

Inculcating of Thinking Skills via Practical Work: Science Teachers' Perception and Practices in Managing Equipment

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Abstract: Solving problem skills is one of elements in thinking skills. The use of practical work involving students in solving problems related to science concepts. The appropriate interaction between students and practical equipment can lead to critical, creative and analytical thinking. This working paper aims to shed light on the results of the study on science teachers who apply practical work as one of approaches in encouraging thinking skills. The focus of the study is on the management of equipment during practical classes conducted. A total of five science teachers were selected through purposive sampling from the Central Zone. Observation instruments and open questionnaire were used in this study while the data were analyzed manually based on themes relevant to the question of this research. The results showed that all science teachers prepared practical equipment before students' arrival to the laboratory. They also provided practical manual to guide the students, especially regarding practical equipment and laboratory procedures. The results of the open-ended questionnaire analysis showed that all the teachers complained of the lack of equipment when it comes to certain practicals. They also stressed the need for the presence of laboratory assistants in helping to manage practical classes, especially from the aspect of equipment management. The study concluded that improvement of practical methods, will encourage Science teachers to inculcate thinking skills via practical work.

Key words: Problem solving • Science laboratory • Learning management

INTRODUCTION

Teaching and managing learning skills of teachers are one of the criteria in measuring *Standard Guru Malaysia* emphasized by the Ministry of Education, MOE [1]. The elements in the teaching and managing learning skills comprise teachers' skills in mastering planning, monitoring, assessing and evaluating, and also managing the classroom. Based on the standards set out, the task of a teacher is not limited to being just an educator, they also play a central role as a classroom manager or a multifaceted profession. Classroom is a very important basement for the thinking skills such as creativity and problem solving, to be nurtured and further develop with good stimulation and support from the conducive and good organizational climate [2].

Teachers need to set their mind with a higher-order thinking learning objective in planning higher order thinking questions to prepare a lesson. If teacher not planned before lesson, discussion can be out of the main objectives. Well-managed classrooms are greatly needed

in ensuring that the teaching and learning process runs effectively. According to [3], well-managed classrooms become a crucial element for an effective classroom to be delivered, and it is the basis of a smooth-running classroom as well. A well-managed 'organisation' which can be implemented into a classroom management as suggested by [4], should consist of these five functions of management which are 1) Planning 2) Organising 3) Leading 4) Directing and 5) Controlling. These functions of management are highly recommended to immerse into the curriculum of primary and secondary education, tertiary and other post-school education.

Lemlech [5] commented that for a basic classroom management to take place it should have included these components such as curriculum planning, well-planned of instructions and well-equipped of resources. In addition, to help ease the process of teaching and learning, educators can create an environment to facilitate learning, keep track of student performances and be prepared for any circumstances occur. A good curriculum-based instructional management depends on teachers'

instructional approaches and techniques used. A wide range of elements in one's learning environment must be addressed to ensure teaching and learning of science receive utmost effectiveness outcome. Due to that, the selection of effective teaching strategies is crucial to maximize students' learning [6]. According to the Theory of Cognitive Development founded by Jean Piaget, a person who learns through concrete operational stage, which involved touching or other senses to learn things about the environment, as through practical work, can enhance one's deep insight and rational thinking [7]. Through student-centred learning with the support of practical equipment and materials, students are able to construct on their own knowledge through problem-solving process, based on real-world (concrete) situation, make sense or rational principles and theories known, and indirectly increase their thinking skills.

For science teachers who wish to use practical work as one of their instructional approaches, the success and efficiency of laboratory management only can be achieved if he or she knows the foundation of the laboratory management. According to [8] and [9], organising and managing practical work are the most difficult and challenging aspects in the teaching of science. Teachers need cope with various science laboratory environments involved such as students' performances in laboratory, how skillful laboratory assistants have to ease the teacher's teaching during practical, type of laboratory activities, sufficient practical equipment and medical supplies, safety and liability features in laboratory setup, adequate time for students' investigation and laboratory infrastructure [10, 6, 11]. Thus, effective laboratory operations and equipment management for practical work is necessary to ensure development of valuable scientific skills, knowledge and understanding to optimize learning in science and encourage the students achieve highest success.

To ensure the success of learning through practical work, factors that affect the learning process need to be dealt with and managed. Lawson [12] described that among the key elements that need to be taken care of by science teachers in practical work is time allocation for students' investigation, students' capability in handling laboratory activities (inquiry-based learning), laboratory safety and the availability of equipment. Sampson [13] also presented five key management advises that need to be mitigated if teachers use the inquiry approach to ensure inquiry-based classroom runs smoothly, they are:

- Teachers should be familiar with classroom environment's organisation and management.

- To ensure students are actively involved in classroom activities and good time-management.
- Teachers should encourage collaborative learning where more interactions take place during practical work.
- Teachers must be well-trained with laboratory safety standards to reduce potential injury during students' investigation.
- Teachers should learn stores and inventory management to keep laboratory materials in good condition and safe for long-term usage.

Sampson [13] also stressed that good and effective inquiry-based science classroom should be dealt with as early as the planning stage until the completion of the approach (inquiry) used. Hayward [10] asserted that the adequate or good conditions of apparatus and materials provide optimum support to the teaching of science in practice.

The handling of practical work requires teachers to act as an efficient manager. This is because although the practical activities may have been well designed, learning environment will become chaotic if it is not conducted and managed well [6, 14]. According to [10], the imperfection of equipment will cause the objective of any practical investigation unreachable because the data collected can be disputed. Investigative activities using equipment to facilitate students manipulate the equipment and associate science concepts learned. The effectiveness of teaching objectives in practical work can also fail if practical equipment is poorly prepared, damaged or does not meet the required standards.

Research Objectives: The objectives of this study were to:

- Identify practices of managing practical equipment in the teaching of Science practicals inculcating thinking skills.
- Identify Science teachers' perception on practical equipment management in inculcating thinking skills.

Research Methodology: The study conducted took after case study that aims to explore how teachers manage practical equipment in the teaching of science practicals. A total of five science teachers with more than 10 years teaching experience, were picked for sampling purposes. All the teachers involved in teaching Science in ordinary secondary schools located in the Central Zone, Peninsular Malaysia.

Observation instruments and open-ended questionnaire was used in this study with validation and reliability of the instrument being agreed upon by the experts of educational research. Verification of information was reinforced as a result of the pilot study's data analysis. According to [15], one of the effective methods to ensure that the instrument designed measures what should be measured is through a pilot study. As a result of the pilot study's data analysis, instrument improvements can be implemented.

Practical work of teaching observation was made three times after the teacher respondents provided information about the practical to be carried out. Before an observation was made, the entries in the Lesson Plan made by science teachers had been scrutinized especially the part on practical equipment. Then, the procedure information for equipment request to be used by science teachers was identified through the laboratory assistant. Once teaching had started, all events and related communication were recorded regarding equipment management. To acquire teachers' perception towards practical equipment management, science teachers were given an open-ended questionnaire to be answered.

The data analysis was manually done based on the research objectives. Data from observation and open-ended questionnaires were analyzed by looking for keywords and themes related to the management of practical equipment. Two aspects of management were focused upon in terms of practical planning and handling of practical equipment.

Analysis on Research Findings

Identify Practices of Managing Practical Equipment in the Teaching of Science Practicals Inculcating Thinking Skills: Through the observation analysis done, it was found that all the teachers did not write down the equipment and apparatus required in the Lesson Plan. However, they did jot down the title of the practical conducted as well as the practical manual referenced. According to the practical manual provided, the equipment and materials required were listed. For practical implementation, teacher had informed the laboratory assistant at least a day before practical was to be carried out. According to the equipment request records, all teachers requested for equipment and materials based on the students number of groups formed. They did not provide more than what was needed as they reasoned that all equipment and materials were in good useable condition.

When it came to practical time, all teachers did not allow students to enter without permission. This was to prevent students from playing with the equipment and materials prepared. Students were then allowed to enter and remained in their respective groups based on the practical's benches. For larger groups of students, teachers instructed the students to size down by moving to another table. This situation showed that teachers were sensitive to student management that would have affected the use of practical equipment and materials.

In the briefing session, all teachers instructed on the practical's purpose and laid out the procedure for the practical. This was followed by information on equipment and materials needed. It was found that only two teachers showed the students each of the equipment involved and how to use them. This naturally helped the students to be able to use the equipment in the right manner. It was also found that no teacher reminded their students on how the equipment were to be used safely and taken care of properly. For the distribution of equipment, all teachers instructed each group to take one set. However, none of the teachers instructed that only the representative of group were to take the equipment on the group's behalf. This situation inevitably led to a chaotic, out-of-control atmosphere.

When students had begun to install the equipment and apparatus, it was found that all the teachers began to monitor the students' activities. The laboratory assistant needed to help the students to manage their equipment. This ensured the smooth progress of the practical work and thus accurate data were obtained. Teachers and laboratory assistants' monitoring also helped in preventing students from playing or misusing the equipment and materials provided. Once the practical work had been conducted, all teachers instructed their students to clean up the equipment and materials and to return them.

Identify Science Teachers' Perception on Practical Equipment Management in Inculcating Thinking Skills:

The results of the open-ended questionnaire analysis showed that all teachers reported that students had more fun being actively involved in the practical because they got to interact with fellow students as well as the equipment and materials provided. Teachers also expressed that using the practical method possessed unique advantages as the students were given the opportunity to use the equipment and science materials to solve problems. Students were also more active, displaying scientific skills when they used the equipment and materials provided.

The results of the data analysis also showed that all teachers reiterated that there was still a lack of equipment for specific practicals. They added that some of the necessary equipment were not found in the lab, did not meet specifications, were not sufficient and did not function properly. There was also a teacher complaining that the practical work was problematic because students were out of order and were often seen playing with the equipment and materials provided.

In collecting the views of teachers on the use of practical work, data analysis showed that the teachers suggested that the budget be increased for the purchase of practical equipment. They also suggested that the number of students in each science class be reduced so as to enable the teachers to form a small practical group. This was to ensure that all students get to interact with the equipment and materials used. Besides that, teachers also proposed that the laboratory assistant be present in the laboratory throughout the entire practical class. This was to help the teacher monitor if students were installing and using the equipment properly and avoid misuse.

DISCUSSION

Provide opportunities for practice in solving problems will encourage students to apply thinking skills. Science teacher must plan teaching approaches properly. In practical work, planning and handling are two management processes that interact with each other to allow the teaching activities go smoothly [5]. In the teaching of science in practical, practical equipment require planning and careful handling so that students can use them properly. Equipment and materials used must be adequate and of high quality. Many management and teaching concepts emphasize the need for planning process and proper handling of practical equipment.

The planning stage is the first stage in the process of teaching and must be examined by every science teacher who will be using the practical work as instructional approach. This is because the planning stage not only determines the success of the practical work itself in driving the students' learning experience acquirement; it emphasizes the safety aspect of the students as well [10, 11]. A teacher's good planning in the practical work can be decisive towards the improvement of students' learning. Hence, a careful record regarding practical work and equipment ought to be made clear in teachers' Lesson Plan Book.

Teachers need to know the type of equipment required and the quantity that is in the laboratory before booking them as early as one week from the date they are

required. According to [16], information on the equipment is vital in designing lessons using the practical work approach. Chin [17] stated that teachers' knowledge regarding the type of equipment and how they are used can help students carry out practical work smoothly. Moreover, the cause of the failure in the practical works can be attributed to mistakes in planning the method to measure, using the equipment and data recording.

The preparation of practical manual which contains an equipment list will provide reassurance to students to undertake their practical work with confidence. McLeod *et al.* [18] stated that early equipment management planning is very important, including preparing the equipment list to be given to students to ensure that they know the type and quantity of equipment required. Nurzatulshima and Lilia [6] also reported in their study that preparation in the form documents helped students to identify the equipment needed while helping teachers to conduct the practical work smoothly.

Teachers need to make the corresponding reservation of equipment quantity to what is available in the laboratory. According to [19], adequate equipment reservation is important in practical planning. A reservation with a quantity that is more than required is also encouraged so that students can make choices and change them if problems occur whilst using them. Hayward [10] also recommended that teachers should inform the direction of equipment sharing so that students did not have to scramble among themselves.

During the operation of the practical classes, teachers need to explain how to use the equipment properly and how to avoid damaging them. Sweeney and Paradis [9] stated that explanation and information regarding usage of practical equipment were greatly helpful to students in performing the practical work smoothly. Chin [17] also noted that a clear description of relevant procedures and practical equipment is very important to enable students to know how to carry out practical work and use the equipment properly.

Next, the giving out instructions on orderly equipment retrieval by group representatives are necessary while being monitored by teachers. According to [18], distribution of materials and equipment for practical work had to be done orderly so that students get every material required in proper condition and sufficient quantity. Carin and Bass [20] stated that task delegation ought to be implemented so that each group has a representative who is responsible for retrieving and returning the equipment. This task delegation also prevents congestion at the equipment location where they are set up at any one time.

Teachers need to patrol to ensure that students arrange and use the equipment correctly and to prevent them from playing with the equipment supplied. According to [12] and [14], besides ensuring students are involved in the assignment given, surveillance also ensure that students use the equipment by employing the right technique. Upon the completion of practical activities, return (equipment) instructions should be given by the teachers because apart from inculcating a responsible attitude towards the equipment used, they also ensure that students take care of the equipment properly and carefully.

The handling of practical equipment can be more effective if the laboratory assistants were to accompany the teachers throughout the duration of the practical method being conducted. This practice was also proposed by [14] which stated that the presence of laboratory assistants or adults, who are skilled in practical equipment, can help teachers monitor students' use of equipment. In addition, he can also help students set up the equipment correctly and safely.

CONCLUSION

Learning through practical hands-on works will increase thinking skills because students carry out their own investigations to obtain information and solve problem through the actual material. Charles and Senter [3] stated that management is very important in teaching without which teaching will fail or difficult to carry out. In science practicals, management is also very important considering practical work has to be done by the students themselves and also the variety of equipment and materials involved. Harlen [8] and also [11] also concluded that teachers put science class management efficiency as a key requirement in conducting practical activities. Teachers need to have the managerial skill so that the practical performed with a variety of equipment and materials can be accomplished.

The design and operation of practical equipment is a vital management process in the teaching of practical science. Orderly planning of practical equipment before class commences can ensure that the practical work designed can be carried out smoothly, thus achieving its objectives. Effective handling of practical equipment during the teaching process which includes directing, monitoring and controlling ensures that the equipment supplied can be used well. Additionally, the practical equipment handling process aided by laboratory assistants also encourages students to be responsible for maintaining practical equipment correctly and carefully.

In summary, solving problems in practical work will enhance students' thinking skills. The practical equipment and material management should be stressed by all science teachers who conduct practical lessons. Teachers need to prepare practical equipment and materials in the appropriate number and in working order. The role of the laboratory assistants needs to be optimized so that practical equipment management can be effective in practical teaching. The following is a list of practical equipment management proposals to strengthen the implementation of practical work by Science teachers:

- Identify the practical equipment needed for the practical selected
- Check the availability of equipment and materials for practical
- Ensure the adequacy of equipment and materials for practical
- Prepare practical manual containing details on practical equipment and materials
- Reserve equipment and materials at least three days before the practical
- Inspect the equipment and materials provided before practical classes
- Divide students into small groups based on the number of available equipment
- Provide a complete description of practical procedures
- Emphasize correct data collection procedures
- Inform the type, quantity and location of the equipment and materials needed
- Show the way to use the equipment and materials needed
- Emphasize safety aspect when using lab equipment and materials
- Instruct students to properly collect and return equipment and materials
- Control students' practical activities with the help of laboratory assistants

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