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The Establishment of Physical Aspects of Science Laboratory Environment Inventory (PSLEI)

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ABSTRACT

The purpose of this study is to develop and validate the learning environment instrument designed to identify teachers' perceptions towards the physical aspect of science learning environment in secondary schools in Malaysia. Through extensive review of the literature and interviews with experienced teachers, items contribute to the physical learning environment in the science laboratory are identified. In order to enhance the validity of this instrument, two experts are invited to review the instrument. In addition, 800 teachers are involved in this study and validated the instrument, revealing six scales regarding physical aspects of the learning environment. The six scales are (1) furniture and equipment; (2) space; (3) lighting; (4) technology; (5) indoor air quality; and (6) safety aspects. Each item in the instrument has a factor loading range between 0.85 and 0.45, while the alpha reliability coefficient for each scale ranges between 0.86 and 0.76. The findings of this study confirm the validity and reliability of the physical science laboratory environment inventory.

Keywords: Physical Aspect of Science Laboratory Environment, Establishing Instrument, Learning Environment.

INTRODUCTION

Classrooms are often regarded as a meaningful place wherein students construct their understanding of subject matters. During lessons, the classroom is composed of various forms of communication and interaction practices that lend themselves to an overall characterization of the learning environment (Weishen Wu et al. 2007). Classroom dynamics are changeable and evolving due to a variety of factors; how all members feel and experience the characteristics of this milieu often depends on the climate, culture, ambiance or atmosphere in which teaching and learning takes place (Fraser 1986). In the classroom, the teacher's role as a manager unveils the importance of planning, organizing, leading, and controlling the learning environment (Tobin & LaMaster 1995). As an ecological system, any intervention in the classroom may cause changes in contextual variables which, in turn, influence the learning environment as a whole.

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The classroom learning environment should encourage students to acquire knowledge and master skills that will help them develop their minds to the optimum level. According to the constructivist view, students learn something when they construct their own understanding. Therefore, constructivist teaching implies modification of teaching tasks and strategies, learning tasks and strategies, and the criteria for learning achievements (Wheijen Chang 2005). There are important attributes of constructivism, which are 1) taking into account students' prior knowledge, 2) learning occurring as a result of student's own effort, 3) learning occurring when students restructure their existing ideas by relating new ideas to old ones and 4) providing opportunities to cooperate, sharing ideas and experiences and reflecting on their learning. All these factors need to be considered when setting the classroom learning environment to ensure an effective teaching and learning process.

Based upon the perspective of constructivism, a teacher is encouraged to create an effective learning environment in which students have opportunities to actively engage in knowledge construction through the interaction between people and objects. According to Wilson (1996), a constructivist learning environment is defined as: "a place where learners may work together and support each other as they use a variety of tools and information resources in their guided pursuit of learning goals and problem-solving activities" (p.5). He emphasizes learning environments as opposed to "instructional" environments in order to promote "a more flexible idea of learning", one which emphasizes "meaningful, authentic activities that help the learner to construct understandings and develop skills relevant to problem solving" (p.3). Therefore, the learning environment should be designed and prepared to match the needs of the learning goal. Thus, assessing the learning environment is particularly a valuable process for a teacher to sustain a student's positive attitude towards the class and the learning process whilst at the same time justifying their provisions to the transformation of the setting (Weishen Wu et al. 2007).

In the teaching of science, the laboratory learning environment plays an important role in engaging students in laboratory activities which would promote the students' understanding of scientific concepts, problem-solving abilities and attitudes towards science (Arzi 2003; Ozkan et al. 2006). Laboratory activities have the potential to engage students in authentic investigation in which they can identify their own problems to investigate, design procedures and draw conclusions. These activities can give students a sense of how scientists go about their work, which in turn may influence their attitudes towards the scientific enterprise (Chiappetta & Koballa 2006). Along with attitudes towards science, laboratory activities can help students to acquire better understanding of concepts and principles as a result of concrete experiences. Research also indicates that students are interested in learning science through laboratory-based activities (Dalgety & Coll 2005, Aydeniz & Kaya 2012). Using appropriate materials accompanied with verbal explanation could encourage students to pay more attention to the material learned and conceptualise and comprehend abstract ideas, thoughts, and data better in their mind and efficiently remember more information (Cimer 2007).

Although science is acknowledged as an important part of every child's education, there is evidence to suggest that science learning environments are in a parlous state in many settings both nationally and internationally (Lewthwaite 2005). This includes the physical aspects of the learning environment. The physical characteristics of the science laboratory could influence teacher-student communication and have an impact on cognitive and affective domains. Lewthwaite & McMillan (2007) state that the commonly cited factors are resource inadequacy associated with limited equipment, space, and facilities (Lewthwaite & McMillan 2007). According to Higgins et al. (2005), physical elements in the school environment have discernible effects on teachers and learners. In particular, inadequate temperature control, lighting, air quality and acoustics have detrimental effects on concentration, mood, well-being, attendance and ultimately attainment. Furthermore, certain seating arrangements or positions may lead to more positive attitudes or an increase in positive interactions between students and teachers. Therefore, a conducive learning environment could provide comfort to students and teachers, which in turn increase interest and motivation, retain focus on learning as well as limit negative behaviour among students. Additionally, a learning environment with adequate equipment and facilities could encourage teachers to diversify their methods of teaching and learning, and thus increase students' understanding and achievement. Conversely, a distinctly poor environment might lead to absence (Earthman 2002) and reduction in learning time.

Weinstein's (1979) also argued that learning is optimized when the physical environment is treated with the same care as curricular materials and teacher preparation. A study by Arzi (2003) shows that active forms of learning are associated with better science facilities. In addition, a higher frequency of the inquiry method is detected when teaching is conducted in a space which combines classroom and laboratory facilities, compared with teaching carried out in separate classrooms and laboratories. This parallels with the constructivist concept of learning where knowledge is individually constructed and socially co-constructed by learners based on their interaction in an environment (Kaser & Riza 2010). Therefore, the laboratory learning environment should give an opportunity to students to explore and access information resources, promote a flexible idea of learning, as well as stress on meaningful, authentic, intentional, complex, cooperative and reflective learning activities that would help learners construct and develop skills relevant to problem solving.

Despite evidence that physical environments do influence students' learning, there is not enough research on the interrelations of physical design and practice in science education (Fulton 1991; Veal & Jackson 2006; Ahmad Fauzi 2005). Most of the research has focused on investigation on the teachers and students' perceptions of the psychological characteristics of their classrooms. Not much research is found to be focusing on the physical characteristics of a laboratory that might affect the science learning environment experienced by the students. Higgins et al. (2005) also argued that more research is needed to assess learning environment especially on the effects of the design or physical aspects on teachers and learners. Therefore, this research is one of the few attempts at filling this gap. The aim of this research is to validate the instrument to identify teachers' perceptions towards the physical science laboratory learning environment in secondary schools in Malaysia.

Science Teaching and Learning Environment

The essence of a learning environment is the interaction that occurs between individuals, groups and the setting within which they operate (Clayton 2007). The investigation in, and of learning environments is based on the formula, B=f (P, E) where 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 behaviour" (Fraser 1998b: 529). Since the 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 (also referred to as climate, atmosphere, tone, ethos or ambience) during this activity is regarded as an important component in the learning process (Fraser & Wubbels 1995).

Over the past several decades, research had established relationships between the classroom environment and students' learning outcomes, evaluated educational programmes and identified determinants of learning environments (Fraser 1994; 2002). In addition, learning environment research in the field of science education has grown vigorously, particularly in the areas of instrumentation and applications (Tobin & Fraser 1998). A rich array of instruments has been developed for various types of science classes, such as the Learning Environment Inventory (LEI) (Walberg & Anderson 1968), Classroom Environment

Scale (CES) (Moos & Trickett 1987), My Class Inventory (MCI) (Fisher & Fraser 1981), Science Laboratory Environment Inventory (SLEI) (Fraser, Giddings & McRobbie 1993), Questionnaire on Teacher Interaction (QTI) (Wubbles, Creton & Hooymayers 1985), What Is Happening in This Class? (WIHIC) (Fraser, Fisher & McRobbie 1996), and Constructivist Learning Environment Survey (CLES) (Taylor, Fraser & Fisher 1997). These instruments have been widely used to assess primary and secondary students' social and psychological perceptions of their science classrooms. Their reactions to, and perceptions of this environment have a significant impact on individual and group performance (Fraser 1998a). Indeed, research indicates that students' achievement is enhanced in those environments which students feel comfortable and positive about the environment (Waldrip & Fisher 2003). Furthermore, a favourable science learning environment correlates significantly to students' involvement, teachers' support and classroom order and organization (Fraser & Tobin 1989). Learning environment instruments appear to offer an efficient, affordable and reliable tool to investigate the learning environment created.

However, assessment by the science learning environment instruments pays relatively little attention to physical dimensions (Fulton 1991; Veal & Jackson 2006; Ahmad Fauzi, 2005; Lilia 2009). Recently, several instruments have been developed to assess physical aspects of the classroom (Zandvliet 1999), but these existing instruments are not entirely applicable to the science laboratory. Therefore, there is a need to develop a new instrument specifically designed for the laboratory learning environment that takes into account the conditions of the general classroom. This study seeks to explore distinct aspects within the physical science laboratory learning environment, where students and teachers have the opportunities to collaborate and enhance their understanding of scientific concepts.

METHODOLOGY

The aim of this study is to validate the Physical Aspect of Science Laboratory Environment Inventory (PASLEI). The study employs the quantitative method and uses a cross-sectional survey design. The quantitative method is used because the researcher seeks to establish the overall tendency of responses from individuals and to note how this tendency varies among people. All the data are collected using a set of questionnaire at one point in time. A total of 800 science teachers from 100 secondary schools in Selangor, Malaysia have participated in this study. The teachers involved are required to answer all the statements in the Physical Aspect of Science Laboratory Environment Inventory (PASLEI). The PASLEI consists of 36 total items and is allocated in six scales; (1) furniture and equipment; (2) space; (3) lighting; (4) technology; (5) indoor air quality; and (6) safety aspects. Each item has a five-point Likert format with responses 1 for strongly disagree, 2 for disagree, 3 for somewhat disagree, 4 for agree and 5 for strongly agree.

Development of the Physical Aspect of Science Laboratory Environment Inventory (PASLEI)

The development of PASLEI uses a three-stage approach. Stage 1 includes the identification of salient scales, Stage 2 involves writing individual items within the scales and Stage 3 involves field testing items followed by item analysis and validation procedures. These three steps were also used by Walker and Fraser (2005). The following is the description of the steps involved in each stage.

Stage 1 – Identification and development of salient scales

Stage 1 consisted of four steps that led to the identification and development of salient scales. The first step was reviewing the literature related to physical learning environments of the classroom. This crucial step sought to identify key components that researchers and practitioners consider to be important and have a strong influence on the social behaviour and also have an impact on the effectiveness of learning in the classroom. The second step involved reviewing previously-developed learning environment instruments for scales that could be modified for the PASLEI. The third step was conducting face to face interviews and discussions with experienced science teachers to obtain their opinion. The fourth step was to develop a set of preliminary scales. The scales selected were furniture and equipment, space, lighting, technology, air quality and safety items.

Stage 2 – Writing individual items

Stage 2 involved two steps. Step one involved adapting items used in previously-validated learning environment questionnaires and developing new items for the new scales identified. Step two involved subjecting the entire set of items to validation by a panel of experts. These scales and example of items in the PASLEI are described in Table 1 that follows.

Table 1. *Physical Aspect of Science Laboratory Environment Inventory (PASLEI)*

Scale	Description	Item per scale	Sample Item
Furniture and equipment	Extent to which the furniture and equipment in the science laboratory are suitable.	6	The chairs in the laboratory are comfortable to be used during learning sessions.
Space	Extent to which the learning space in the science laboratory is suitable.	5	There is spacious workspace for the student in the science laboratory.
Technology	Extent to which the science laboratory is supported by technology facilities.	7	Science laboratory is equipped with a functional computer.
Lighting	Extent to which the quality of lighting in the science laboratory is suitable.	5	The intensity of light in the laboratory can be controlled by a separate switch for each row of lights.
Air quality	Extent to which the indoor air quality in the science laboratory is suitable.	5	Exhaust fan present in the laboratory to increase the efficiency of air rate exchange.
Safety item	Extent to which safety items in the science laboratory are available.	8	Science laboratory is equipped with functional fire extinguishers.

Stage 3 – Field testing and analyses

Stage 3 required two steps. Step one included field testing the draft instrument with a large sample of the target population in order to collect sufficient responses to utilize in the statistical analysis. Step two involved factor analysis, aimed at identifying items which removal would enhance the instrument’s factor structure and internal consistency reliability analysis to determine the extent to which items within a scale measure the same construct as other items within that scale.

Field testing: Responses were collected from 800 teachers from one hundred secondary schools in Selangor, Malaysia. All teachers are science teachers who are experienced in the teaching of science in the laboratory. According to Lilia (2009), since Malaysian schools follow the same curriculum and have the same facilities, the teacher respondents in this study may to certain extent reflect the population of Malaysian science teachers as a whole.

Item analysis and factor analysis: Factor analysis is conducted to serve two purposes; firstly, to refine the PASLEI scales; and secondly, to provide evidence regarding the reliability and the validity of the refined scales. Data are analysed using Cronbach's Alpha (α) coefficient to measure internal consistency reliability in terms of the inter-correlations among items. Specifically, this is a measure of the extent to which items within a scale measure the same construct as other items in the same scale. Those items that are not highly correlated with their respective scales are removed and data are reanalysed until all the items with the lowest item-scale correlations are removed and the alpha coefficient is maximized. The analyses of the refined data set provide evidence to support the overall reliability and factorial validity of the refined scales.

FINDINGS

The development of the Physical Aspect of Science Laboratory Environment Inventory (PASLEI) utilizes the intuitive-rational strategy in which only items with high internal consistency remain in the final instrument. It also relies upon the internal strategy (Hase & Goldberg 1967), whereby only those items with high factor loadings on their own scales and low loadings on other scales are kept in the final instrument. This section describes the methods by which PASLEI is refined and its validity and reliability are determined.

a) Validity

Construct validity is investigated, as described below, using principal component factor analysis with Varimax rotation and Kaiser Normalization. The aim of factor analysis is to ascertain the fundamental structure of a comparatively large set of variables (Garson 2001). This method of analysis is consistent with the intuitive-rational method of learning environment instrument development (Fraser 1986) and has recently been used (Dorman 2003) to determine if items load on a priori scale.

In essence, factor analysis provides information about whether items within a given scale are measuring that scale and no other scale. In learning environment research, the value of factor loadings used varies. For example, factor loadings of between 0.30 and 0.35 of items on their a priori scale and no other scales are acceptable in some studies (Dorman & d'Arbon 2001; Johnson & Stevens 2001); while other studies argue that factor loadings below 0.50 are unacceptable (Walker 2003). It appears that a large number of learning environment studies have worked within these two ranges and regarded a factor loading of 0.40 for an item on their a priori scale, with no other scale acceptable (Dorman 2003; Zandvliet & Fraser 2005). In this study, only those items with a factor loading of at least 0.40 on their own scale are kept in the refined instrument.

Prior to factor analysis, Barlett Test of Sphercity, which provides information whether there is a relation between Kaiser-Meyer-Olkin (KMO) coefficient and variables, is applied to test whether the data are suitable for factor analysis. The sample should be of an adequate size, since the size of the sample affects the results of factor analysis. Related literature suggests that KMO should be greater than .60 for factor analysis be applied on the data (Pallant 2001). KMO value of the data of this study is calculated as .91, which falls within the intended range. Besides the result of Barlett Test is significant [Barlet Test =12267.540, df=435, (p<.000)]. The results of KMO and Barlett Test imply that adequate sample size has been provided for the study and factor analysis could be carried out on these data.

Factor identification is the process used to ascertain the number of factors to keep in a survey. There are a few tools available for researchers to help determine the appropriate number of factors to retain. One is the Kaiser criterion, which recommends that researchers select factors with Eigenvalues greater than 1.0. Second is the Scree Test. The Scree Test examines the Scree Plot, which is a plot of the Eigenvalues along an x-y axis. The point at which the curve decreases and straightens out (i.e. the "elbow" of the graph) is the point where researchers should include all factors before and at the elbow. The factor analysis for physical aspects of the learning environment began with 36 items. From the analysis, thirty six items are accumulated under 6 factors that have Eigenvalue greater than 1. Scree Plot (Figure 1) also indicates 6 points before start to straight. Therefore, the scale can be accepted to have a maximum of 6 factors.

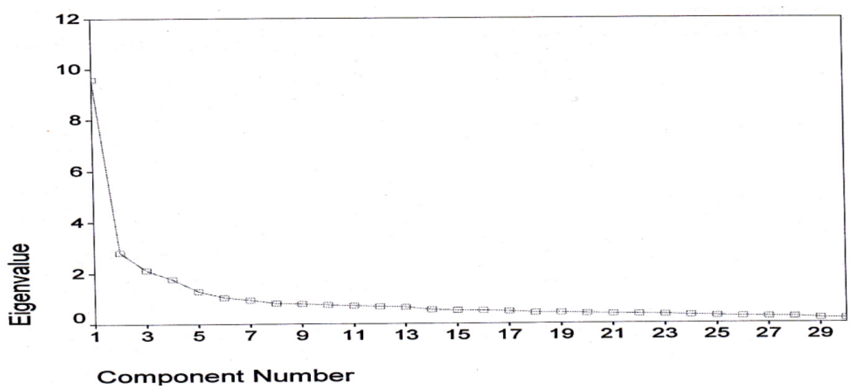

Figure 1. *Factor Selection Using a Scree Plot*

These Six factors explain 62.02 % of the total variance while 34.25% of the variance remains unaccounted. For social sciences, variance rates between 40% and 60% are accepted and adequate (Kutluca et al. 2010). Table 2 shows Eigenvalues and a percentage of variance accounted by each factor in the PASLEI. Six scales were originally developed for the PASLEI field test and, after factor analysis, the same six scales remained: furniture and equipment, space, lighting, technology, air quality and safety items. As in Table 2, these 30 items cluster in six factors with Eigenvalues greater than 1. The first factor explains 31.930% of the total variance, while the second factor explains 9,379% of the total variance. In addition, the third factor explains 7.047% of the variance, the forth factor explains 5.877% of the variance and the fifth factor explains 4.296% of the variance. The last factor explains 3.499% of the total variance. Overall, these six factors explain 62.029% of the total variance.

Table 2. *Eigenvalues and Percentage of Variance Accounted by Each Factor in the PASLEI*

Factors	Eigenvalues	Percentage of Variance explained	Total Percentage of Variance
1	9.579	31.930	31.930
2	2.814	9.379	41.309
3	2.114	7.047	48.357
4	1.763	5.877	54.234
5	1.289	4.296	58.529
6	1.050	3.499	62.029

In the factor analysis, the items with load factor greater than 0.40 are retained; so six items (load factor less than 0.4) which are items 5, 15, 19, 25, 29 and 33 have been removed. Finally, the scale ends up with 30 items. Table 3 illustrates items of each factor and their factor loads.

Table 3. *Factor Loadings for a Refined 30-İtem Version of the PASLEI*

	Factor loading					
	Technology	Space	Safety items	Air quality	Lighting	Furniture & equipment
16c	.858					
16b	.848					
16a	.817					
17	.617					
18	.609					
20	.509					
8		.802				
9		.761				
7		.715				
6		.651				
10		.557				
26			.749			
32			.700			
27			.672			
31			.668			
30			.617			
33			.603			
28			.586			
22				.802		
24				.753		
23				.654		
21				.643		
13					.672	
12					.650	
14					.595	
11					.577	
2						.766
1						.747
3						.504
4						.450

The first factor, Technology scale has 6 items (16c, 16b, 16a, 17, 18 and 20) and the load values of these items vary between 0.51 and 0.86. The second factor, Space scale has 5 items (6, 7, 8, 9 and 10) and the load values vary between 0.56 and 0.80. The third factor, Safety Aspect scale has 7 items (26, 27, 28, 30, 31, 32 and 34) and the load values vary between 0.59 and 0.75. The fourth factor, Indoor Air Quality scale has 4 items (22, 24, 23 and 21) and the load values vary between 0.63 and 0.80. The fifth factor, Lighting scale has 4 items (13, 12, 14 and 11) and the load values vary between 0.60 and 0.67. Finally the last factor, Furniture and Equipment scale has 4 items (1, 2, 3 and 4) and the load values vary between 0.45 and 0.77.

b) Reliability

In the development of the PASLEI, each scale is assessed for internal consistency using Cronbach's Alpha coefficient. Table 4 presents the reliability for each refined PASLEI scale for the sample of 800 teachers. The internal consistency reliability (coefficient alpha) ranges between 0.76 and 0.87 for the six PASLEI scales. In detail, the Cronbach's Alpha is 0.79 for Furniture and Equipment, 0.87 for Space, 0.76 for Lighting, 0.87 for Technology, 0.80 for Air Quality and 0.79 for Safety Items.

Table 4. *Scale Reliability Using Cronbach's Alpha Coefficient for PASLEI*

Scales	Number of Items	Reliability Coefficient
Furniture and Equipment	4	0.79
Space	5	0.87
Lighting	4	0.76
Technology	6	0.87
Air Quality	4	0.80
Safety Item	7	0.79

N=800

Using a generally applied 'rule-of-thumb' this range is considered acceptable to good (George & Mallery 2001), since the closer the alpha is to 1, the greater the internal consistency of the items. The alpha for the scales of space (0.87), technology (0.87), air quality (0.80) and furniture are considered good while the scale of equipment (0.79), lighting (0.76) and safety items (0.79) are deemed acceptable. Table 5 presents the final instruments which consist of six constructs and 30 items.

Table 5. *Physical Aspect of Science Laboratory Environment Inventory (PASLEI)*

Item no.	Items
	Furniture and equipment
1.	The layout of the furniture in the science laboratory can promote active learning of science.
2.	The design of the tables in the science lab is compatible with its role as a place of science learning.
3.	The chairs available in the science lab are comfortable to use while learning science.
4.	The science laboratory is equipped with adequate learning tools.
	Learning space
5.	The space and size of the laboratory is in line with the needs of the teaching and learning of science.
6.	The number of students in a science lab is not more than 30.
7.	There is spacious work space for each student in the science lab.
8.	The space between tables in the science lab allows students to move easily and safely.
9.	My science lab has enough space to display and store the equipment for learning of science.
	Lighting
10.	The intensity of light in the lab can illuminate the science lab across the room.
11.	The lighting in the science lab can be adjusted according to the needs of various learning activities such as teaching of science, hands-on activities, presentations, the use of technologies, etc.
12.	The intensity of light in the laboratory can be controlled by a separate switch for each row of lights.
13.	The science laboratory can be darkened when the lesson calls for it.

Table 5. ***Continued…***

	Technology
14.	My science laboratory is equipped with Information and Communication Technologies instruments such as, 14a. A functioning computer, 14b. A functioning LCD, 14c. Functioning hardware and software to assist the teaching and learning of science.
15.	The layout of the ICT equipment is suitable and effectively aids in its usage in the learning of science.
16.	The ICT equipment in the science lab is always in a good condition.
17.	There are a sufficient number of computers in the science lab.
	Indoor air quality
18.	The science lab has a suitable temperature to allow the learning process take place comfortably.
19.	The temperature in the science lab can be modified according to my needs and the learning activities.
20.	The science laboratory has an adequate number of working fans to ensure a good airflow in the lab.
21.	The science laboratory has an exhaust fan installed to increase the efficiency of airflow.
	Safety
22.	The science laboratory is equipped with a first-aid kit that is filled with medical devices that can be used in case of an emergency.
23.	The first-aid kit displayed in the science lab can be clearly seen by students.
24.	The science laboratory is equipped with a well-functioning fire extinguisher.
25.	The science lab has two doors that function properly.
26.	The science laboratory is equipped with an emergency route plan that can be used in case of an emergency.
27.	The science laboratory has sufficient safety equipment (such as goggles and lab coats) to be used by students during experiments.
28.	There is a functioning emergency shower in the lab.

DISCUSSION

This study is aimed at developing a reliable and valid scale to measure the physical aspects of the science laboratory environment. The draft scale has 36 items and is applied to 800 science teachers in secondary schools. As a result of analysis, 6 items are excluded from the scale and 30 items are retained. These items are placed under Furniture and Equipment, Space, Lighting, Technology, Air quality and Safety aspects.

Based on the analysis conducted, the instrument PASLEI is found to have a high reliability and also a good construct validity which could be used in the study of the physical learning environment of the science laboratory. This instrument also has its own uniqueness as it contains the physical aspects of the learning environment that might affect student learning. These physical aspects are chosen based on the results of previous studies and are also based on interviews with experienced science teachers. In addition, this instrument includes the safety aspects of the physical science laboratory environment which is important because it helps to avoid the risk of injury by creating a safe learning environment. Safety aspects are essential especially when carrying out practical activities and have the added benefit of encouraging students to undertake practical activities effectively.

The PASLEI also has the advantage of being easily administered and answered by the respondents; it consists of six scales with a total of thirty items. This number is appropriate and does not burden the respondents. In addition, it is user-friendly; the grammar and words used in PASLEI are simple and easy to understand. It is also very economical to use in terms of time and cost efficiency. According to Lewthwaite et al. (2007), because of the time constraints imposed on teachers, it is essential to ensure that the instrument requires only a relatively short time to complete and process.

Although in this study PASLEI instrument is built to determine the suitability of the physical environment in the aspects of furniture, space, lighting, technology, air quality and safety of the science laboratory, it could also be used and adapted for assessing other spaces of learning environment such as the classroom or workshop. It all depends on the creativity of the researchers. Furthermore, it is suitable for use by different respondents. For example, students because the items developed are not specific for teachers only.

PASLEI is an addition to existing instruments, particularly for evaluating facilities in the science laboratory learning environment. The development of PASLEI takes into account the constructivist view and tries to incorporate all the factors that contribute to the conducive learning environment that emphasizes on the knowledge construction, interaction and collaboration among students.

The PASLEI also could be adapted and used for various kinds of respondents and for different environments depending on the needs and creativity of researchers. However, care needs to be taken in its construction and verification, since its inception it was designed for the science laboratory environment and envisaged that only science teachers should be the respondents.

CONCLUSION

This paper has reported the development and validation of an instrument designed to assess the physical aspects of the learning environment in the science laboratory. It is developed within the tradition of using inhabitants' perceptual data to define the learning environment which has been the overwhelming approach to national and international research for the past 30 years. The development of PASLEI is an addition to the learning environment instrument. The findings of this study confirmed the validity and reliability of the Physical Aspect of Science Laboratory Environment Inventory showing that it is a useful instrument for its evaluation. However, an extensive research is needed to further refine this instrument by involving different characteristics of respondents to establish more valid and reliable measures of physical learning environment in the science laboratory.

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