers, students, supervisors and school principals revealed similar achievement problems in this subject due to various factors. This seemed to happen as students solutions to problems were entirely formula centred devoid of qualitative sketches, diagrams and figures that contribute in understanding this subject. In this case, students keep away physics since it has been perceived as difficult. As a result, they are unable to solve practical problems at the required level of proficiency. Among other factors, the reason includes students' perception that physics is a hard science (Smithers & Robinson, 2013).

Scholars, therefore, suggested that employing appropriate and effective teaching methods are critical in achieving physics. For instance, Okebukola (2014) confirmed that the use of appropriate instructional strategies influence the performances of low achieving students. As scholars recommended, in order to reach a conclusion as which one of those methods best fits the nature of teaching physics and students at elementary level demanded conducting an experimental research.

The purpose of this study was to investigate the effects of problem-solving method on elementary school students of physics achievement at Dudmegn full cycle elementary school.

The goal and contributions of this study in the existing studies, i.e. the main contributions of this research, are mentioned as follows:

- Ensure learners preferences, needs and interests; avoid superiority and inferiority; create democratic ways of doing things and mutual respect;
- Allow each learner to interact, value, view the opinions aired by learners;
- Enable students to acquire skills and attitudes which help them to live as a useful member of community since this method focuses on practice and active method of learning;
- Ensure self-fulfilment that is developing cognitive, affective and psychomotor skills;
- Enhance the release of learners' creative potential;
- Help the teacher to consider and provide a wider alternative teaching–learning method and techniques and teacher's improvement of his professional knowledge as well as skills.

Majority of grade eight students achieved far below expected mean in physics in the regional examination. Hence, the basic research questions are designed as follows:

1. Is there any statistically significant difference in physics achievement between students taught through problem-solving method and those taught using lecture method at elementary level?
2. Do students in the experimental group participate actively in the classes of the sample population?

The purpose of this study was to investigate the effects of using problem-solving method on elementary school students' physics achievement. Specifically, this study is carried out to examine the mean scores differences in physics achievement between students taught through problem-solving method and those taught using lecture method and to assess the standard differences in physics achievement between students taught through problem-solving method and those taught using lecture method.

2. Materials and methods

A quasi-experimental design with control and experimental groups was used in this study. Prior to the intervention, a teacher for the experimental group was trained to use the problem-solving method for about a week. A pre-test using the physics achievement test (PAT) was then administered to both the control and experimental groups, followed by the intervention. One of the most common ways of detecting whether an improvement is achieved by an education institution is through measuring the students' achievement in a test. Therefore, physics achievement test is designed to measure general knowledge of physics as well as an instruction implemented. The control group was taught using the conventional teaching method (lecture), while the experimental group was taught using the problem-solving method.

The most important methodological choice the researcher makes is based on the distinction between qualitative and quantitative data. Qualitative data takes the form of descriptions based on language or images, while quantitative data takes the form of numbers. The purpose of this study was to examine the effects of problem-solving teaching method on elementary school students' physics achievement. Both qualitative and quantitative perspectives were employed under this study.

The research design of study was an experimental research by which sample students were assigned to the experimental and the control groups in relation to their pre-test results by using purposive sampling technique. Besides, pre-test and post-test comparisons were made in actual experimental design by detecting mean scores differences between those groups before and after treatment using *t*-test. Thus, source of data, population, sampling techniques, data gathering instruments and procedures as well as data analysis techniques were the component parts of this experimental research.

2.1. Sources of data

Primary source of data was applied under this study. The experimental and the control group of students, classroom teachers, school principals and stakeholders were the sources of data.

The Population of this study contained all grade eight students of full cycle elementary schools at Woreta administrative city, Ethiopia. The total population includes 1,063(556female and 507 male) grade 8 physics students in the four full cycle elementary schools of the city.

Among these full cycle elementary schools, Dudmegn was selected purposively as a sample since it is convenient for the researcher to access relevant information easily. Along with this, a sample of one class with 60 (30 female and 30 male) students was selected among six classes of grade eight 378 students (198 female and 180 male) using simple random sampling technique at the sample school. Then, based on the pre-test results, mixed ability groups such as fifteen high and fifteen low scoring (30) students each were assigned as experimental (13 female and 17 male) and control (15 female and 15 male) group using purposive sampling technique.

2.2. Data gathering instruments

Based on the study purpose, the pre-test and post-test as well as classroom observations about the interaction among the experimental group of students and with the researcher were used as data gathering tools. In this respect, objective type of questions were prepared by the researcher in grade 8 physics curriculum material, under the chapter of "Introduction to electronics" to measure sample students' knowledge of fundamental concepts, skills and degree of performance. Generally, three instruments such as pre-test teacher made questions, post-test teacher made questions and classroom observation were used.

A pre-test consisting of 25 multiple choice items or measuring tools (see page 23) were prepared in the sample chapter by the researcher. Each item was made to have four alternatives, one point each as well as represent the concepts of the lesson equally. It was validated by the expert and thereby administered to the selected section of students by the researcher before treatment. Its purpose was to know the knowledge of sample students in the subject area selected.

While the treatment was conducted at the target school, the chapter "Introduction to Electronics" was taught for both the experimental and control groups by the researcher using the same time schedule with different teaching methods. In this manner, students in the control group were taught using lecture method, whereas students in the experimental group were taught through problem-solving method that involved procedures for solving problems. Similarly, students in the experimental group were explained what those steps were and how to put those techniques into practice in the 4th week of the schedule. Then, both groups were taught for a month, for a period of 40 minutes, totally 10 periods (400 minutes) each using 10 lesson plans for each group as indicated in the syllabus and the teacher's guide.

Along with this, classroom observations were undertaken while students in the experimental group were taught the sample chapter through problem-solving methods to collect detailed data. In the next period, the strong sides were encouraged while the gaps were filled through interactions accordingly until the lesson was completed.

Finally, a post-test different from the pre-test in content but the same in form, constructed in the unit taught by the researcher and validated by the expert was administered to both groups after treatment. It consisted of 25 multiple choice items or measuring tools (see page 26) with four alternatives and one point each as well as represented concepts of the lesson taught equally. Then, the test papers were collected, corrected and recorded by the researcher.

2.3. Data analysis techniques

More importantly, there is no one right way to analyse data. Depending on needs and the type of data the researcher collects, the right data analysis methods will shift. This also makes it necessary to understand each type of data, and which methodology can deliver the best results. Even so, there are some common techniques that come included in most data analysis technique because they are effective. The first step in choosing the right data analysis technique for data set begins with understanding what type of data it is quantitative or qualitative. As the name implies, **quantitative data** deals with quantities and hard numbers. This data includes sales numbers, marketing data such as click-through rates, payroll data, revenues, and other data that can be counted and measured objectively.

Qualitative data is slightly harder to pin down as it pertains to aspects of an organisation that are more interpretive and subjective. This includes information taken from customer surveys, interviews with employees, and generally refers to qualities over quantities. As such, the analysis methods used are less structured than quantitative techniques.

Based on the leading questions formulated and study purpose, the data collected through tests were analysed using mean score, standard deviation and independent samples *t*-test accordingly. Then, classroom observations data were subjected to word narration. Finally, analysis and interpretation of data, discussion, summary, conclusion and recommendations were made.

3. Results

3.1. Characteristics of sample students

The minimum and maximum age, the standard deviation of age and the mean of age, sex frequency and sex percentage of sample students as well as the mean ages and the standard deviation of ages for the control and experimental groups were calculated and presented in Table 1.

Table 1. Both age and sex related statistics for sample students

Groups	*n*	Min. age	Max. age	Mean age	SD age	Sex frequency		Sex (%)	
						m	***f***	***m***	***f***
Sample students	60	13	18	15.47	1.17	32	28	53.3	46.7
Control group	30	14	17	15.50	1.07	15	15	50	50
Experimental group	30	13	18	15.43	1.27	17	13	56.7	43.3

Where Min =minimum; Max = Maximum; SD = Standard deviation; *m* = male; *f*=female, Sex (%) = sex percentage.

The standard deviation of age and the mean age of sample students were found to be 1.17 and 15.47 respectively. These exhibited that students involved in the sample seemed to have homogeneous age because their standard deviation of age was very close to their mean age either below or above it as shown in Table1.

The mean ages and standard deviation of ages of the control and experimental groups also revealed the homogeneity age of sample students involved in the study as shown in Table 1.

Sex frequency exhibited the number of female (28) and male (32) students represented in the total sample involved in the study. These were found valid statistically.

Similarly, sex percentage revealed the percentile size of female (46.7) and male (53.3) students from the total number of sample students involved in the study. These were also found valid statistically.

3.2. Analysis of data

Both the pre-test and the post-test scores of the experimental and control group of students were gathered before and after treatment, arranged and analysed using mean scores (M), standard deviations (SD) as well as independent samples *t*-test as statistical tools at alpha level 0.05 to interpret the results accordingly.

Then, the pre-test means, the SD as well as the *t*-test value were calculated and presented in Table 2 below. In this case, a *t*-test was applied to check the difference between the pre-test averages of the experimental and control groups to see if it was meaningful or not as shown in Table 2.

Table 1. t-test for the pre-test results of the experimental and control groups

Groups'	*n*	*M*	*SD*	*Df*	*t*-cal	*t*-Critical	*p*-value
Experimental group	30	7.63	2.72	2.72	58	0.00	0.999
Control group	30	7.63	2.41				

df = degree of freedom; SD = standard deviation; cal = calculated.

The achievement mean scores of the experimental group (M = 7.63) and control group (M = 7.63) were found exactly the same out of a maximum possible mean score of 25. This exhibited the non-existence of mean score achievement difference between those groups before treatment. In a similar way, there was almost a slight difference in SD between the experimental group (SD = 2.72) and the control group (SD = 2.41).This means that students in the experimental and control group have homogeneous characteristics before treatment.

Likewise, the calculated *t*-value (t = 0.00) at p>0.05 was found smaller than the standard *t*-critical table value (*t*-critical = 2.01) after the analysed results were compared and thereby the difference between the averages was not statistically significant with *t*-test at (*df* = 58, *t*-calculated = 0.00, *t*-critical = 2.01 with $p > 0.05$. In this case, the null hypothesis was accepted, as it was an indicator for the absence of statistical significant difference between the mean scores of physics students involved in the sample groups. Similarly, the greater *p*-value than 0.05 alpha level proved that there was no statistically significant difference obtained between the mean scores of those groups with respect to their pre-test results as shown in Table 2.

Thus, those statistical values in Table 2, demonstrated that the physics achievement levels of experimental and control groups were found to be the same before treatment. Thus, this seemed that sample students involved in the study exhibited comparable characteristics which were suitable in comparing the effects of problem-solving teaching method and lecture teaching method on elementary school students' physics achievement at the target school after treatment.

The post-test means, the SD as well as the *t*-test value were calculated and presented in Table 3 below. In this regard, a *t*-test was applied to check the difference between the post-test averages of the experimental and control groups to see if it was meaningful or not as shown in Table 3.

Table 3. t-test for post-test results of the experimental and control groups

Groups'	*n*	*M*	*SD*	*Df*	*t*-cal	*t*-Critical	*p*-value
Experimental group	30	15.97	2.03	85	5.11	2.00	p<0.0001
Control group	30	12.97	2.49				

Significant at $p < 0.05$ alpha level.

As can be seen from the results in Table 3, the achievement average of the experimental group (M = 15.97) was found higher than the average of the control group (M = 12.97).This revealed that students exposed to problem-solving teaching method achieved better mean score in the sample chapter than those subjected to lecture teaching method. In a similar way, the standard deviation of the experimental group (SD = 2.03) was found smaller than the standard deviation of the control group (SD = 2.49). It indicates students in the experimental group shows homogeneous features while those in the control group show heterogeneous.

Likewise, a *t*-test was applied to check whether these groups differed significantly on PAT mean scores or not. As a result, the analysed results in Table 3 illustrate that students instructed by problem-solving approach received higher achievement mean score in the sample unit than those instructed by lecture method and thereby a statistical significant difference was maintained with a *t*-test since the calculated *t*-value (*t*-cal = 5.11) was higher than the standard *t*-critical table value (*t*-critical = 2.01) that favoured the experimental group over the control group from the statistical aspect of [$df = 58$, $t(5.11) = 2.01$)] with $p < 0.0001$. Besides, the smaller *p*-value than 0.05 alpha confirmed the statistical significant difference obtained between the means of those groups' with respect to the post-test scores. The study revealed that students in the experimental group participate actively in the classes of the sample population.

Ultimately, all the aforementioned statistical values in Table 3, exhibited that students exposed to problem-solving approach achieved better mean score and standard deviation in the sample unit as compared with those instructed through lecture method because the mean scores difference between the experimental and control groups was found statistically significant with a *t*-test at ($df = 58$, $t(5.11) = 2.01$), with $p < 0.0001$. Thus, this seemed that the problem-solving method applied in the study might have helped students in the experimental group to learn the sample lesson better than those in the control group subjected to lecture method.

4. Discussion

The current study aimed at investigating the effects of problem-solving teaching method on elementary school students' physics achievement. With respect to this, mean scores and SD comparisons were made in physics before and after treatment between the experimental and control groups.

In this respect, the analysis from Table 2, displayed that there was no statistical significant difference in the pre-test measures of the experimental and control groups. On the other hand, as the post-test achievement mean scores as well as SD were compared, it was found that students taught by problem-solving teaching method had superior achievement than those taught by lecture teaching method as shown in Table 3, because the difference was found statistically significant with a *t*-test. As a result, it was determined that problem-solving teaching method had increased the achievement of physics students' at a higher level than lecture teaching method although both groups were exposed to the same topics, solved the same problems and taught by the same teacher with the same time table.

Thus, the results of this study made clear that there was a high statistical significant difference between the mean scores of physics students who were taught by problem-solving approach and those instructed by lecture method. More importantly, students in the experimental group who were subjected to problem-solving instruction demonstrated better performance on the sample unit than the control group of students taught by lecture method.

This implied that problem-solving teaching method had positive effects on the achievements of physics students in the experimental group as compared with the achievement of the control group subjected to lecture teaching method. Furthermore, the effective utilisation of student-centred learning promotes students' classroom active participation in addition to understand the basic concepts, values and skills of the objective domain. For this reason, the role of students in teacher-centred approach is to demonstrate their power of memory and not their skills in processing that knowledge Plass (2012). In contrast to this, teaching students to solve problems is based on the hypothesis that knowledge is organised and stored in memory in sequential and logical networks Anderson (1992) and thereby retrieved step by step in a sequential manner to solve problems.

Hence, problem-solving instruction is more effective as compared with lecture teaching method since the former has provided suitable learning environment for the experimental group of students to learn the sample unit easily, effectively as well as meaningfully. Likewise, the interactions made among the experimental group of students while solving problems, deciding on solutions through discussions and evaluating different views have provided them better learning conditions as proved through video recorded observations. Thus, Cohen, Manion and Morrison (2015) explained the open or progressive view of education was and still is characterised by three broad concepts: freedom of activity, discovery and a concern with input-process-output as opposed to a concern for subject matter knowledge.

Students who have learnt by problem-solving method have induced positive effects in achieving the desired objectives through experience sharing, identifying and correcting misunderstandings, working in team, interacting with friends as well as with the teacher, applying strategies in the right place and time, realising weak points in team discussions and taking corrective measures, supporting each other, relating prior knowledge and experiences with the new learned information. In this case, knowledge is something unified, coherent and interrelated rather than being made up of separate bits and pieces of information (Leu, 2011).

Results from Table 3 exhibited the difference between the achievement averages of those groups analysed with independent samples t-test was found to be in favour of the experimental group of students from the statistical aspect (df = 58, $t(5.11) = 2.01$)), $p < 0.0001$ which likely played a significant role in reducing students prior perception that physics is too hard. Since prior conceptions of learners determine to a large extent what each individual can learn from a particular situation (Hestenes, 2011).

Similarly, from Table 3, it was observed that students who received problem-solving instruction were significantly more successful in the problem-solving tasks with $p < 0.0001$ than students who received lecture instruction. In this case, the central qualities of problem-solving rest on its potential to facilitate the construction of knowledge: its transfer of learning from one context to another as well as to encourage the transfer of responsibility for learning from teacher to learner. According to, Newton (2008) problem-solving is an approach that presents what is to be learned as a scientific problem, possible solutions or usually possible explanations are generally investigated practically.

In contrast to this, students in the control group achieved low mean score in the unit taught as compared with the achievement of students in the experimental group for the following reasons: solving problems individually; no exchange of information with friends; hesitating to ask unknown concepts or questions to teachers or friends; committing careless mistakes that went against physics laws; teacher-centred instruction etc. Because Silberman (2010) argued, during lecturing, students' attention decreases with each passing minute.

In addition, lack of participation; applying formula incorrectly; trying to act as a teacher while solving problems; lack of opportunities' for self or peer corrections; lack of problem-solving skills; misleading calculations; solving problems by guessing; delaying to respond to questions; lack of responsibility for learning; lack of help and support with each other; tracing solution steps incorrectly; relying heavily on teachers as sources of knowledge and all-knowing persons who should play decisive roles in their learning process. In this regard, Derebesa (2006) agreed, lecture method that is teachers talk and students listen dominate most classrooms. Likewise, Rugg and Shumaker (2011) reported that in the traditional school, students are expected to sit as well as study their lessons silently and obey the teacher fast and questionably. Besides, a scholar agreed that the role of the teacher is to fill the minds of students with the contents of his narration regardless of their existing experiences (Freire, 2007). Furthermore, Ajaja and Kpangban (2000) noted, the student knows or doesn't know depend mainly on the teacher.

The use of problem-solving strategy is assumed to be more suitable method in teaching physics because according to Schmidt(2009), the acquisition and structuring of knowledge in problem based learning is thought to work through the next cognitive effects: initial analysis of the problem; activation of prior knowledge through small-group discussion; elaboration on prior knowledge and active processing of new information; restructuring of knowledge; construction of a semantic network; social knowledge construction ;learning in context and stimulation of curiosity related to presentation of a relevant problem.

Besides, qualitative narrative description of data analysis revealed that students attempted to define terms like electronics, capacitor, dielectric etc.; participate in group activities; exchange information during team work; share ideas to friends; provide oral explanations to each other about the concepts under discussions; observe their own knowledge through active participations; apply the sequential steps of problem-solving strategies while solving problems, reflecting group discussion results to the class, seeking support from the researcher although gaps like checking the magnitudes and units of the answers as well as problem-solving pathway; responding to questions; hesitating to ask unknown concepts to friends or the researcher; seeking information to fill gaps etc. were observed and there by corrective measures were encouraged step by step accordingly. Problem-solving method enhances students' problem-solving skills in their daily life activities (Krulik & Rudnick, 2009).

One of the best experiences observed for instance was that students who worked in pairs or groups to solve problems were describing to partners how he/she would solve problems while other partners were listening. In turn, the listeners contributed to the process by asking questions for the purpose of more clarifications and thereby used these experiences repeatedly to learn the sample unit effectively. As Kort (1992) agreed, students in a group interact with each other, share ideas and information, seek additional information and make decisions about their findings to the entire class. Moreover, Problem-solving is viewed as a fundamental part of learning science in regular schools (Loucks, 2007).

In this regard, the video recorded classroom observations had played significant roles for the better achievement of physics students in the experimental group through filling gaps students exhibited in the unit taught step by step and, through encouraging their better performances throughout the lesson.

5. Findings of the study

The major purpose of this study was to investigate the effects of problem-solving teaching method on elementary school students' physics achievement at Dudmegn full cycle elementary school, Woreta Administrative city, Ethiopia. In this manner, the means as well as SD were calculated, compared and *t*-test was applied to check the differences between the averages of those groups to see if they were meaningful or not.

Thus, the following leading questions were addressed in this study accordingly.

1. Is there any statistically significant difference in physics achievement between students taught through problem-solving teaching method and those taught using lecture teaching method at elementary level?

As it can be seen from the results in Table 3, the achievement average of the experimental group (M = 15.97) was found higher than the average of the control group (M = 12.97), p < 0.0001.Thus, students taught through problem-solving teaching method gained more mean score achievement in physics as compared with those taught through lecture method. This difference was found statistically significant with a t-test at [df = 58, t(5.11) = 2.01],with p < 0.0001. More importantly, students in the experimental group who were subjected to problem-solving instruction demonstrated better performance on the sample unit than the control group of students subjected to lecture method. As can be seen from the results in Table 3, the standard deviation of the experimental group (SD = 2.03) was found smaller than that of the control group (SD = 2.49). This also revealed that students in the experimental group seemed to have homogeneous features while those in the control group heterogeneous because the standard deviation of the experimental group (SD = 2.03) was very close to its mean score (*M* = 15.97) than the standard deviation of the control group.

1. Do students in the experimental group participate actively in the classes of the sample unit?

Researchers are able to see if the independent variable had any impact on the behaviour of the participants. Comparing the experimental group to the control group allows researchers to see how much of an impact the variables had on the participants. This quasi-experimental study with two groups of pre- and post-tests were conducted on two groups of elementary school students who had taken the physics course.

Students who were instructed through problem-solving approach were observed responsible for their learning both in groups as well as individually. Hence, the data obtained from classroom observations had played significant roles for the better achievement of physics students in the experimental group through filling gaps students exhibited in the unit taught step-by-step as well as through encouraging their better performances throughout the lesson.

The pre-test and post-test scores were collected from the control and experimental groups of students (15 F and 15 M) and (13 F and 17 M) respectively, totally 60 (28 F and 32 M) grade eight elementary school students. Students' in the sample class were selected out of six classes and thereby assigned as the control and experimental groups using lottery method of sampling technique at Dudmegn elementary school. The experimental group was taught by problem-solving approach while the control group was instructed using lecture method. PAT Pre-test and post-test as well as classroom observations were used as data collecting tools. Quantitative means of analysis was used. PAT the Pre-test and the post-test scores were analysed using mean, standard deviation, and *t*-test where the difference between the pre-test means was not statistically significant at *df* = 58; *t*-cal. = 0.00; *t*-critica l = 2.01; with alpha level 0.05 while the difference between the post-test means was statistically significant with a *t*-test at *df* = 58, *t*-cal. = 5.11, *t*-critical = 2.01, with alpha 0.05 as well as the classroom observations filled the gaps through interactions that students exhibited while learning the sample unit as well as made to be encouraged and promoted the better achievement of the experimental group. In the end, the results of the study favoured the experimental group of students over the control group.

6. Conclusion and implications of the study

Based on those results of the study, the conclusion was that problem-solving method is more effective in facilitating the achievement of physics students' as compared with lecture method at elementary school level. This finding gives grounds for the argument that the problem-solving method came to teacher education programmes with a learning approach that is suited to promote active learning approach. In other words, the learning approach that teachers exercise at elementary school suited to adopt problem-solving method. Thus, it seems reasonable to conclude that the actual implementation of problem-solving method in elementary schools will remain doubtful. Investigating the effects of problem-solving method on the elementary school students' physics achievement would:

- Help education planners to organise physics text books and the syllabi in the way they can be taught through problem-solving method at elementary level.
- Give insights for college instructors to improve their teaching methods while training elementary school physics teachers.
- Initiate physics teachers to employ problem-solving method at elementary level.
- Initiate school principals, vice principals, supervisors, district education office professionals etc. to create conducive working environment while employing problem-solving method in elementary schools.
- Help students to achieve better in elementary school physics.

7. Recommendations

Based on the findings, the following recommendations were put forward:

- It would be necessary to organise workshops and seminars for practicing teachers whereby the importance and appropriateness of the problem-solving method for teaching and learning physics could be established.
- Curriculum developers should use this study result to design elementary school physics textbooks and syllabi in the ways they can be taught through problem-solving teaching method.
- School principals, vice principals, supervisors and physics department heads should create conducive working environment for elementary school physics teachers so as to employ problem-solving method effectively.
- Physics teachers had to adopt the use of problem-solving method at elementary schools in order to facilitate students learning.
- Zonal as well as district education office professionals should organise workshops, conferences and seminars to familiarise school teachers, supervisors, school principals etc. about the usability and viability of problem-solving method at elementary school level.
- The researcher would like to suggest for future researchers to undertake a deeper or further research on the effects of problem-solving method, not only in the achievement of physics but also other grade eight subjects where achievement problems have been observed at elementary school level.

Acknowledgments

The author would like to thank the administrative bodies of Dudmegn full cycle elementary school organisation which gave me permission to gather data for the study. It is also my pleasure to thank grade eight students who voluntarily participated in the experimental and control groups of this study. The author also want to express my deepest gratitude to the school principal, vice principal, supervisor and teachers who actively cooperated in giving the necessary information to conduct this research.

References

Ajaja, O. & Kpangban, E. (2000). *Enriching biology teaching in the 21st Century in Nigeria*. Implications for the teacher, 41st Conference proceedings of STAN.

Akinlaye, F. (1998). *Teacher guided inquiry guided-discussion and students learning outcomes in some aspects of social studies* (Unpublished dissertation). University of Ibadan, Ibadan, Nigeria.

Anderson, J.(1992).*Cognitive psychology and its implication*. New York, NY: Freeman.

Ayalew, S. (2014). Assessment of science education quality indicators in addis ababa, BahirDar and Hawasa Universities. Quality of Higher Education in Ethiopia Public Institutions. Addis Ababa, Ethiopia: Forum for social studies.

Chan, K. (2007). Hong Kong teacher education students' epistemological beliefs and their relations with conceptions of learning and learning strategies. *The Asia Pacific-Education Researcher, 16*(2), 199–212.

Cohen, L., Manion, L. & Morrison, K. (2015). *A guide to teaching practice* (4th ed.).London, UK and New York, NY: Routledge.

Derebesa, D. (2006).Quality of teaching and learning in Ethiopia primary schools: tension between traditional and innovative teaching -learning approaches. Addis Ababa, Ethiopia: Addis Ababa University.

Freire, P. (2007). *Pedagogy of the oppressed. Strategy for the college classroom*. San Francisco, CA: Jossey-Bass.

Hestenes, D.(2011). *Modeling methodology for physics teachers*. Proceedings for the International Conference on Undergraduate physics Education, College Park, MD.

Kassie, A. (2012).*Assessment of grade eight students performance in regional examinations* (Unpublished master's thesis). Bahir Dar University, Faculty of Behavioral Science and Teachers Education, Bahir Dar, Ethiopia.

Kenya National Examinations Council.(2003).Year 2002 Kenya Certificate Secondary Education Examination candidates performance report. Nairobi, Kenya: Self.

Kim, E.&Pak, J. (2002). Students don't over come conceptual difficulties after solving1000 traditional problems. *American Journal of Physics, 70*(7), 759.

Kort,M. (1992). Down from the podium. InE.J.Samual (Eds.), *New directions for community college. Journal of Research Education* (vol. 3). San Francisoc, CA: Jossey- Bass.

Krulik,S. & Rundick, J.(2009).*Problem solving. A hand book for teachers* (2nd ed.).Boston, MA: Allyn, Bacon, Inc.

Leu, E.(2011). *The new curriculum: issues of theory and practice for teacher educators* (Unpublished). Tigray Education Bureau, BESO Project, Mek'ele, Ethiopia.

Loucks, S. (2007).*Introductory physics with algebra: mastering problem*-solving. Hoboken, NJ: John Wiley and Sons.

Mahan, L.A. (2015). *The effect of problem-solving and lecture-discussion methods of teaching general science in developing student growth in basic understandings, problem-solving skills, attitudes, interests, and personal adjustment* (Unpublished doctoral theses). Pennsylvania State University, University Park, State College, PA, p. 220.

Ministry of Education. (2013). Education and training policy. Addis Ababa, Ethiopia: EMPDA.

Ministry of Education. (2015).*Under graduate and graduate degree programs mix and students placement in the expanding higher education system in Ethiopia* (Unpublished Policy Brief).Addis Ababa, Ethiopia.

Newton, P. (2008). *A practical guide to teaching science in the second school*. New York, NY: Routledge.

Okebukola, P. (2014). Can good concept mappers be good problem solvers? *Educational Psychology, 12*(2), 113–130.

Piaget, J.(2013).*Science of education and the psychology of the child*. New York, NY: Viking.

Plass, H. (2012). *The learner-centered classroom. Quality education in Ethiopia vision for 21st century*. Addis Ababa, Ethiopia: IER.

Redish, E., Scherr, R. & Tuminaro, J. (2006).Reverse-engineering the solution of a simple physics problem: why learning physics is hard than it looks. *The Physics Teacher, 44*.

Rugg, H. & Shumaker, A. (2011). *The child-centered school*. New York, NY: Arno press and The New York Times.

Schmidt, H. (2009). Foundations of problem-based learning: some explanatory notes. *Medical Education, 27*(5), 422–432.

Semeal, T. (2010).Who is joining physics and why? Factors influencing the choice of physics among Ethiopian University Students. *International Journal of Environmental and Science Education,* 5(3), 319–340.

Silberman, M. (2010). Active learning, 1001 strategies to teach any subject. Boston, MA: Allyn and Bacon.

Smithers, A. & Robinson, P. (2013). *Physics in schools and universities III*. Buckingham, England: Center for Education and Employment Research at the University of Buckingham.

Dagnew, A. & Dagnew, G (2020). The effects of problem-solving teaching methods on elementary school student's physics achievement at Dudmegn full cycle elementary school, Ethiopia. *Global Journal of Guidance and Counseling in Schools: Current Perspectives. 10*(1), 49–63. https://doi.org/10.18844/gjgc.v10i1.4653

Vygotsky, L. (2008). *Mind in society: the development of higher psychological processes*. Cambridge, UK: Harvard University Press.

Weham, J., Dorlin, G., Snell, J. & Taylor, B. (2012).Physics: concepts and models (2nded.).Boston, MA: Addison Wesley.