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Space configuration and learning comfort; a case study of Federal University of Technology Minna lecture halls

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Abstract

This research pursuit the objectives of testing and measuring the level of indoor environmental quality in the lecture theatres across the university; analysing the challenges of the learning component that affects the learning process and appraise the learning space configuration that best suits the learning process of the students in various lecture halls. This research employed empirical research method involving questionnaires and scientific measurement of the acoustic level, thermal comfort level, lighting and particulate matter 2.5, 1.0 and 10. The research results show that the various learning spaces have good orientation and are adequately ventilated. The thermal comfort of most of the lecture halls reduces in the afternoon. The furniture arrangement within the lecture spaces reduced the level of interaction amongst the students and between lecturers and students. Therefore, this paper recommends effective artificial cooling must be introduced in the afternoon and the ergonomics within the lecture halls must be made flexible.

Keywords: Space configuration; Technology; Minna

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1. Introduction

Comfort is one very important search that man strives for daily and desire to create in every part of his life and the indoor environment of the home, workplace, recreation and healthcare environment. Human health is foremost when it comes to evaluating the overall comfort of the environment. In a situation where the built environment is leading to negative impact on occupant health, then it becomes alarming and could point to some design or technical flaw in the building system. ASHRAE guidelines stated that occupants spend about 80%–90% of their time indoors and studies have indicated that a range of comfort and health-related effects are linked to characteristics of the building (Akadiri, Chinyio & Olomolaiye, 2012; Arif, Katafygiotou, Mazroei, Kaushik & Elsarrag, 2016; ASHRAE, 2010).

There are studies to suggest that a few symptoms of discomfort from indoor environment lead to significant reduction in work performance of occupants (EPA, 2000). New building regulations/ legislation and green building guidelines have highlighted the past idea of sustainability that often ignored psychological, cultural and sociological dimensions (ASHRAE, 2004). Research has clearly established that problems with indoor environmental quality (IEQ) (thermal, acoustic, visual and air quality) of a building has a direct effect on the comfort, health and productivity of the occupants (De Giuli, Da Pos & De Carli, 2012).

The environmental performance of a building does not only depend on the physical factors but also on the interface that exists between the physical environment and the occupants. The essential requirement of a building is to ensure that the building meets not only the required standards for an indoor environment but also occupants' needs and satisfaction. In whatever situation people find them, they are surrounded by an environment; as a result, maintaining health and comfort is a great challenge (Parsons, 2013). When designing an environment for people, the physical environment and peoples' response must be taken into account (De Giuli, Zecchin, Salmaso, Corain & De Carli, 2013). This response by the people is what would determine comfort, wellbeing, satisfaction or dissatisfaction with the indoor environment and this also applies for all forms of buildings and the learning environment for students is not an exception.

Indoor environmental factors significantly affect the energy consumption of a building and, therefore, their evaluation and quantification during the design process have been widely debated in various spheres of environmental design and implementation (Santamouris, Mihalakakou, Patargias, Gaitani, Sfakianaki, Papaglastra, et al., 2007; Theodosiou & Ordoumpozanis, 2008). Several studies have been conducted to evaluate students' performance and the intricate factors that influence the learning outcomes of students, these factors include among others: orientation of the building, fenestration and the IEQ of the classrooms (Bako-Biro, Clements-Croome, Kochhar, Awbi & Williams, 2012; Daisey, Angell & Apte, 2003).

The environmental conditions inside classrooms, which are determined by factors such as the effect of temperature and indoor air quality (IAQ), play a significant role in influencing students' health, attitude and performance within the lecture space. It is, therefore, a common knowledge that most of the classrooms in the schools in most developing and underdeveloped countries have poor IEQ and the Nigerian scenario is not an exception (Daisey et al., 2003; Higgins, Hall, Wall, Woolner & McCaughey, 2005; Michelot, Marchand, Ramalho, Delmas & Carrega, 2013). However, in spite of the growing assemblage of IEQ studies, the impact of IEQ on student learning performance in classrooms has not been given any serious attention (Frontczak & Wargocki, 2011; Lee, Mui, Wong, Chan, Lee & Cheung, 2012; Wong & Jan, 2003).

In view of the aforesaid, improved air-conditioning systems and recommended energy-saving strategies for ventilated classrooms due to the complex interaction among indoor environmental parameters have been encountered in the various institutions, a more concrete guidance on environmental performance for schools is still a major necessity for improved learning and enhanced educational outcomes which inculcate the knowledge of proper ventilation and good space/

anthropometric measurement for effective learning space (Chang, Li, Tsai & Yang, 2009, Mumovic, Palmer, Davies, Orme, Ridley, Oreszczyn, et al., 2009).

Anthropometric measurements have been adjudged as an integral factor that should be taken into account in school furniture design. Specific measurements, such as popliteal height, knee height, buttock–popliteal length and elbow height are necessary in order to determine school furniture dimensions that enable the accurate sitting posture (Knight and Noyes, 1999; Miller, 2000; Parcells, Stommel & Hubbard, 1999). Anthropometric measurements whenever it is considered for designing help students to achieve the required level of comfortability (Adu, Adu, Effah, Frimpong-Mensah & Darkwa, 2014); reduce musculoskeletal disorders (Salunke & Kallurkar, 2015; Sepehri, Habibi & Shakerian, 2013, Shin, Kim, Hallbeck, Haight & Jung, 2008) and improve performance of students in terms of attentiveness while been instructed (Mokdad & Al-Ansari, 2009; Musa, 2011).

The basic philosophy of ergonomics is to make any design of furniture which leads to comfortability, physical health, safety (Dawal, Ismail, Yusuf, Abdul-Rashid, Shalahim, Abdullah, et al., 2015), well-being, convenient and bring motive towards studies (Tunay & Melemez, 2008). Students require well-designed furniture because any awkward posture confinement while performing educational tasks such as writing lectures, drawing, reading on desktops and others often aggravates psychological stress and can impose ill effects on students' performance (Adu, Adu, Frimpong-Mensah & Darkwa, 2015). Few researchers suggest that anthropometric measurements need to be used during designing activities of furniture as the use of poorly designed furniture can result in poor learning outcomes and even ill health for the students (Khanam, Reddy & Mrunalini, 2006; Mehrparvar, Mirmohammadi, Hafezi, Mostaghaci & Davari, 2015; Qutubuddin, Hebbala & Kumarb, 2013; Shin et al., 2008).

Classroom size (dimensions, area and volume) is an important factor that can influence the students' perception of crowding and adequacy. Layout includes the shape, configuration of walls, floor and ceiling. As per Schneider (2002), school design, layout and spatial configuration have an impact on learning. Lei (2010) states that classroom layout affects the learning outcomes. Furniture includes type, design, postural comfort and ergonomics. Classroom furniture has a crucial role in meeting the varying pedagogical requirements and learning styles (Choi, Guerin, Kim, Brigham & Bauer, 2014). Flexible furniture that can be configured to the demands of varying teaching mode plays a significant role in learning (Brown & Lippincott, 2003).

In the context of learning environments, there are limited studies that have investigated the relations between spatial environment and student performance. Plan-form and size of classroom facilitate students' interaction and support learning activities (Roskos & Neuman, 2011; Veltri, Banning & Davies, 2006). It is, therefore, in the light of the foregoing that this research tends to scientifically measure the various indoor environmental components that contribute to the quality of the indoor environment; comparatively analyse the level of IEQ of lecture halls; and investigate the perception of students with respect to the impact of IEQ and space configuration of lecture theatres on the learning outcomes of students in Federal University of Technology, Minna, Nigeria.

2. Materials and methods

This research was conducted employing the use of primary data which was obtained using the instrumentality of questionnaire to obtain responses from students who have utilised the various lecturer theatres for at least 2 years; which, invariably eliminates the new students who do not have adequate knowledge of the operations of the lecture theatres that are under investigation. Furthermore, these responses of students were further strengthened by using various scientific instruments for measuring the IAQ, indoor temperature, humidity, sound level metre, light intensity range metre and particulate matter (2.5, 1.0 and 10).

For the purpose of the questionnaire administration, 250 student users of the five identified lecture theatres were purposively identified and the questionnaires relating to the comfort level of the lecture theatres, ventilation level, acoustic efficiency around the halls, furniture arrangement, thermal comfort and other indoor elements that contribute to promoting a good learning environment were asked in the prepared questionnaire which is made closed-ended and elicits certain degree of responses by the students. A total of 250 students using the lecture theatres were identified and sampled and their responses checked against the various changes noticed in the scientific measurement of the various factors of IEQ identified.

The measurements carried out using the various measuring instruments such as the Geardon Air Quality Detector, MK09 Sound Level Metre and Digital Lux Metre were operated between 8 AM and 6 PM which are the time period of the day when most of the lecture theatres are in active use for lecture purpose. These form a total operational time of 12 hours of the day. These operational times were divided into an interval of 2 hours for every measurement and therefore, a total of six different readings at an interval of 2 hours were carried out in each of the lecture halls in the day.

The scientific measurement of the various impurities that reduce IEQ was carried out between 15th December 2017 and 15th March 2018, a period of 3 months within which the various theatres were in active use. The readings taken per day within the working days of Monday to Friday were of the 3-month period and a 2-hour daily interval was taken per day. The mean value of the measurement per day was recorded and presented in tables.

3. Results and discussions

3.1. Level of indoor environmental quality in the lecture theatres across the university

These research studies identified various lecture theatres and the condition of the IEQ in the Federal University of Technology, Minna, Niger State, Nigeria. Five lecture theatres were identified in three schools with capacity of the lecture theatres ranging from 250 to 500 seating capacity. The lecture theatres as identified include the Engineering lecture theatre (500 sitting capacity); Agric Lecture theatre (250 sitting capacity); Caverton Lecture theatre (500 sitting capacity) and Environmental lecture theatres A and B (250 sitting capacities each). A total of 250 students were purposively sampled and their responses presented in Tables. Basically, in view of the various measurements taken using the instruments and the available technology, the identified IEQ factors considered responsible for either poor or good IEQ and comfort in the lecture spaces are the particulate matters, formaldehyde (HCHO), total volatile compound, temperature, humidity, acoustic and sound level and the light intensity.

The scientific test for the various factors of the IEQ of the identified lecture theatres is presented in Table 1. The analysis shown on the table indicated that the particulate matter PMT 2.5 was observed to increase from 22 to 24 between 12 noon and 2 PM, peaking at 28 between 2:01 and 6 PM. Other particulate matters (PMT 1.0 and 10) were also observed to steadily increase as the hours of the day wanes towards the evening for the Engineering lecture theatre. Also, noticeable in the Engineering lecture theatre is the presence of HCHO which the presence of its particles ranges between 0.170 and 0.179 within the day. The relative humidity of the engineering lecture theatre was also observed to increase as the temperature of the hall increases, with the highest temperature at 89.8° F and humidity highest at 68% both occurring between 4.01 and 6 PM.

The analysis also shows measurements from environmental lecture theatre A situated in the school of Environmental Technology of the University. The analysis shows that; this lecture theatre has a very high level of PMT 2.5, as shown in Table 1. This analysis shows that between 12 and 2 PM within the 3-month period evaluated, the mean average PMT for this lecture theatre is at 48. For other particulate matters (PMT 1.0 and 10), it is also noticed that within the period of the research measurement, these indoor air pollutants were highest at 39 and 58, respectively. The HCHO level within these periods was also averaged 0.214 between 10:00 and 12 noon as the mean average for the 3-month period of the measurement. The temperature, humidity, sound level and light level were also measured at highest of 86.9°F, 58%, 78.2 db and 23.2 fc, respectively.

The analysis also shows measurements from environmental lecture theatre B situated in the school of Environmental Technology of the University. The analysis shows that; this lecture theatre has a very high level of PMT 2.5, as shown in Table 1. This analysis shows that between 4 and 6 PM within the 3-month period evaluated, the mean average PMT for this lecture theatre is at 32. For other particulate matters (PMT 1.0 and 10), it is also noticed that within the period of the research measurement, these indoor air pollutants were highest at 27 and 38, respectively. The HCHO level within these periods was also averaged 0.151 between 4 and 6 PM as the mean average for the 3-month period of the measurement. The temperature, humidity, sound level and light level were also measured at highest of 88.2°F, 58%, 71.2 db and 16.18 fc, respectively.

Basically, the test and measurement result for impurities and other indoor pollutants for Agric. Lecture and Caverton lecture theatres are also shown in Table 1.

Table 1. Measured variables of indoor environment quality

Period	PMT 2.5	PMT 1.0	PMT 10	HCHO	TVOC	Temp. (°F)	Humidity (%)	Sound Level (db)	Light Level (fc)
					Engineering Hall				
8:00–10:00 AM	22	20	20	0.176	0.081	75.6	56	60.8	22.2
10:01–12:00 AM	22	20	20	0.171	0.087	75.8	57	61.8	21.3
12:01–2:00 PM	24	20	31	0.170	0.080	78.6	66	65.8	21.2
2:01–4:00 PM	28	21	31	0.177	0.089	88.7	67	65.0	21.6
4:01–6:00 PM	28	22	31	0.178	0.090	89.8	68	65.2	23.6
					Environmental LTA				
8:00–10:00 AM	40	36	50	0.213	0.114	76.8	48	78.2	20.1
10:00–12:00 AM	42	33	49	0.214	0.113	76.5	46	77.2	23.2
12:00–2:00 PM	48	38	57	0.126	0.116	84.9	58	76.1	19.28
2:00–4:00 PM	47	39	58	0.136	0.117	85.8	58	78.2	18.88
4:00–6:00 PM	46	33	50	0.132	0.118	86.9	48	78.2	20.02
					Environmental LTB				
8:00–10:00 AM	26	19	30	0.121	0.112	76.2	48	70.4	14.12
10:00–12:00 AM	28	18	32	0.122	0.122	75.4	44	71.3	14.38
12:00–2:00 PM	28	23	35	0.143	0.127	84.9	57	68.9	15.11
2:00–4:00 PM	29	26	36	0.144	0.131	88.2	58	62.5	15.44
4:00–6:00 PM	32	27	38	0.151	0.132	87.3	58	61.4	16.18
					Agric Lecture Hall				
8:00–10:00 AM	22	21	28	0.141	0.160	83.4	46	48.4	41.9
10:00–12:00 AM	22	23	28	0.142	0.161	83.1	48	50.4	41.6
12:00–2:00 PM	24	20	31	0.147	0.175	82.8	59	54.6	43.0
2:00–4:00 PM	24	21	33	0.148	0.181	82.9	60	51.6	44.2
4:00–6:00 PM	26	24	34	0.144	0.182	84.4	62	54.1	46.7
					Caverton Hall				
8:00–10:00 AM	23	20	24	0.164	0.081	76.1	46	58.1	48.9
10:00–12:00 AM	21	20	26	0.165	0.082	78.9	48	56.3	50.1
12:00–2:00 PM	25	20	31	0.157	0.084	81.9	58	66.7	58.9
2:00–4:00 PM	26	21	28	0.168	0.085	83.6	59	60.8	59.1
4:00–6:00 PM	28	22	28	0.161	0.088	87.4	58	68.4	60.2

Source: Alfa et al., (2018)

3.2. Comparative analysis of IEQ level for various lecture theatres

On a comparative note, the analysis also revealed that Caverton lecture theatre has the lowest mean level of PMT 2.5 (21) amongst all the lecture theatres evaluated, while, environmental lecture theatre A has the mean highest PMT 2.5 of 48. Others have mean ranges of this particulate matter ranging between highest of 28 and 32. This analysis also infers that; the environmental lecture theatre A is the most dangerous in terms of PMT 2.5 on a comparative note to the other four lecture halls. The research also revealed that the mean temperature ranges for all the lecture theatres almost present a uniform order though relatively high for the comfort of students in the afternoon periods for proper student comprehension. Other comparative measurements are, therefore, presented in Table 1 for other indoor air pollutants such as HCHO, PMT 1.0, 2.5 and 10; temperature, humidity, sound and light intensity.

3.3. Students perception of the indoor environment quality and space challenges

In view of the importance of an effective and conducive indoor environment for learning and comprehension of students in any learning environment, the research further evaluated the perception of the student users of the identified lecture halls.

This analysis is presented in Table 2. The analysis of the perception of the student users of the lecture theatres being evaluated showed that the age range of the students sampled ranges between 16 and above 25 years of age. The research revealed that 48% of the sampled students have an age range between 16 and 20 years, 30% of the students were between the age range of 21 and 24 years, while, those between the age range above 25 years were 22% of the total sampled students. The gender of the students researched was also investigated. The research revealed that though the students sampled were even across the various lecture halls, the gender ranges between the male and female gender.

Thermal comfort as an integral factor of the IEQ evaluation was also investigated from the perception of the student users, this served as a check for the scientific measurement carried out. The perception of the students in the five lecture theatres evaluated shows that 12% of the sampled students were very satisfied with the thermal condition of the lecture theatres, 18% said they were not satisfied with the thermal condition of the lecture halls, 12% said they were merely satisfied, 34% said they were not satisfied with the thermal condition of the lecture hall, while, 24% said they were very unsatisfied with the thermal condition of the lecture theatres. This analysis with reference to the temperature measurement carried out at various time intervals of the research (Table 1) revealed that the increase in temperature as the day wears on, the thermal comfort of the lecture theatres evaluated tend to decrease. This shows that thermal comfort is a function of ventilation and it decreases as the temperature of the surrounding environment increases.

The sound level of the various lecture theatres evaluated was also appraised in this research. It shows that 22% of the sampled students were very satisfied with the acoustic level of the sampled lecture theatres, 18% of the sampled students said they are satisfied with the acoustic components and level of the lecture theatres, 14% of the sampled students were observed to be merely satisfied with the condition of acoustics, 24% of the sampled students were unsatisfied with the acoustic conditions of the selected lecture theatres in the university, while, 22% said they are very unsatisfied with the acoustic level of the sampled lecture theatres. This on a comparative note with the measurements carried out as shown in Table 1, the analysis shows that the acoustic level of the sampled lecture theatres with respect to sound level and effects was within the acceptable level for learning.

The level of lighting of the sampled lecture theatres was also evaluated as this affects the learning and visualisation of the students learning the process. The analysis shows that 28% of the sampled students opined that the lecture theatres have effective lighting system, 22% said the said they are satisfied with the lighting condition of the halls, 16% of the sampled student also said they are merely satisfied with the condition of the lighting system of the lecture theatres. However, this analysis shows that majority of the sampled students perceived the lighting system to be satisfactory and acceptable, as shown in Table 2.

Table 2. Students' perception of space efficiency and IEQ impact on effective teaching and learning

		Personal Information			
		Age			
Location	**16–20 (years)**		**21–24 years**		**Above 25**
Engineering LT	25		10		15
Environmental LTA	20		15		15
Environmental LTA	25		20		5
Caverton LT	30		10		10
Agric LT	20		20		10
Total	120 (48%)		75 (30%)		55 (22%)
		Gender of Respondents			
	Engineering LT	Environmental LTA	Environmental LTB	Caverton LT	Agric LT
Male	30	35	15	30	20
Female	20	15	35	20	30
Total	50 (20%)	50 (20%)	50 (20%)	50 (20%)	50 (20%)
		Thermal Comfort for the Student Users of Lecture Theatres			
	Very Satisfied	Satısfied	Merely Satisfied	Unsatisfied	Very Unsatisfied
Engineering LT	-	10	5	20	15
Environmental LTA	5	10	10	20	10
Environmental LTA	10	10	5	15	5
Caverton LT	10	10	5	10	15
Agric LT	5	5	5	20	15
Total	30 (12%)	45 (18%)	30 (12%)	85 (34%)	60 (24%)
		Acoustıc Qualıty			
Engineering LT	10	5	5	10	20
Environmental LTA	5	10	10	15	15
Environmental LTA	10	10	5	20	15
Caverton LT	20	15	5	10	-
Agric LT	10	5	10	15	5
Total	55 (22%)	45 (18%)	35 (14%)	60 (24%)	55 (22%)
		Lighting Quality			
Engineering LT	20	10	5	5	10
Environmental LTA	10	15	15	10	-
Environmental LTA	15	10	10	10	5
Caverton LT	15	10	10	15	-
Agric LT	10	10	5	15	15
Total	70 (28%)	55 (22%)	40 (16%)	55 (22%)	30 (12%)

Source: Alfa et al., (2018)

3.4. Assessment of space composition and impacts on the effective student learning

The impact of the space composition on effective student learning was evaluated in this section. This was based on the perception of student users of the lecture theatres assessed within the university campus. These analyses are presented in Table 3. Reviewing the environmental quality factors of this research from the viewpoint of the student users of the lecture theatres, it is observable that majority of these students are not satisfied with the environmental quality of the various lecture theatres, also on a comparative note with the measurements taken on the various variables that constitute factors in IEQ evaluation, it is noticeable that, as temperature increases in the surrounding areas of the lecture theatres, this affects the indoor air, thereby reducing the quality of the indoor environment.

The space composition of the evaluated lecture theatres shows that all the lecture theatres have hard surface furniture and desk lining in rows with little space and with less consideration for comfort as is observed from the responses of the evaluated students of the institution. From the analysis presented in Table 3, it is apparent that the space composition of the various lecture theatres is not satisfactory as is observed from the cumulative responses of the student users of the lecture halls; as a total of 44% of the sampled students were observed to be unsatisfied with the condition and space composition of the lecture theatres, while, another 20% were observed to be merely satisfied with the space composition of the lecture spaces. The analysis indicated that only 36% of the sampled students were satisfied with the space composition of the lecture hall. In view of the aforesaid, judging from the level of dissatisfaction of the students to the space composition of the lecture theatres, it is worthy of note that this poor space composition has a direct impact on the learning outcomes of the students in the institution as their dissatisfaction with the environment where the learning is taking place can directly impact negatively with their learning and understanding in the various lecture spaces.

From the physical observations carried out, the research found out that all the lecture theatres selected and evaluated have fixed furniture and oriented towards a fixed direction. This rigid and inflexible arrangement of furniture components of the lecture spaces sampled is a major negative factor in the students learning and comfort in the learning environment. Majority of the sampled students (72%) were observed to be unsatisfied with space and furniture arrangement of the lecture spaces in the sampled lecture theatres and from the perception of the sampled students. This situation inferred that the poor space configuration and poor furniture arrangement are a major precursor to student's poor performance as can be inferred from the reactions of the students using the various lecture halls and spaces evaluated.

Another important factor evaluated in this research is the space comfort and learning outcomes from the perception of the student users of the selected lecture spaces, it can be inferred from the responses of the various students sampled that; a cumulative of 62% of the students sampled were dissatisfied with the space composition and learning outcomes as a result of the poor state of the space and poor composition of the lecture halls. It therefore means that, the poor space configuration and poor comfort level as is observed from the responses of the students and the measurements of the various key elements of the IEQ and comfort in the lecture halls (Tables 1 and 3), it can be concluded that, the poor student performance in the lecture spaces can be directly linked to the poor and inefficient space comfort, space configuration and arrangement.

Table 3. Assessment of students perception on space configuration and composition

			Air Qualıty		
Location	**Very Satisfied**	**Satisfied**	**Merely Satisfied**	**Unsatisfied**	**Very Unsatisfied**
Engineering LT	10	15	10	10	5
Environmental LTA	-	10	5	15	15
Environmental LTA	10	5	15	15	10
Caverton LT	10	10	10	15	5
Agric LT	5	15	5	15	10
Total	35 (14%)	55 (22%)	45 (18%)	70 (28%)	45 (18%)
			Space Composition		
	Very Satisfied	Satisfied	Merely Satisfied	Unsatisfied	Very Unsatisfied
Engineering LT	10	5	10	10	15
Environmental LTA	15	-	10	10	15

Environmental LTA	10	10	15	10	5
Caverton LT	10	10	10	10	10
Agric LT	5	15	5	10	15
Total	50 (20%)	40 (16%)	50 (20%)	50 (20%)	60 (24%)
	Space and Furniture Arrangement				
	Very Satisfied	Satisfied	Merely Satisfied	Unsatisfied	Very Unsatisfied
Engineering LT	5	10	5	15	15
Environmental LTA	5	5	10	15	15
Environmental LTA	5	5	5	15	20
Caverton LT	10	5	5	10	20
Agric LT	10	10	10	5	15
Total	35 (14%)	35 (14%)	35 (14%)	60 (24%)	85 (34%)
	Space Comfort and Learning Outcomes				
	Very Satisfied	Satisfied	Merely Satisfied	Unsatisfied	Very Unsatisfied
Engineering LT	10	5	15	15	5
Environmental LTA	5	5	15	15	10
Environmental LTA	5	5	5	15	20
Caverton LT	5	10	5	10	20
Agric LT	10	10	15	5	10
Total	35 (14%)	35 (14%)	55 (22%)	60 (14%)	65 (26%)

Source: Alfa et al., (2018)

4. Conclusion and recommendations

Learning as an important factor in the human evolution and development process as is observed from the analysis above, is not just dependent on the expertise of the lecturer and his communication skills, but it lies seriously also on the healthiness of the learning environment and the comfort provided in the space apportioned for this learning. This research has also revealed that; learning outcomes also depend on the attractiveness or repulsiveness of the provided space. It is on the strength of the foregoing that the following recommendations were advanced in order to bridge the space inefficiency gap in the learning spaces provided for the student in the selected lecture halls in the Federal University of Technology, Minna, Niger State, Nigeria.

The research was able to establish that the rigid nature of the various components such as furniture, podium and all other learning enhancement has not in any way improved learning of students within the various lecture halls. It is on this note that we recommend a flexible space composition, such that the furniture can be oriented in diverse ways to suit the conditions and time demands of the students within the lecture theatres.

Creativity in space composition is also a very important factor that students appreciate in the learning space, this research, therefore, recommends a creative arrangement of the various components of the lecture spaces in order to promote interactive learning and teaching process which is a very significant factor in the education of every individual.

In view of the challenges of a rise in daily temperature and rise in temperature at different times of the day, artificial cooling is hereby recommended since the university campus can at least boast of steady power supply. Therefore, providing air conditioners of industrial capacities will help to cool down the indoor temperature of the lecture halls and improve the comfort level for the student users in the afternoon times of the day. This is especially important in the period between 1:00 and 4:00 PM as is observed across the various halls sampled.

Furthermore, an improved lighting system is also required as the current lighting situations in the various halls and their maintenance are not effectively managed. This is important as most of the lecture halls become dark and not well lit at the evening times of the day. Finally, the acoustic enhancement of the halls also requires serious overhaul. This is so because, beyond the front rows, most of the students do not hear what the lecturer in front is explaining. It is, therefore, important to improve the acoustic makeup of the halls which will help amplify the voice of the lecturers for effective communication.

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