Relationship between physical and psychosocial aspects in science laboratory learning environment

Che Nidzam Che Ahmad\textsuperscript{a}, Kamisah Osman\textsuperscript{b}, Lilia Halim\textsuperscript{c}

\textsuperscript{a}Faculty of Science and Mathematics, Universiti Pendidikan Sultan Idris, Tanjong Malim, 35900, Perak, Malaysia
\textsuperscript{b}Faculty of Education, Universiti Kebangsaan Malaysia, Bangi, 43600, Selangor, Malaysia
\textsuperscript{c}Faculty of Education, Universiti Kebangsaan Malaysia, Bangi, 43600, Selangor, Malaysia

Abstract

The learning environment needs to be adjusted in line with the learning outcomes and teaching strategies, while at the same time, fulfills the teachers’ and students’ needs. Thus, it is argued that evaluation of learning environment is important because by doing so, it provides not only information for measuring the learners’ performance, but also information on teachers’ competency in planning positive learning outcomes. This paper reports a survey which was conducted to determine teachers’ perception of and the relationship between physical and psychosocial aspects of science laboratory learning environment in schools in the state of Selangor. Teachers’ perception of psychosocial science laboratory learning environment was measured using Science Laboratory Environment Inventory (SLEI), while the physical environment was measured using Physical Science Laboratory Environment Inventory (PSLEI). Analysis of findings revealed that overall, teachers demonstrated positive attitudes towards the psychosocial environment and moderate level of suitability towards the physical environment. Subsequent analysis also revealed that there existed significant contributions of physical aspects on psychosocial aspects of the science laboratory learning environment.

Keywords: science laboratory, learning environment, physical aspects, psychosocial aspects

1. Introduction

The learning environment is a place meant for students to acquire knowledge and has been identified as a critical factor in student achievement (Baek and Choi, 2002). Therefore, the quality of classroom life is significant in shaping students’ emotions and attitudes towards their classmates, teachers, the subjects that they study and the entire education system (Zedan 2010). In the teaching of science, the laboratory has an important role as it offers students an environment different from the conventional classroom. Engaging students in laboratory activities promotes students’ understanding of scientific concepts and problem-solving skills, and improves their attitudes towards science (Arzi 2003). Carefully crafted laboratory activities, with appropriate physical facilities and positive psychosocial environment stimulate intellectual activities, increase social contact, and promote learning and students’ development, as well as limit negative behaviours among students.

Many studies have been conducted to determine the effectiveness of the teaching and learning of science using laboratory activities in order to improve students’ achievement in cognitive and affective domains (Kilgour 2006; Hofstein and Lunetta 2004; Hofstein and Mamlok-Naaman 2007; Fraser and Lee 2009). However, a critical review on the role of laboratory in the teaching and learning of science indicates that the research has failed to show the relationship between experiences in a laboratory and student learning (Hofstein and Lunetta 2003).
Furthermore, the laboratory learning environment still emphasizes on “teacher-centeredness” and “confirmatory laboratory” model which limit the opportunity for open-ended investigation and therefore, may be boring for most students (Lilia 2009). According to Lilia (2009), laboratory learning environment could be improved upon either by: a) teachers’ using information from students’ perceptions of the learning environment to improve their pedagogical practices, or b) changing the physical design of the laboratories. Therefore, it is important to evaluate the learning environment in secondary school laboratories.

2. Review of Literature

The essence of a learning environment is the interaction that occurs between individuals, groups and the setting within which they operate. The investigation in, and of, learning environment is based on the formula, B=f (P, E) whereby behaviour (B) is considered to be a function of (f) the person (P) and the environment (E). The formula recognizes that “both the environment and its interaction with personal characteristics of the individual are ‘potent determinants of human behavior’ ” (Fraser, 1998). Since learning environment is a place where learners and educators congregate for extended periods of time to participate in the activity of learning, the environment created during this activity is regarded as an important component in the teaching and learning process. The learning environment encompasses a variety of tools and information resources, the interaction, the relationships between and among students and teachers, as well as expectations and norms of learning behaviour.

Over the past several decades, research has established relationships between the classroom environment and student, as well as evaluated educational programmes and identified determinants of learning environment. Indeed, research indicates that student’s achievement is higher in an environment in which students feel comfortable and positive (Waldrip & Fisher, 2003). Furthermore, a favorable science learning environment correlates significantly to student involvement, teacher support, and classroom order and organization. In Malaysia, research on learning environment is still at its infancy stage. Vast research focuses on the investigation of the but little research has been done on physical characteristics of the laboratory that might affect the science learning environment experienced by the students (Lilia 2009). According to Fraser (2003), there is a scope for Asian researchers to adopt, adapt or create a new theoretical frame in learning environment studies. This research therefore, tries to identify teachers’ perception of science laboratory learning environment from the physical and psychosocial aspects, and to explore the relationship between these variables.

3. Methodology

This study explores teachers’ perception on physical and psychosocial aspects of the science laboratory and the relationships between these two variables. The study uses quantitative methods and all data are collected using questionnaire. A total of 800 science teachers from 100 secondary schools in Selangor participated in this study. Teachers’ perception of psychosocial aspects are measured using Science Laboratory Environment Inventory (SLEI) while perception of physical aspects are measured using Physical Science Laboratory Environment Inventory (PSLEI). SLEI consists of five scales, which are students’ cohesiveness, open-endedness, integration, rule clarity and material environment. On the other hand, PSLEI consists of six scales, which are furniture and equipment, space, technology, lighting, air quality and safety aspects. Both instruments have been validated by two experts in science education as well as supervisors. Additionally, reliability is obtained through a pilot study. The internal consistency reliability (coefficient alpha) ranges from 0.79 to 0.91 for the five SLEI scales and ranges from 0.74 to 0.90 for the six PSLEI scales. These ranges are considered acceptable to good (George & Mallery, 2001), since the closer the alpha is to 1, the greater the internal consistency of the items.
4. Results and Discussion

4.1 Physical aspects of science laboratory learning environment

Table 1 shows that from the physical aspects, teachers’ perception indicates a high level of fitness for lighting and technology. For furniture and equipment, space, air quality and safety aspects, teachers’ perception is found to be at a moderate level. The high level of fitness for lighting from teachers’ perspective may be due to the use of combination of natural and fluorescent lighting in most of the science laboratory studied. According to Barnitt (2003), this combination provides quality lighting. The moderate level of fitness for furniture and equipment, air quality and safety aspects is also reported in previous studies (Giddings & Waldrip 1993).

Table 1: Average mean and average standard deviation of PSLEI scales

<table>
<thead>
<tr>
<th>No.</th>
<th>Scale</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Furniture &amp; equipments</td>
<td>3.62</td>
<td>0.71</td>
</tr>
<tr>
<td>2.</td>
<td>Space</td>
<td>3.60</td>
<td>0.85</td>
</tr>
<tr>
<td>3.</td>
<td>Lighting</td>
<td>3.78</td>
<td>0.67</td>
</tr>
<tr>
<td>4.</td>
<td>Technology</td>
<td>3.76</td>
<td>0.76</td>
</tr>
<tr>
<td>5.</td>
<td>Air quality</td>
<td>3.23</td>
<td>0.89</td>
</tr>
<tr>
<td>6.</td>
<td>Safety aspects</td>
<td>3.30</td>
<td>0.67</td>
</tr>
</tbody>
</table>

Giddings and Waldrip (1993) argued that perceptions on science laboratory facilities are important. These perceptions could affect science teachers and students who use these facilities. If the science laboratory facilities are perceived as inadequate, it could be that the teachers are not maximising the use of these facilities, and this could affect the optimisation of educational productivity. Efforts should be made to ensure that all science laboratories are well-equipped with equipment and facilities that are in line with the teaching and learning needs, particularly the identified physical aspects, in order to improve on the effectiveness of the teaching and learning process in the science laboratories. This physical environment could be considered as a second teacher whereby it could motivate students, enhance learning, and reduce disciplinary problems and undesirable behaviours (Matai and Matai 2007; Aladejana and Aderibigbe 2007; Che Ahmad et al. 2010). Due to this, many countries have modified their science laboratories learning environment, particularly to provide students with the opportunities to explore and construct knowledge in a more conducive and encouraging learning environment.

4.2 Psychosocial aspects of science laboratory learning environment

From the psychosocial aspects, teachers demonstrate positive attitudes in all SLEI scales, with an exception of open-ended scale as shown in Table 2 below.

Table 2: Average mean and average standard deviation of SLEI scales

<table>
<thead>
<tr>
<th>No.</th>
<th>Scale</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Student cohesiveness</td>
<td>3.67</td>
<td>0.53</td>
</tr>
<tr>
<td>2.</td>
<td>Open-endedness</td>
<td>2.60</td>
<td>0.67</td>
</tr>
<tr>
<td>3.</td>
<td>Integration</td>
<td>3.99</td>
<td>0.55</td>
</tr>
<tr>
<td>4.</td>
<td>Rule clarity</td>
<td>3.93</td>
<td>0.54</td>
</tr>
<tr>
<td>5.</td>
<td>Material environment</td>
<td>3.36</td>
<td>0.66</td>
</tr>
<tr>
<td>6.</td>
<td>Satisfaction</td>
<td>3.82</td>
<td>0.68</td>
</tr>
</tbody>
</table>

The mean score of the integration scale is the highest of all the scales. In contrast, the mean score of the open-endedness scale is the lowest (mean intermediates between seldom and sometimes). The high mean score of
integration scale is consistent with previous studies (Lilia, 2009; Fraser & Lee, 2009). The low score of open-endedness scale is also consistent with the findings of previous studies in various countries (Lee & Fraser, 2001; McEwen et al., 2009; Lilia, 2009; Fraser & Lee, 2009). The reason of having a low mean score of this scale could be because the practical laboratory work in Malaysia is mainly to verify knowledge provided by teachers in the classroom. Fraser and Lee (2009) also stated that laboratory activities would normally reinforce what students have already learned in the classroom. Numerous studies in other countries also show that the environment in science laboratories seems to be close-ended.

In addition, Lee and Fraser (2001) stated that practical laboratory work is only a supplement to learning theory in the classroom and science teachers also seem to be unsure about the value of the practical work in the science laboratory. This could be due to the fact that Malaysian science teachers:

(i) focus more on examinations,
(ii) face time constraint, and
(iii) are not well-equipped with the required skills to generate ideas.

According to Kalu (2004), science teachers do not carry out open-labs and inquiry-oriented activities due to the lack of ability and understanding of inquiry teaching strategies and their ways of implementation, or perhaps the tendency of the teachers to teach as they were previously taught. Thus, teachers need to be exposed to the latest teaching techniques that emphasise on collaboration and interaction in the classroom, as well as active learning. One of the strategies is to emphasise on the use of inquiry methods. These methods could encourage the generation of ideas among students (Hofstein et al. 2001).

4.3 Relationship between physical and psychosocial aspects

The relationship between physical and psychosocial aspects of a science laboratory environment is based on multiple regression (stepwise) analysis. In this study, multiple regression analysis is conducted five times and the results are summarised in Table 3.

The results show that there are significant contributions of physical aspects on the psychosocial aspects in the laboratory. The learning space, air quality, furniture and equipment are predictors of students’ cohesiveness. The predictors of open-endedness are furniture and equipment, technology and safety aspects. Next, the predictors of integration between theories and practice are air quality, learning space and safety aspects. In addition, the predictors of rule clarity are air quality and learning space, and lastly the predictors of material environment in the science laboratory are furniture and equipment, and learning space, at a significant value, p < 0.05.

<table>
<thead>
<tr>
<th>Physical</th>
<th>Students’ cohesiveness</th>
<th>Open-endedness</th>
<th>Integration</th>
<th>Rule clarity</th>
<th>Material environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Furniture and equipment</td>
<td>0.11*</td>
<td>0.13*</td>
<td>-</td>
<td>-</td>
<td>0.19*</td>
</tr>
<tr>
<td>Learning space</td>
<td>0.21*</td>
<td>-</td>
<td>0.32*</td>
<td>0.23*</td>
<td>0.17*</td>
</tr>
<tr>
<td>Lighting</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Technology</td>
<td>-</td>
<td>0.18*</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Air quality</td>
<td>0.19*</td>
<td>-</td>
<td>0.29*</td>
<td>0.29*</td>
<td>-</td>
</tr>
<tr>
<td>Safety aspects</td>
<td>0.10*</td>
<td>0.10*</td>
<td>0.10*</td>
<td>0.08</td>
<td>0.11</td>
</tr>
<tr>
<td>Multiple Correlation (R)</td>
<td>0.07</td>
<td>0.10</td>
<td>0.11</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The variation in each psychosocial aspect among teachers could be described by the identified physical aspects. Thus, it can be deduced that the physical aspects can impact the psychosocial aspects in the science laboratory learning environment. Zandvliet (1999) in his study on high-technology classroom environment also finds that there is a relationship between the physical aspects and psychosocial aspects in the classroom. Therefore, in our efforts to improve the effectiveness of teaching and learning in the school science laboratory, we need to ensure that the learning environment is in line with the pedagogical needs of teaching and learning, and meets the needs of the...
teachers and students. Taylor (2008) notes that a well-designed learning environment would be able to drive teachers and students towards active learning, and enhance the positive effects of the learning pedagogy. Good consideration about the size of classrooms and furniture styles are also important in creating flexible and easily modified spaces (Kabrich 2007).

5. Conclusion

This study adds to the growing body of research on the learning environment, especially in Malaysia. Data analysis reveals that science laboratory learning environment in Malaysia still needs improvement in some aspects. The suitability of the physical aspects in the science laboratories should be enhanced to meet the requirements of teaching pedagogy and the needs of the teachers and students. Psychosocial aspects (especially the open-endedness scale which encourages students to generate ideas) should be applied in the teaching of science in order to give opportunities to students to pursue knowledge on their own. Attention must also be given to the physical aspects, which contribute to the psychosocial aspects in teaching and learning. By fulfilling the teachers’ need in physical aspects and increasing the exposure associated with the latest teaching techniques, such as the use of inquiry, the teaching and learning of science could be improved. This in turn can enhance the overall quality of the learning environment.

References


