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Dealing with Apparatus in laboratory: Science Teachers' Perception and Practices

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Abstract

The use of laboratory is centered on students' involvement in solving problems related to science concepts. For troubleshooting purposes, appropriate apparatus will be used, namely laboratory apparatus, chemicals, specimens, and so on. The correct and appropriate interaction between students and laboratory apparatus can lead to critical, creative and analytical thinking. The planning and handling of laboratory apparatus for practical activities need to be carried out carefully so that the learning outcomes of these activities can be obtained effectively. This working paper aims to shed light on the results of the study on science teachers who employ laboratory. The focus of the study is on the management of apparatus 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 apparatus before students' arrival to the laboratory. They also provided practical manual to guide the students, especially regarding practical apparatus and laboratory procedures. The results of the open-ended questionnaire analysis showed that all the teachers complained of the lack of apparatus when it comes to certain practical. They also stressed the need for the presence of laboratory assistants in helping to manage practical classes, especially from the aspect of apparatus management. The study concluded that a list of practical science apparatus management proposals be put forward to improve the implementation of practical methods by Science teachers.

Keywords: Practical method, laboratory apparatus, science practical management, science learning

Introduction

Teaching and managing learning skills of teachers are one of the criteria in measuring Malaysia standard teacher that emphasized by the Ministry of Education (Ministry of Education Malaysia, 2009). 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.

Well-managed classrooms are greatly needed in ensuring that the teaching and learning process runs effectively. According to Charles and Senter (2002), 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. Managing classroom in active learning approach that encourages thinking skills should be given priority (Baharin, Kamarudin, & Abdul Manaf, 2018). A well-managed 'organization' which can be implemented into a classroom management as suggested by Fayol (1988) and Sampson (2004), should consist of planning, organizing, leading, directing and controlling. These functions of management are highly recommended to immerse into the curriculum of primary and secondary education, tertiary and other post-school education.

Pedagogical innovation in science teaching can be achieved when students be more interested in the subject and able to understand well (Baharin, Kamarudin, & Abdul Manaf, 2018). 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. They will be fun to learn, learn actively and get involved directly with inquiry and discovery activities. A basic classroom management need to be included such as curriculum planning, well-planned of instructions and well-equipped of resources.

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 (Nurzatulshima Kamarudin & Lilia Halim, 2013). 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 laboratory, can enhance one's deep insight and rational thinking (Joyce et al. 2000). Through student-centered learning with the support of laboratory apparatus 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.

For science teachers who wish to use laboratory as one of their instructional approaches, the success and efficiency of lab management only can be achieved if he or she knows the foundation of the laboratory management. According to Harlen (2000) and Sweeney and Paradis (2003), organizing and managing laboratory 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 laboratory apparatus and medical supplies, safety and liability features in laboratory setup, adequate time for students' investigation and laboratory infrastructure (Hayward 2003; Nurzatulshima Kamarudin & Lilia Halim, 2013; 2014). Thus,

effective laboratory operations and apparatus management for laboratory 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 laboratory, factors that affect the learning process need to be dealt with and managed. Lawson (2000) described that among the key elements that need to be taken care of by science teachers in laboratory is time allocation for students' investigation, students' capability in handling lab activities (inquiry-based learning), lab safety and the availability of apparatus. Sampson (2004) recommended the way that need to be mitigated if teachers use the inquiry approach to ensure inquiry-based classroom runs efficiently:

- a) Students are actively engaged in classroom activities
- b) The important of good time-management.
- c) Encourage collaborative learning during laboratory work.
- d) Focusing on laboratory safety standards during students' investigation.
- e) Skillful about stores and inventory management.

He 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 (2003) asserted that the adequate or good conditions of apparatus and materials provide optimum support to the teaching of science in practice.

The handling of laboratory 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 (Nurzatulshima Kamarudin & Lilia Halim, 2013; Packard & Race 2000). According to Hayward (2003), the imperfection of apparatus will cause the objective of any practical investigation unreachable because the data collected can be disputed. Investigative activities using apparatus to facilitate students manipulate the apparatus and associate science concepts learned. The effectiveness of teaching objectives in laboratory can also fail if laboratory apparatus are poorly prepared, damaged or does not meet the required standards.

Research Objectives

The objective of this study was to:

- a) identify practices of managing practical apparatus in the teaching of Science practical.
- b) identify teachers' perception on practical apparatus management in the teaching of Science practical.

Research Methodology

The study conducted took after case study that aims to explore how teachers manage practical apparatus in the teaching of science practical. A total of five science teachers 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 Noraini (2010), 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.

Laboratory 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 apparatus. Then, the procedure information for apparatus 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 apparatus management. To acquire teachers' perception towards practical apparatus 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 apparatus. Two aspects of management were focused upon in terms of practical planning and handling of practical apparatus.

Analysis on Research Findings

a. Identifying practices of managing practical apparatus in the teaching of Science

Through the observation analysis done, it was found that all the teachers did not write down the apparatus 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 apparatus 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 apparatus request records, all teachers requested for apparatus and materials based on the students number of groups formed. They did not provide more than what was needed as they reasoned that all apparatus 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 apparatus 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 had affected the use of laboratory apparatus 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 apparatus and materials needed. It was found

that only teachers D and E showed the students each of the apparatus involved and how to use them. This naturally helped the students to be able to use the apparatus in the right manner. It was also found that no teacher reminded their students on how the apparatus were to be used safely and taken care of properly. For the distribution of apparatus, 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 apparatus on the group's behalf. This situation inevitably led to a chaotic, out-of-control atmosphere.

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

b. Identifying teachers' perception towards practical apparatus management in the teaching of Science

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 apparatus and materials provided. Teachers also expressed that using the practical method possessed unique advantages as the students were given the opportunity to use the apparatus and science materials to solve problems. Students were also more active, displaying scientific skills when they used the apparatus and materials provided.

The results of the data analysis also showed that all teachers reiterated that there was still a lack of apparatus for specific practical. They added that some of the necessary apparatus 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 laboratory was problematic because students were out of order and were often seen playing with the apparatus and materials provided.

In collecting the views of teachers on the use of laboratory, data analysis showed that the teachers suggested that the budget be increased for the purchase of practical apparatus. 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 apparatus 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 apparatus properly and avoid misuse.

Discussion

The approach to inquiry such as planning and handling, requires a deep knowledge and a neat preparation by students and teachers (Baharin, Kamarudin, & Abdul Manaf, 2018). In the teaching of

science in practical, practical apparatus require planning and careful handling so that students can use them properly. Apparatus 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 laboratory apparatus.

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 laboratory as instructional approach. This is because the planning stage not only determines the success of the laboratory itself in driving the students' learning experience acquirement; it emphasizes the safety aspect of the students as well (Nurzatulshima Kamarudin & Lilia Halim, 2014; Orlich et al. 2004). A teacher's good planning in the laboratory can be critical towards the improvement of students' learning. Hence, a careful record regarding laboratory and apparatus ought to be made clear in teachers' Lesson Plan Book.

Teachers need to know the type of apparatus 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 Hensley (2002), information on the apparatus is vital in designing lessons using the laboratory approach. Chin (2003) stated that teachers' knowledge regarding the type of apparatus and how they are used can help students carry out laboratory smoothly. Moreover, the cause of the failure in the laboratories can be attributed to mistakes in planning the method to measure, using the apparatus and data recording.

The preparation of practical manual which contains an apparatus list will provide reassurance to students to undertake their laboratory with confidence. McLeod et al. (2003) stated that early apparatus management planning is very important, including preparing the apparatus list to be given to students to ensure that they know the type and quantity of apparatus required. Well-planned science inquiry activities such as laboratory work, would construct a student's thinking skills from lower to higher order (Jiun, Kamarudin, Talib, & Hassan, 2018).

Teachers need to make the corresponding arrangement of apparatus quantity to what is available in the laboratory. Students also should be given the opportunity to develop their ability to collect the data by preparing suitable and adequate apparatus (Mordeno, Lahoylahoy, Alguno & Malayao, 2017). A booking 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 (2003) also recommended that teachers should inform the direction of apparatus sharing so that students did not have to scramble among themselves.

During the set-up of the practical classes, teachers need to explain how to use the apparatus properly and how to avoid damaging them. McDermott *et al.* (2000) and Sweeney and Paradis (2003) stated that explanation and information regarding usage of laboratory apparatus were greatly helpful to students in performing the laboratory smoothly. Chin (2003) also noted that a clear description of relevant procedures and laboratory apparatus is very important to enable students to know how to carry out laboratory and use the apparatus properly.

Next, the giving out instructions on orderly apparatus retrieval by group representatives are necessary while being monitored by teachers. According to McLeod *et al.* (2003), delivery of materials and apparatus for laboratory had to be done orderly so that students get every material required in proper condition and sufficient quantity. Carin and Bass (2001) stated that task delegation ought to be implemented so that each group has a representative who is responsible for retrieving and returning the apparatus. This task delegation also prevents congestion at the apparatus location where they are set up at any one time.

Teachers need to patrol to ensure that students organize and use the apparatus correctly and to prevent them from playing with the apparatus supplied. According to Lawson (2000) and Packard and Race (2000), besides ensuring students are involved in the assignment given, surveillance also ensure that students use the apparatus by employing the right technique. Upon the completion of practical activities, return of apparatus instructions should be given by the teachers because apart from inculcating a responsible attitude towards the apparatus used, they also ensure that students take care of the apparatus properly and carefully.

The handling of laboratory apparatus 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 Packard and Race (2000) which stated that the presence of laboratory assistants or adults, who are skilled in laboratory apparatus, can help teachers monitor students' use of apparatus. In addition, he can also help students set up the apparatus correctly and safely.

Conclusion

Practical teaching also known as laboratory, laboratory work, experiments or testing is conducted in a laboratory that is student-oriented. It involves laboratory apparatus and instruments, chemicals, fresh and preserved specimens (Nurzatulshima 2011; Jordan *et al.*, 2011). Learning through practical hands-on works occurs faster because students carry out their own investigations to obtain information through the actual material.

Charles and Senter (2002) stated that management is very significant in teaching without which teaching will fail or difficult to carry out. In science practical, management is also very important considering laboratory has to be done by the students themselves and also the variety of apparatus and materials involved. Harlen (2000) and also Nurzatulshima Kamarudin and Lilia Halim (2013; 2014) also concluded that teachers set 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 apparatus and materials can be accomplished.

The design and operation of laboratory apparatus is a vital management process in the teaching of practical science. Orderly preparation of laboratory apparatus before class commences can ensure that the laboratory designed can be carried out smoothly, thus achieving its objectives. Effective handling of laboratory apparatus during the teaching process which includes directing, monitoring

and controlling ensures that the apparatus supplied can be used well. Additionally, the laboratory apparatus control process aided by laboratory assistants also encourages students to be responsible for maintaining laboratory apparatus correctly and carefully.

In summary, the practical apparatus and material management should be strained by all science teachers who conduct practical lessons. Teachers need to arrange practical apparatus and materials in the appropriate number and in working order. The role of the laboratory assistants needs to be optimized so that laboratory apparatus management can be effective in practical teaching. The following is a list of practical apparatus management proposals to strengthen the implementation of laboratory by Science teachers:

- a) Identify and check the availability of apparatus needed for the practical selected
- b) Prepare the details on practical apparatus and materials
- c) Inspect and reserve apparatus and materials before the practical
- d) Divide students into small groups based on the number of available apparatus
- e) Provide a complete description of practical procedures
- f) Show the way to use the apparatus and materials needed
- g) Emphasize safety aspect when using lab apparatus and materials

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