

# **Assessment and Impact of Technology-Based Self-Directed Learning of Anatomy Among Clinical and Anatomy Students in Two Universities**

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## **ABSTRACT**

Global lockdown occasioned by COVID-19 pandemic showed that students in Nigeria ought to have continued learning at home if digital technologies were adequately deployed. Impact of technology-based self-directed learning of anatomy on academic performance was evaluated in a 10-month longitudinal cross-sectional study among 268 volunteer preclinical and anatomy students of two universities in South East Nigeria. Validated electronic questionnaire was used to extract information on students' demographics, knowledge, perceptions and use of technology-based self-directed learning of anatomy, as well as their average performance in most recent anatomy examinations. Anatomy and preclinical students' ratio were 41.8:58.2 but females and age-group of 21-25 years contributed 63.1 and 52.2% of the participants, respectively. About 69.4% of the students used smart phones, 46.3% downloaded one or no anatomy software while 49.6% experienced 5-9 hours daily phone-screen-time. Significant association was found between knowledge of technology-based self-directed learning and performance in anatomy courses ( $\chi^2=8.239$ ;  $p=0.044$ ). Respective 5.2%, 28.7%, 61.2%, and 4.9% of the students never, rarely, sometimes, and often used technology-based self-directed learning of anatomy. Students with good knowledge of technology-based self-directed learning (Adjusted OR = 1.049,  $p=0.007$ ) are 1.05 times more likely to progress from lower to higher performance level when use and perception of technology-based self-directed learning are constant. Faculties should develop anatomy software, as well as provide computerized classrooms and laboratories for enhanced technology-based self-directed learning of anatomy.

**Keywords:** Anatomy education, technology-based, self-directed learning, Nigeria

## INTRODUCTION

### Background to the Study

Student-directed learning (SDL) is a self-paced learning approach where the learner is responsible for his/her own progresses in education, and it is often augmented with technologies [1]. The self-directed learner's readiness and motivation to use web-based technologies and technology-based applications is paramount [2]. Students in developed countries continued learning anatomy at home using technologies [3]. The SDL involving social networks, learning management systems, and computer-assisted learning and assessment are now leading trends in the evolution of anatomy education [4, 5] as well as using Quick-time virtual reality objects in computer assisted instruction of gross anatomy [6].

Social media has become an important integral part of the society where people network and exchange information in split seconds [7]; and undergraduates are its highest users [8]. In medical schools, social media serve as the platform for students to hold academic discussions and ask questions to tutors [7]. Some of the social media platforms such as Facebook [9], Twitter, YouTube [10], Linked-in, Whats App and Telegram are inexpensive tools that are freely accessed for participation in anatomy discussion [11, 12] but the major drawback is the associated distraction during the course of online learning [13].

With mobile technologies (smart phones, tablets and laptops) connectable to the internet [14], knowledge outside of the classroom is readily available and this provides a self-directed learning environment that gives the students the opportunity to study and practice [1, 2,15,16]. Nearly all students now have mobile phones with which they can watch videos, play educational games and access social media [16]. Videos such as that of Netter 3D anatomy software equip students with chances to prepare for practical classes, enhance their confidence, help them to familiarize with anatomical structures and serve as revision aids [17, 18]. Provision of these instructional videos to students may reduce the enormous load that teaching staff encounter [18].

Screen-cast which is a video representation of a computer screen activity can enable students view drawing process, replicate such drawings and improve their understanding of anatomical relationships with memorization [19]. The ease of access, short length of the anatomy drawing screen-casts by YouTube channels, and the producer of the content are factors that encourage usage by students [20]. Though anatomy videos allow students to study at their convenience and pace, they are prone to behaviors ranging from loss of focus, feeling sleepy to interruptions that will lead to distraction while watching videos; and since they are likely to be connected to internet, they may divert to social media networks [13, 21]. Online dissection audio-visual resources for human anatomy are important for the undergraduate medical students' usage and learning outcomes [22], but it has also been reported that the use of videos by students has led to both decline in student lecture attendance and workload on academic staff [18, 21]. However, students may still use technology to learn, access information, and succeed academically [23].

Games can as well be created for the purpose of learning anatomy such as identification of structures and tracing muscle origins and insertions, and these games are especially played from web pages using mobile phones or computers [13]. Use of online formative assessments (OFA) is another way of applying technology for an additional student-learning and access to

information at any particular time [24]. The OFA gives automated feedback that is useful for examination preparation and it promotes and supports student-directed learning, especially for students with better study habits [24].

### **Statement of the Problem**

During corona-virus disease 2019 (COVID-19) pandemic, students in developed countries continued learning anatomy at home using technologies while those in developing nations could not continue. Also, the academic Faculty could neither subscribe to nor develop interactive online distant-learning platforms.

### **Aim of the Study**

This study was aimed at evaluating technology-based self-directed learning of anatomy and its impact on academic performance among anatomy students in two universities in South-East Nigeria.

### **Objectives of the Study**

The objectives of this study were to assess knowledge and perception of technology-based self-directed learning of anatomy among the preclinical and anatomy students, evaluate their use of technology-based self-directed learning of anatomy, and determine the impact of technology-based self-directed learning of anatomy on their academic performance in the most recent examinations in anatomy-based courses.

### **Significance of Study**

This study will expose preclinical and anatomy students in the South-East Nigeria to various technologies that could be deployed in self-directed study of anatomy. The Generation Z students could then use technology to learn, access information, and succeed academically.

### **Scope of Study**

This study was limited to preclinical and anatomy students in Ebonyi State, South-East Nigeria and their self-directed learning of anatomy with technologies such as eBooks, e-learning materials, social media platforms, podcasts, video, anatomy websites, games, online formative assessment software, and anatomy education applications (apps).

## **MATERIALS AND METHODS**

### **Study Universities**

The study was done in medical Departments of Anatomy in Ebonyi State University (EBSU) and Alex Ekwueme Federal University Ndufe Alike Ikwo (AEFUNAI), Ebonyi State, Nigeria.

### **Study Population and Sample Size**

Participation in the study was voluntary and study population  $N$ , was about 400 preclinical and anatomy students in the two universities. The sample size was determined using the formula

$$n = \frac{N}{[1 + (N e^2)]}$$
 [25], where  $n$  is minimum sample size,  $N$  is study population,  $e$  is error term, 95% confidence interval [25] was used to determine the number of undergraduates to be sampled. Therefore,  $n$  was computed as:

$$n = \frac{400}{[1 + (400 \times 0.05^2)]} = \frac{400}{[1 + (400 \times 0.0025)]} = \frac{400}{[1 + (1)]} = \frac{400}{[2]} = 200.$$
 Since a higher sample size ensures a more reliable result, two hundred and sixty-eight (268) volunteers, comprising 134 students from each university were recruited for the study. All participants remained anonymous.

### Exclusion Criteria

Medical students of 100 level and above 300 level; and year one anatomy students were excluded.

### Ethical Approval

Ethical approval was obtained from the Faculty of Basic Medical Science Research Ethics Committee of Ebonyi State University (EBSU); with ethical code number: EBSU/FBMS/02/2018/22/004.

### Research Design

This study was a longitudinal cross-sectional study from December, 2021 to September, 2022.

### Instrument for Data Collection

The Association of Medical Education in Europe (AMEE) Guide Number 87 [26] was used to design electronic questionnaire by created using Google form employed as the instrument of data collection. The post-graduate anatomy lecturers of EBSU were given copies of the questionnaire for expert validation following the Analysis of Pretest-Post test Designs [27].

### Data Collection

Awareness on the study was created among the various preclinical and anatomy students of EBSU and AEFUNAI who expressed the desired to learn anatomy with technology. Copies of the questionnaire were physically shared at anatomy lecture halls at AEFUNAI and EBSU. All the questionnaires administered were responded to and collected by the researchers.

### Data Analysis

Data generated from the questionnaires were analyzed for both descriptive and inferential statistics using SPSS (version 25) software, and Excel Chart Wizard where error bars helped to also indicate significance difference ( $P < 0.05$ ) among variables considered. Ordinal logistic regression model was used to estimate performance on knowledge, perception and use of TBSDL0A.

## RESULTS

### Demographics of Study Participants

Distributions of demographic variables of students studied are indicated in Table 1. Participants from EBSU and AEFUNAI contributed 50% each. Anatomy students and Medicine and Surgery student also contributed 41.8% and 58.2% respectively. About 52.2% of the participants were 200 level students, with only 13.8% from 400 levels. Students within the ages of 21-25 years accounted for 52.6% of all participants though females (63.1%) were more than the males.

**Table 1: Distributions of demographic variables of the students studied**

| Demographic variables |                    | Students studied |             |
|-----------------------|--------------------|------------------|-------------|
|                       |                    | Numbers          | Percentages |
| Institutions          | EBSU               | 134              | 50.0        |
|                       | AEFUNAI            | 134              | 50.0        |
| Departments           | Anatomy            | 112              | 41.8        |
|                       | Medicine & Surgery | 156              | 58.2        |
| Levels of study       | 200                | 140              | 52.2        |
|                       | 300                | 91               | 34.0        |
|                       | 400                | 37               | 13.8        |
| Age (years)           | 15-20              | 116              | 43.3        |
|                       | 21-25              | 141              | 52.6        |
|                       | 26-30              | 8                | 3.0         |
|                       | 31-35              | 3                | 1.1         |
| Gender                | Female             | 169              | 63.1        |
|                       | Male               | 99               | 36.9        |
| Total                 |                    | 268              | 100         |

### Experience of Students on TBSDLOA

Table 2 shows the Experience of the students on TBSDLOA. Students' experiences were on gadgets use, phone screen time per day, download of anatomy software (s), social media diet, ICT compliant and Internet subscription. Majority of the students (69.4%) used smart phones only. About 49.6% of the students had a phone screen time per day of 5-9 hours. Although their ICT-compliant was at medium (48.3%), internet subscription was very common among 70.1% of all participants.

**Table 2: Experience of the students on TBSDLOA**

| TBSDLOA                           | Experience         | Number of students | Percentage |
|-----------------------------------|--------------------|--------------------|------------|
| Gadgets                           | Smartphone         | 186                | 69.4       |
|                                   | Laptop             | 34                 | 12.7       |
|                                   | Tablet             | 11                 | 4.1        |
|                                   | Smartphone +Laptop | 32                 | 11.9       |
|                                   | Smartphone +Tablet | 5                  | 1.9        |
| Phone screen time per day (hours) | 0-4                | 111                | 41.4       |
|                                   | 5-9                | 133                | 49.6       |
|                                   | 10-15              | 24                 | 9.0        |
| Downloaded Anatomy Software       | Yes                | 124                | 46.3       |
|                                   | No                 | 144                | 53.7       |
| Social Media Diet                 | LinkedIn           | 1                  | 0.4        |
|                                   | Twitter            | 19                 | 7.1        |
|                                   | Facebook           | 19                 | 7.1        |
|                                   | WhatsApp           | 20                 | 7.4        |
|                                   | Telegram           | 1                  | 0.4        |
|                                   | YouTube            | 9                  | 3.3        |
|                                   | Diets combinations | 199                | 74.3       |
| ICT compliant                     | High               | 103                | 38.4       |
|                                   | Medium             | 130                | 48.5       |

|                       |              |     |      |
|-----------------------|--------------|-----|------|
|                       | Low          | 35  | 13.1 |
| Internet subscription | Regularly    | 188 | 70.1 |
|                       | Infrequently | 76  | 28.4 |
|                       | Never        | 4   | 1.5  |
| Total                 |              | 268 | 100  |

### Responses of Students on Knowledge of TBSDLOAL

Overall responses to questions regarding students' knowledge of TBSDLOA is shown in Figure 1. It was revealed that about 84.5% of them knew about social medial platforms that discuss anatomy topics, share images and materials, and upload videos. Surprisingly, up to 27% of them neither knew that anatomy software could be downloaded from Google Play, apple app store, blackberry world and windows phone store nor that videos on dissection and anatomy are on YouTube nor that computer-assisted program and computer-based learning software are available.

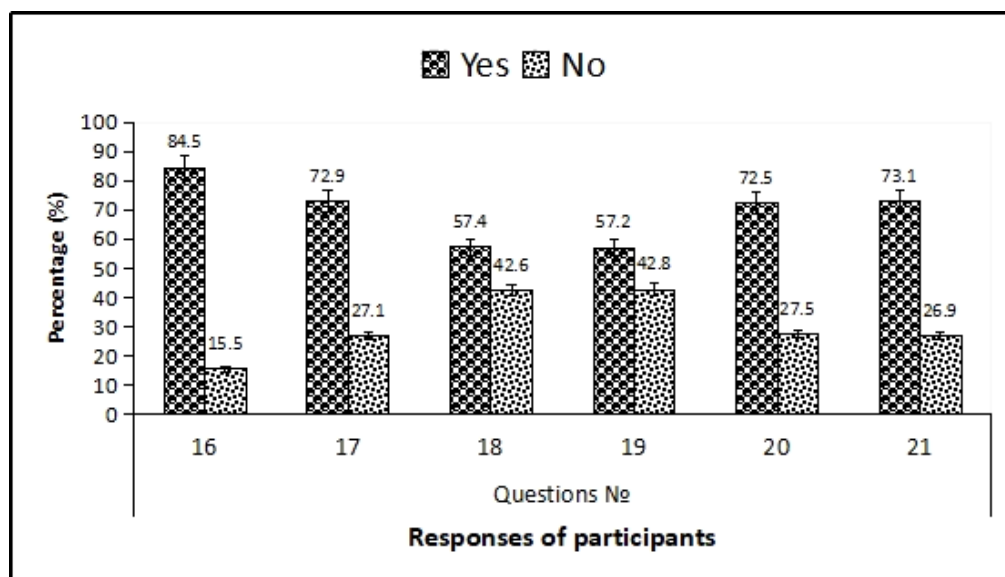


Figure 1: Overall responses to questions 16 - 21 on knowledge of TBSDLOA

16. Do you know about social medial platforms that discus anatomy topics, share images and materials and upload videos?

17. Do you know that anatomy software could be downloaded from Google play, apple app store, blackberry world and windrows phone store?

18. Do you know about websites that offer anatomy online courses and quizzes?

19. Have you come across links that for downloading soft copies of anatomy textbooks?

20. Do you know of dissection videos and anatomy videos on YouTube?

21. Do you know about computer-assisted program and computer-based learning?

### Performance of Students in Anatomy-Based Courses

Performance of students in anatomy-based courses is displayed in Table 3. Generally, about 28.7% of the student were within the grade scale of 50 - 59% in various anatomy-based courses whereas 26.9% and 23.5% of the participants scored 60-69% and  $\geq 70$ , respectively. The remaining 20.9% scored below 50%.

**Table 3: Performance of students in anatomy-based courses**

| Grade scale  | Students graded in anatomy-based courses |            |            |            |            |            |              |            |            |            |
|--------------|------------------------------------------|------------|------------|------------|------------|------------|--------------|------------|------------|------------|
|              | Gross Anatomy                            |            | Histology  |            | Embryology |            | Neuroanatomy |            | Overall    |            |
| Scores %     | No.                                      | %          | No.        | %          | No.        | %          | No.          | %          | No.        | %          |
| <40          | 1                                        | 0.4        | 1          | 0.4        | 3          | 1.1        | 2            | 0.8        | 2          | 0.7        |
| 40-44        | 11                                       | 4.1        | 12         | 4.4        | 13         | 4.9        | 14           | 5.2        | 12         | 4.5        |
| 45-49        | 48                                       | 17.9       | 47         | 17.5       | 38         | 14.2       | 33           | 12.3       | 42         | 15.7       |
| 50-59        | 84                                       | 31.3       | 86         | 32.1       | 68         | 25.4       | 70           | 26.1       | 77         | 28.7       |
| 60-69        | 74                                       | 27.6       | 61         | 22.8       | 76         | 28.3       | 76           | 28.4       | 72         | 26.9       |
| ≥70          | 50                                       | 18.7       | 61         | 22.8       | 70         | 26.1       | 73           | 27.2       | 63         | 23.5       |
| <b>Total</b> | <b>268</b>                               | <b>100</b> | <b>268</b> | <b>100</b> | <b>268</b> | <b>100</b> | <b>268</b>   | <b>100</b> | <b>268</b> | <b>100</b> |

### Students' Knowledge of TBSDLOAL

Assessment of students' knowledge of TBSDLOA along their demographics is shown in Table 4. Among all the demographics considered, Good TBSDLOA knowledge (87.7%) and Poor TBSDLOA knowledge (12.3%) differ significantly ( $p < 0.05$ ). About 91.7% of the females were observed to have good knowledge of TBSDLOA more than 80.8% of the males. The overall Good Knowledge of TBSDLOA was uniformly distributed among institutions, departments, levels of study, age groups, and gender of participants, except Age-group of 31-35 years where no participant apparently had Poor Knowledge of TBSDLOA.

**Table 4: Students' knowledge of TBSDLOA along their demographics**

| Students' demographics |                    | TBSDLOA knowledge |              | $\chi^2$ | p-value |
|------------------------|--------------------|-------------------|--------------|----------|---------|
|                        |                    | Good No. (%)      | Poor No. (%) |          |         |
| Institution            | EBSU               | 119 (88.8)        | 15 (11.2)    | 6.020*   | 0.522   |
|                        | AEFUNAI            | 116 (86.6)        | 18 (13.4)    |          |         |
| Department             | Anatomy            | 96 (85.7)         | 16 (14.3)    | 0.575    | 0.448   |
|                        | Medicine & Surgery | 139 (89.1)        | 17 (10.9)    |          |         |
| Level                  | 200                | 121 (86.4)        | 19 (13.6)    | 2.350    | 0.309   |
|                        | 300                | 83 (91.2)         | 8 (8.8)      |          |         |
|                        | 400                | 31 (83.8)         | 6 (16.2)     |          |         |
| Age (years)            | 15-20              | 101 (87.1)        | 15 (12.9)    | 0.526    | 0.978   |
|                        | 21-25              | 124 (87.9)        | 17 (12.1)    |          |         |
|                        | 26-30              | 7 (87.5)          | 1 (12.5)     |          |         |
|                        | 31-35              | 3 (100)           | 0 (0.0)      |          |         |
| Gender                 | Female             | 155 (91.7)        | 14 (8.3)     | 11.472   | 0.001   |
|                        | Male               | 80 (80.8)         | 19 (19.2)    |          |         |
| Total                  |                    | 235 (87.7)        | 33 (12.3)    |          |         |

\*= Fisher's exact test statistic,  $p < 0.05$  indicates significant difference

### Knowledge of TBSDLOA Along Performance in Different Anatomy-Based Courses

Knowledge of TBSDLOA along performance of students in different anatomy-based courses is shown in Table 5. No participant with good knowledge scored less than 40% in Gross Anatomy and Histology but varying percentages of participants with both good and poor knowledge of TBSDLOA scored more than 40% in the different anatomy-based courses.

**Table 5: Knowledge of TBSDLOA along performance of students in anatomy-based courses**

| Anatomy-based courses | Performance | TBSDLOA knowledge |                 | $\chi^2$ | p-value |
|-----------------------|-------------|-------------------|-----------------|----------|---------|
|                       |             | Good<br>No. (%)   | Poor<br>No. (%) |          |         |
| Gross Anatomy         | <40         | 0 (0.0)           | 1 (100.0)       | 13.839*  | 0.013   |
|                       | 40-44       | 8 (72.7)          | 3 (27.3)        |          |         |
|                       | 45-49       | 40 (83.3)         | 8 (16.7)        |          |         |
|                       | 50-59       | 78 (92.9)         | 6 (7.1)         |          |         |
|                       | 60-69       | 63 (85.1)         | 11 (14.9)       |          |         |
|                       | $\geq 70$   | 46 (92.0)         | 4 (8.0)         |          |         |
| Histology             | <40         | 0 (0.0)           | 1 (100)         | 12.705*  | 0.021   |
|                       | 40-44       | 9 (75.0)          | 3 (25.0)        |          |         |
|                       | 45-49       | 43 (91.5)         | 4 (8.5)         |          |         |
|                       | 50-59       | 73 (84.9)         | 13 (15.1)       |          |         |
|                       | 60-69       | 56 (91.8)         | 5 (8.2)         |          |         |
|                       | $\geq 70$   | 54 (88.5)         | 7 (11.5)        |          |         |
| Embryology            | <40         | 2 (66.7)          | 1 (33.3)        | 4.609*   | 0.435   |
|                       | 40-44       | 11 (84.6)         | 2 (15.4)        |          |         |
|                       | 45-49       | 32 (84.2)         | 6 (15.8)        |          |         |
|                       | 50-59       | 61 (89.7)         | 7 (10.3)        |          |         |
|                       | 60-69       | 66 (86.8)         | 10 (13.2)       |          |         |
|                       | $\geq 70$   | 63 (90.0)         | 7 (10.0)        |          |         |
| Neuroanatomy          | <40         | 1 (50.0)          | 1 (50.0)        | 13.443*  | 0.013   |
|                       | 40-44       | 11 (78.6)         | 3 (21.4)        |          |         |
|                       | 45-49       | 27 (81.8)         | 6 (18.2)        |          |         |
|                       | 50-59       | 64 (91.4)         | 6 (8.6)         |          |         |
|                       | 60-69       | 65 (85.5)         | 11 (14.5)       |          |         |
|                       | $\geq 70$   | 67 (91.8)         | 6 (8.2)         |          |         |
| Total                 |             | 235 (87.7)        | 33 (12.3)       |          |         |

\*= Fisher's exact test statistic,  $p < 0.05$  indicates significance between Good and Poor TBSDLOA Knowledge

### Responses of Students on Perception of TBSDLOA

Responses of students regarding their Perception of TBSDLOA is indicated in Figure 2. About 40-45% of the students agreed that they enjoy using technology to study anatomy. However, less than 5% strongly disagreed, and those neutral were 18-22% of the students. Also, about 26.7% and 20% respectively disagreed and strongly disagreed that using technology to learn anatomy is not necessary.

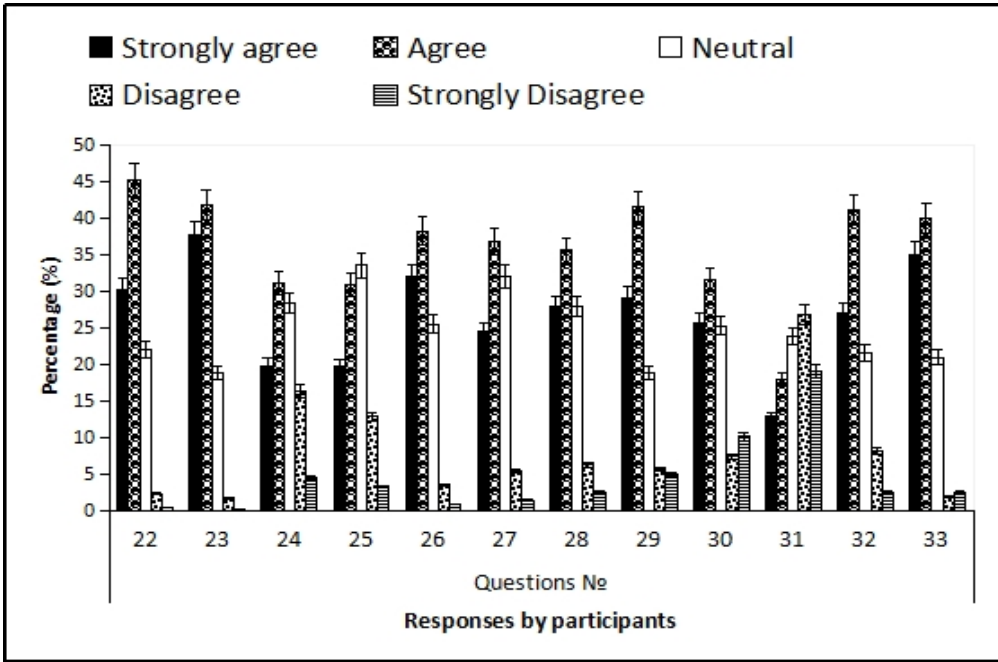


Figure 2: Overall response of students on questions 22-33 on perception of TBSDLOA.

- 16. I enjoy using technology to study anatomy
- 17. Technology can help me learn the branches of anatomy
- 18. Using technology to study can distract me
- 19. Using technology to study affects my eyes
- 20. Students should know how to use technology to study anatomy
- 21. I am very confident using technology to study anatomy
- 22. It is expensive to sustain use of technology to study
- 23. Gadget battery when low limits my use of technology to study
- 24. I would be a better learner if I knew how to use technology properly
- 25. Using technology to learn anatomy is not necessary
- 26. I can improve my academic performance using the internet to study
- 27. I want to learn more about using technology for self-study

Perception of TBSDLOA Along Demographic Variables

Perception of TBSDLOA among demographics of the students studied is shown in Table 6. About 91.8% of the students have a right perception of TBSDLOA, and it could be clearly observed that students with right perception differed significantly from those with wrong perspectives. Right perception was found to be inversely related with age but there was no gender difference in either right nor wrong perception of TBSDLOA.

Table 6: Perception of TBSDLOA among demographics of students studied

| Variable    |         | Perception of TBSDLOA by students |               | $\chi^2$ | p-value |
|-------------|---------|-----------------------------------|---------------|----------|---------|
|             |         | Right No. (%)                     | Wrong No. (%) |          |         |
| Institution | EBSU    | 118 (88.1)                        | 16 (11.9)     | 9.907*   | 0.155   |
|             | AEFUNAI | 128 (95.2)                        | 6 (4.5)       |          |         |
| Department  | Anatomy | 103 (92.6)                        | 9 (8.0)       | 0.966    | 0.326   |

|                    |                    |            |           |        |        |
|--------------------|--------------------|------------|-----------|--------|--------|
|                    | Medicine & Surgery | 143 (91.6) | 13 (8.3)  |        |        |
| <b>Level</b>       | 200                | 132 (94.3) | 8 (5.7)   | 17.388 | <0.001 |
|                    | 300                | 78 (85.7)  | 13 (14.3) |        |        |
|                    | 400                | 36 (96.9)  | 1 (2.7)   |        |        |
| <b>Age (years)</b> | 15-20              | 108 (93.1) | 8 (6.9)   | 7.615* | 0.042  |
|                    | 21-25              | 130 (92.2) | 11 (7.8)  |        |        |
|                    | 26-30              | 6 (75.0)   | 2 (25.0)  |        |        |
|                    | 31-35              | 2 (66.7)   | 1 (33.3)  |        |        |
| <b>Gender</b>      | Female             | 154 (91.1) | 15 (8.9)  | 0.004  | 0.951  |
|                    | Male               | 92 (92.9)  | 7 (7.1)   |        |        |
| <b>Overall</b>     |                    | 246 (91.8) | 22 (8.2)  |        |        |

\*= Fisher's exact test statistic,  $p < 0.05$  indicates significance,

### Perception of TBSDLOA Along Students' Performance in Anatomy

Perception of TBSDLOA and overall performance of students in anatomy-based examination is illustrated in Figure 3. Perception of TBSDLOA along different performances in Gross Anatomy, Histology, Embryology and Neuroanatomy was consistent both for overall performance and for each domain under study. Generally, only participants with good perception scored more than 40%, and none with poor perception got up to 70% ( $\chi^2 = 26.740$ ,  $p < 0.001$ ).

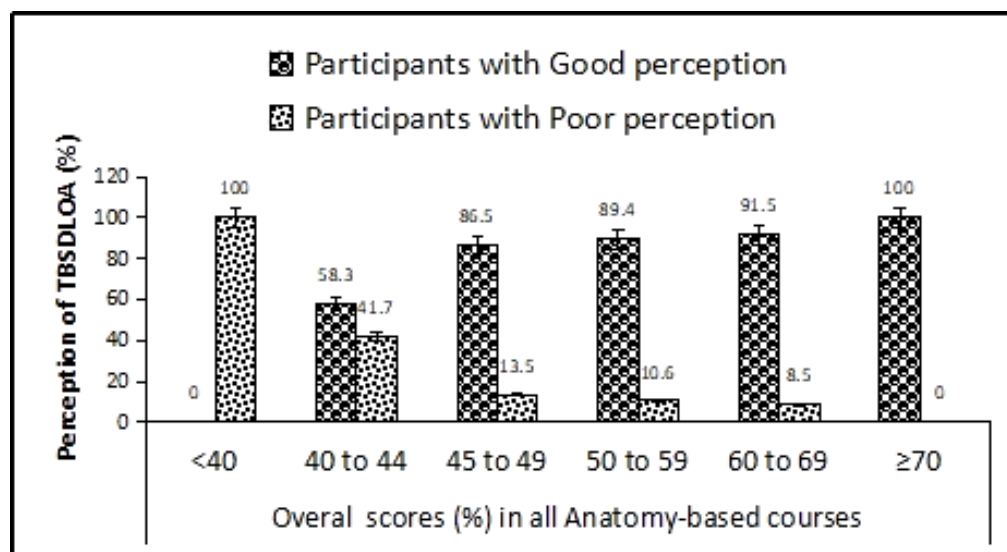


Figure 3: Perception of TBSDLOA and overall performance of students in anatomy-based examination ( $\chi^2 = 26.740$ ,  $p < 0.001$ ).

### Responses on Use of TBSDLOA along demographic variables

Assessment of the use of TBSDLOA along the demographics of students studied is presented in Table 7. It is revealed that students with most "Often use TBSDLOA" were from EBSU (5.9%) while AEFUNAI were 3.7%, Also, those with most "Never use TBSDLOA" were from EBSU (7.5%) while those from AEFUNAI were (3.5%) ( $\chi^2 = 52.095$ ;  $p = 0.002$ ). Similar comparisons showed no significant differences between overall responses on uses of TBSDLOA namely, never (5.2%), Rarely (28.7%), Sometimes (61.2%), and Often (4.9%) when compared with corresponding responses from the Department of Anatomy, and Department Medicine & Surgery ( $\chi^2 = 3.947$ ;  $p = 0.267$ ). There were significant differences in "Rarely (20.9%)" and "Sometimes (70.3%)"

recorded for 300 Level participants when compared with corresponding responses from 200 Level, 400 Level, and the overall responses on “Rarely (28.7%)” and “Sometimes (61.2%)” ( $\chi^2=21.545$ ;  $p=0.001$ ). There were also significant differences between overall use of TBSDLOA and responses by age groups of participants ( $\chi^2=16.674$ ;  $p=0.054$ ) and in gender responses ( $\chi^2=16.674$ ;  $p=0.054$ ).

**Table 7: Response on use of TBSDLOA along the demographics of the students studied**

| Variable    |                    | Students' use of TBSDLOA |                   |                      |                  | $\chi^2$ | p-value |
|-------------|--------------------|--------------------------|-------------------|----------------------|------------------|----------|---------|
|             |                    | Never<br>No. (%)         | Rarely<br>No. (%) | Sometimes<br>No. (%) | Often<br>No. (%) |          |         |
| Institution | EBSU               | 10(7.5)                  | 25(18.7)          | 91(68.9)             | 8(5.9)           | 52.095*  | 0.002   |
|             | AEFUNAI            | 4(3.0)                   | 52(38.8)          | 73(54.5)             | 5(3.7)           |          |         |
| Department  | Anatomy            | 7(6.3)                   | 36(32.1)          | 66(58.9)             | 3(2.7)           | 3.947    | 0.267   |
|             | Medicine & Surgery | 7(4.5)                   | 41(26.3)          | 98(62.8)             | 10(6.4)          |          |         |
| Level       | 200                | 8(5.7)                   | 55(39.3)          | 70(50.0)             | 7(5.0)           | 21.545*  | 0.001   |
|             | 300                | 3(3.3)                   | 19(20.9)          | 64(70.3)             | 5(5.5)           |          |         |
|             | 400                | 3(8.1)                   | 3(8.1)            | 30(81.1)             | 1(2.7)           |          |         |
| Age (years) | 15-20              | 8(6.9)                   | 47(40.5)          | 60(51.7)             | 1(0.9)           | 16.674*  | 0.054   |
|             | 21-25              | 6(4.3)                   | 27(19.1)          | 97(68.8)             | 11(7.8)          |          |         |
|             | 26-30              | 0(0.0)                   | 2(25.0)           | 6(75.0)              | 0(0.0)           |          |         |
|             | 31-35              | 0(0.0)                   | 1(33.3)           | 1(33.3)              | 1(33.3)          |          |         |
| Gender      | Female             | 7(4.2)                   | 50(29.6)          | 104(61.5)            | 8(4.7)           | 5.894    | 0.117   |
|             | Male               | 7(7.1)                   | 27(27.3)          | 60(60.6)             | 5(5.0)           |          |         |
| Overall     |                    | 14(5.2)                  | 77(28.7)          | 164(61.2)            | 13(4.9)          |          |         |

\*= Fisher's exact test statistic,  $p<0.05$  indicates significance.

### Use of TBSDLOA Along Performance of Students in Anatomy-Based Courses

Use of TBSDLOA by students along their performance in anatomy-based courses is shown in Table 8. Generally, of the students graded, 5.2%, 28.7%, 61.2%, and 4.9% of the students never, rarely, sometimes, and often used technology-based self-directed learning of anatomy. About 50% of the participants who rarely and sometimes use TBSDLOA scored less than 40% in Gross Anatomy while all the students that rarely use technology scored less than 40% in Histology. However, between 70-75 percent of the students that sometimes use technology scored 60-69% in Histology, Embryology and Neuroanatomy while between 33-43% of students that sometimes use technology scored more than 70% in all the anatomy-based courses.

**Table 8: Use of TBSDLOA along performance of students in anatomy-based courses**

| Anatomy-based courses | Grade scales | Students graded |      | Use of TBSDLOA by students graded |                   |                      |                  | $\chi^2$ | p-value |
|-----------------------|--------------|-----------------|------|-----------------------------------|-------------------|----------------------|------------------|----------|---------|
|                       |              |                 |      | Never<br>No. (%)                  | Rarely<br>No. (%) | Sometimes<br>No. (%) | Often<br>No. (%) |          |         |
| Overall               | %            | No.             | %    |                                   |                   |                      |                  | 77.112*  | <0.001  |
|                       | <40          | 2               | 0.7  | 0(0.0)                            | 2(100.0)          | 0(0.0)               | 0(0.0)           |          |         |
|                       | 40-44        | 12              | 4.5  | 0(0.0)                            | 2(16.7)           | 8(66.7)              | 2(16.6)          |          |         |
|                       | 45-49        | 42              | 15.7 | 0(0.0)                            | 14(6.3)           | 26(61.9)             | 2(4.8)           |          |         |
|                       | 50-59        | 77              | 28.7 | 7(9.1)                            | 23(29.9)          | 43(55.8)             | 4(5.2)           |          |         |
|                       |              |                 |      |                                   |                   |                      |                  |          |         |

|                      |              |            |            |                |                 |                  |                |        |        |
|----------------------|--------------|------------|------------|----------------|-----------------|------------------|----------------|--------|--------|
|                      | 60-69        | 72         | 26.9       | 2(2.8)         | 14(19.4)        | 54(75.0)         | 2(2.8)         |        |        |
|                      | ≥70          | 63         | 23.5       | 5(7.9)         | 22(34.9)        | 33(52.4)         | 3(4.8)         |        |        |
|                      | <b>Total</b> | <b>268</b> | <b>100</b> | <b>14(5.2)</b> | <b>77(28.7)</b> | <b>164(61.2)</b> | <b>13(4.9)</b> |        |        |
| <b>Gross Anatomy</b> | <40          | 1          | 0.4        | 0(0.0)         | 0(0.0)          | 0(0.0)           | 1(100.0)       | 55.869 | <0.001 |
|                      | 40-44        | 11         | 4.1        | 1(9.1)         | 3(27.3)         | 6(54.5)          | 1(9.1)         |        |        |
|                      | 45-49        | 48         | 17.9       | 1(2.1)         | 12(25.0)        | 31(64.6)         | 4(8.3)         |        |        |
|                      | 50-59        | 84         | 31.3       | 4(4.8)         | 18(21.4)        | 58(69.0)         | 4(4.8)         |        |        |
|                      | 60-69        | 74         | 27.6       | 8(10.8)        | 26(35.1)        | 40(54.1)         | 0(0.0)         |        |        |
|                      | ≥70          | 50         | 18.7       | 0(0.0)         | 18(36.0)        | 29(58.0)         | 3(6.0)         |        |        |
|                      | <b>Total</b> | <b>268</b> | <b>100</b> | <b>14(5.2)</b> | <b>77(28.7)</b> | <b>164(61.2)</b> | <b>13(4.9)</b> |        |        |
|                      |              |            |            |                |                 |                  |                |        |        |
| <b>Histology</b>     | <40          | 1          | 0.4        | 0(0.0)         | 1(100.0)        | 0(0.0)           | 0(0.0)         | 58.227 | <0.001 |
|                      | 40-44        | 12         | 4.5        | 0(0.0)         | 3(25.0)         | 8(66.7)          | 1(8.3)         |        |        |
|                      | 45-49        | 47         | 17.5       | 2(4.3)         | 16(34.0)        | 25(53.2)         | 4(8.5)         |        |        |
|                      | 50-59        | 86         | 32.0       | 6(7.0)         | 22(25.6)        | 55(63.9)         | 3(3.5)         |        |        |
|                      | 60-69        | 61         | 22.8       | 1(1.6)         | 14(23.0)        | 46(75.4)         | 0(0.0)         |        |        |
|                      | ≥70          | 61         | 22.8       | 5(8.2)         | 21(34.4)        | 30(49.2)         | 5(8.2)         |        |        |
|                      | <b>Total</b> | <b>268</b> | <b>100</b> | <b>14(5.2)</b> | <b>77(28.7)</b> | <b>164(61.2)</b> | <b>13(4.9)</b> |        |        |
|                      |              |            |            |                |                 |                  |                |        |        |
| <b>Embryology</b>    | <40          | 3          | 1.1        | 0(0.0)         | 2(66.7)         | 1(33.3)          | 0(0.0)         | 42.081 | <0.001 |
|                      | 40-44        | 13         | 4.9        | 0(0.0)         | 5(38.5)         | 8(61.5)          | 0(0.0)         |        |        |
|                      | 45-49        | 38         | 14.2       | 1(2.6)         | 15(39.5)        | 19(50.0)         | 3(7.9)         |        |        |
|                      | 50-59        | 68         | 25.4       | 5(7.4)         | 16(23.5)        | 44(64.7)         | 3(4.4)         |        |        |
|                      | 60-69        | 76         | 28.3       | 5(6.6)         | 14(18.4)        | 53(69.7)         | 4(5.3)         |        |        |
|                      | ≥70          | 70         | 26.1       | 3(4.3)         | 25(35.7)        | 39(55.7)         | 3(4.3)         |        |        |
|                      | <b>Total</b> | <b>268</b> | <b>100</b> | <b>14(5.2)</b> | <b>77(28.7)</b> | <b>164(61.2)</b> | <b>13(4.9)</b> |        |        |
|                      |              |            |            |                |                 |                  |                |        |        |
| <b>Neuroanatomy</b>  | <40          | 2          | 0.8        | 0(0.0)         | 1(50.0)         | 1(50.0)          | 0(0.0)         | 42.422 | <0.001 |
|                      | 40-44        | 14         | 5.2        | 1(7.1)         | 6(42.9)         | 6(42.9)          | 1(7.1)         |        |        |
|                      | 45-49        | 33         | 12.3       | 1(3.0)         | 11(33.3)        | 19(57.6)         | 2(6.1)         |        |        |
|                      | 50-59        | 70         | 26.1       | 6(8.6)         | 21(30.0)        | 40(57.1)         | 3(4.3)         |        |        |
|                      | 60-69        | 76         | 28.4       | 5(6.6)         | 13(17.1)        | 56(73.7)         | 2(2.6)         |        |        |
|                      | ≥70          | 73         | 27.2       | 1(1.4)         | 25(34.2)        | 42(57.5)         | 5(6.9)         |        |        |
|                      | <b>Total</b> | <b>268</b> | <b>100</b> | <b>14(5.2)</b> | <b>77(28.7)</b> | <b>164(61.2)</b> | <b>13(4.9)</b> |        |        |
|                      |              |            |            |                |                 |                  |                |        |        |

\*= Fisher's exact test statistic, p<0.05 indicates significance.

## Ordinal Logistic Regression estimate of Performance on Knowledge, Perception and Use of TBSDLOA

Ordinal logistic regression estimates of performance on knowledge, perception and use of TBSDLOA is indicated in Table 9. The estimated performance on knowledge, perception and use of TBSDLOA showed that students with good knowledge (Adjusted OR = 1,049,  $p=0.007$ ) are 1.05 times more likely to move from one lower level of performance to another level of performance compare with those with poor knowledge of technology-based self-directed learning of Anatomy while use and perception are held constant. Perception has insignificant ( $p=0.195>0.05$ ) coefficient, indicating that perception of technology-based self-directed learning of Anatomy cannot independently predict performance of student in the various courses under consideration. On TBSDLOA use, it was found that those who never use TBSDLOA are 3.9% less likely to improve in level of performance compare to those that often, rarely and sometimes use TBSDLOA.

**Table 9: Ordinal logistic regression estimates of performance on knowledge, perception and use of TBSDLOA**

| Variables  |              | $\beta$ | Adjusted OR | p-value | 95% CI for Adjusted OR |       |
|------------|--------------|---------|-------------|---------|------------------------|-------|
|            |              |         |             |         | Lower                  | Upper |
| Knowledge  | Good         | 0.047   | 1.049       | 0.007   | 0.743                  | 1.479 |
|            | Poor (ref.)  |         | 1           |         |                        |       |
| Perception | Right        | 0.280   | 0.756       | 0.197   | 0.494                  | 1.156 |
|            | Wrong (ref.) |         | 1           |         |                        |       |
| Use        | Never        | 0.710   | 0.492       | 0.039   | 0.251                  | 0.965 |
|            | Rarely       | 0.165   | 0.848       | 0.551   | 0.492                  | 1.459 |
|            | Sometimes    | 0.067   | 1.070       | 0.805   | 0.627                  | 1.826 |
|            | Often (ref.) |         | 1           |         |                        |       |

$\beta$  = regression estimates, OR= odds ratio, CI = confidence interval, ref = reference category,  $p<0.05$  indicates significant difference

## DISCUSSION

In the present study, Internet subscription was noted to be high (Table 2), with 70% and 28.8% of the students having regular and infrequent internet subscription respectively. This finding was nearly similar to the results of a South African study by Lazarus *et al.* [28] where 83% had internet access. Though it was also observed in the present study that 38.4% and 48.8% of the students were high and medium level Information, Communication and Technology (ICT) complaint respectively, but 69.4% had smartphones while 46.3% downloaded anatomy software unlike in a study by Zargaran *et al.* [29] where technology usage was ubiquitous among medical students with 98% of medical students owning smartphones, but medical education apps were used by 64.3% of medical students, and 61.9% of the apps cover anatomy though 60.4% of the students prefer traditional cadaveric teaching to other technological interventions.

Also, in this study 74.2% of the students combined different social media platforms (i.e., combinations of diets) while only 3.3% of them concentrated on YouTube (Table 2) as compared to the study on Perspective of Jordanian Medical Students Using YouTube to Learn Anatomy by Mustafa *et al.* [30] that reported 79.1% usage and recommendation of YouTube as anatomy-learning tool. Also, Pickering and Swinnerton [20] explored the Dimensions of

Medical Student Engagement with Technology-Enhanced Learning Resources, which showed 83% and 76% use of YouTube and other technologies among medical students. It was obvious that all Anatomy and Medicine & Surgery students that participated in present study were ICT compliant (Table 2) as it was observed that a reasonable proportion of them (28.7% and 26.9%) scored 50-59% and 60-69%, respectively, in all the anatomy-based courses while about 23 percent of them scored  $\geq 70$  (Table 3). However, Mars and McLean [31] had reported a scenario where thirteen out of thirty-four volunteers from the class of 125 second-year M.B. Ch.B. students that participated in CAI module course were not computer-literate but that lack of computer literacy did not restrict or hinder their use of the programme. This does not undermine the need for medical students in the present study to be computer literate.

Majority of the students (88% and 91.1%) in this study had good knowledge and perception of technology-based self-directed learning of anatomy respectively as reflected in the average performance in the last semester exams in four different anatomy courses, which showed significant association between good knowledge and right perception of technology-based self-directed learning of anatomy-based courses (Tables 4, 5, and 6) with high academic performance. The Overall percentages 28.7%, 61.2% and 4.9% respectively observed for students who 'rarely', 'sometimes' and 'often' use technology-based self-directed learning of anatomy (Table 7) also reflected in the academic performance of students that had good performance on overall basis, and in specific anatomy-based courses that used technology for self-directed learning (Table 8). These findings are consistent with the report by [1, 16, 32, 33] that improved academic performance of students is associated with good knowledge, perception and use of technology-based self-directed learning of anatomy.

Ordinal logistic regression model estimates of performance on knowledge, perception and use of TBSDLOA in this study (Table 9) indicated that students with good knowledge are 1.05 times more likely to move from one lower level of performance to another level of performance when compared with those with poor knowledge of TBSDLOA; use and perception being constant. Perception of TBSDLOA cannot independently predict performance of student in the various Anatomy-based courses under consideration. In their study, Zureick *et al.* [21] pointed out that the use of technologies for learning anatomy does not guarantee having high mean scores in examination as it could even interrupt learning process. In a different study Nagandla *et al.* [24] recorded no difference in the mean scores in examinations between users and non-users of technology for self-directed learning of anatomy. Furthermore, a drastic contrast was seen in a survey by Alhassan and Majeed [34] where only 8% of the students studied preferred learning anatomy with technology.

## CONCLUSION

Technology-based self-directed learning has a significant positive impact on the academic performance and success among preclinical and anatomy students in the southeast. Majority of students are ICT-compliant and have smartphones with regular internet subscription to access online technological learning tools. Ordinal logistic regression confirms that Perception has insignificant coefficient, meaning that perception of technology-based self-directed learning of Anatomy cannot independently predict performance of student in various Anatomy-based courses. Students with good use of technology-based self-directed learning of anatomy knowledge would be 1.05 times more likely to progress from lower to higher performance level when use and perception are constant. Students who never use technology-based self-directed

learning of Anatomy are 3.9% less likely to improve in level of performance when compared with those that 'often', 'rarely' and 'sometimes' use technology-based self-directed learning of Anatomy.

This paper recommends that increased awareness should be created for Medical and anatomy students on the positive impact of using technology in self-directed learning of anatomy and this research findings should also be part of the orientation given to newly admitted students by the University. Development of anatomy applications and soft wares by university faculties should be encouraged. Free internet connectivity inside the university premises should be made available. Online classrooms and computerized anatomy classrooms/ laboratories should be provided, and Anatomy teachers should be encouraged to have YouTube channels. Departmental premium subscriptions to anatomy online websites for learning tools like the Elsevier Complete Anatomy representative 3D platform will also enhance performance, thus should be made available by university management.

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