



Augmented Reality in Action: Getting High Schoolers an Early Start with Tertiary Education

Project Thesis

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Declaration

We declare that this thesis is our original work and has not been submitted in any form for another degree or diploma at any university or other institute of tertiary education. Information derived from the published and unpublished work of others has been acknowledged in the text and a list of references is given.

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Abstract

Augmented Reality (AR) is gaining popularity in education and training. Whether AR can play an important role in giving high school students an early start for university degree programs or not is a question that need to be examined thoroughly. Many scholars have demonstrated how AR can be a viable tool for better lesson delivery or training, but no one analysed its value in preparing high school students for tertiary education. We have used an AR based medical book on human lungs with a counterpart text book to see how students learn from each. Two groups of students were selected with one group studying the AR based book and the other studying the text based book. Each group then took part in the same exam prepared to test their understanding of the subject matter. Students who studied the AR based book did significantly better than the group who studied the text book. This research has laid the foundation for further, more extensive studies to understand the benefits of AR in preparing high school students for higher studies.

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Chapter 1: Introduction

1.1 Overture

Augmented reality (AR) is a three dimensional (3D) interactive experience that integrates present views adding systemic components. AR is generating a huge impact in our education system. AR can merge virtual items into users' actual world, making simulations more realistic and immersive, it has a lot of potential in education, particularly in medical education. The educational benefits of AR applications in formal education are shown, and they include attention, engagement, interest, motivation, knowledge, understanding, educational achievement, effective learning, satisfaction and autonomy.

1.2 Background

The earliest Augmented Reality starts from 1950s, when Morton Heilig thought of cinema as an activity that would be able to bring the live activity by effectively manipulating all of the senses. Heilig developed such Sensorama prototype of his vision, which he declared in 1955 in "The Cinema of the Future," in 1962, which helped digital computers [[11]]. Next, in 1966, Ivan Sutherland designed the HMD. Sutherland was the first to develop an AR system employing an optical see-through HMD in 1968 (Fig. 1-1) [12]. In 1975, Myron Krueger designs the Videoplace, where for the first time allows viewers to interact with virtual items. Later, While assisting employees in the assembly of cables and cabling for an airplane, Boeing's Tom Caudell and David Mizell discovered Augmented Reality [[13]]. They also started discussing about Augmented Reality versus Virtual Reality (VR), such as utilizing energy since fewer medium are needed [[12]].



Fig. 1-1: Ivan Sutherland's HMD [[12]].

In the same year, L.B Rosenberg created one of the earliest working AR systems, Virtual Fixtures, and proved outstanding performance, while Steven Feiner, Blair MacIntyre, and Doree Seligmann released the study on an AR system prototype derived KARMA [[13]]. The reality virtuality continuum seen in Fig. 1-2 is not discovered until 1994 by Paul



Fig. 1-2: Milgram's RealityVirtuality Continuum [[13]].

Milgram and Fumio Kishino as a platform that spans from the real environment to the virtual environment. AR is placed somewhere in the middle, and AR being accountable

to the actual world and it is being adherent to the virtual world. Ronald Azuma publishes the study in AR in 1997, presenting a definition of Augmented Reality as emerging solid and virtual simulations while being both signed in 3D and potential in real time [[12]]. Bruce Thomas created the mobile AR game, ARQuake, early 2000 and showed it at the International Symposium on Wearable Computers Inc. The Horizon Report was published in 2005 by Atlas [[14]].

Now let's consider the present situations of Augmented Reality in education.

Governments have initiated efforts in recent years with the goal of improving the quantity and effectivity of the teaching and learning outcomes. Besides, Malaysia is on its way to become a SDG developed country, which need a platform that is intelligent, progressive, imaginative, superlative and capable of contributing to STEM. These initiatives are driven by the visualizations that the traditional chalkboard and speaking teaching style, as well as the utilizing of static textbooks, fail to engage students and results in extreme poor learning outcomes. Respondents participated in a research performed by Teoh and Neo (2007), for example, felt that simply hearing the instructor speak in front of them was dull. The pupils thought that using technology will dictate them in their learning process. Therefore, educators have begun to look for advancements that have the potential to be simulated into education in order to provide guidelines students study more actively and better simulative science subjects [[15]].

1.3 Reasons for undertaking the research

Augmented reality is a revolutionary window of opportunity to be used in education. In every field of education, Augmented Reality is considered as crucial to solving significant challenges. We proposed an AR based education system in HSC or 11th grade standard students as we observed that in future degree related studies like, for example, medical or engineering, we can implement it in our education. In many other countries (For example, Greece, Ukraine, Hong Kong, Canada, Spain and India), they have accomplished AR based education in their education system.

In Greece, it is invented that the main idea behind is to combine reality with VR by superimposing additional simulations as visuals, audio, senses, touch, smell, and taste over a present scene to allow the user to interact with the AR [[16]].

In Ukraine, AR technology are increasingly being employed in a variety of social activity domains, including SDG. A lot of educational simulations in biology, physics, chemistry, natural science, mathematics, history and other subjects have been deployed, and even simulative books for high school or 11th grade students have been possible. However, the use of machine technology in tech preparation of prospective entities of Ukrainian language and literature is still developing [[17]].

In Hong Kong, the field of mobile augmented reality (MAR) has piqued the interest of both industry and academics. MAR augments a mobile user's actual world with computer-generated virtual material. In the case of powerful graphics that affect the mobile user's original vision, the intensity of the virtual contents and their influence on the mobile user's view define realism or virtual [[18]].

In both Canada and Spain, teachers in VET, VT institutions face significant challenges in the teaching fragments due to a wide range of students' special intellectual needs, as well as students' lack of adherence in simulations, motivation, concentration, attention, confidence approach, and background knowledge, among other factors exists. Many studies have found that Augmented Reality (AR) apps have a good target on student motivation, learning outcomes, cooperation, interaction, learning attitudes, and pleasure in higher education, among other things may exist [[19]].

In India, Augmented Reality plays an important part in engineering education by enhancing student learning and providing an enriching experience. Nowadays, mobile phones are outfitted with powerful processors, massive memory capacities, high-resolution cameras, a plethora of multimedia functions, and sensors. Along with this, with enhanced coverage with high speed technology can meet the fundamental hardware calibration for AR on mobiles and deliver a MAR experience. AR technology allows for the integrational simulations of the real environment with 3D virtual assistant, which may quickly spark the learner's outcomes and so make the learning process more tech-based, enjoyable, and motivating too [[20]].

Finally, can we make AR an AR based app where students can learn interactively so that we can make them come on a better track? We want to see if we can make AR based applications that will be better for our students and if we can implement them in our education so that our students can be on a better track.

1.4 Literature review

Saleem, Kamarudin, Shoaib and Nasar [9] stated that, Augmented Reality-based applications are unique e-learning tools that accelerates student learning in virtual classrooms. Because of the rapid spread of Coronavirus illness since the commencement of the COVID-19 pandemic, standard teaching procedures have been pushed back. During the COVID-19 epidemic, their study explores students' intentions toward e-learning using an augmented reality app.

During a review of Augmented Reality in educational applications, Majeed and Ali [3] described that in education, because of its advantages of showing 3D virtual information and interactivity, augmented reality (AR) gives a better user experience. Thus, many academics have been drawn to using this technology in their studies. However, in the educational setting, several forms of AR technology are represented. Therefore, the impact of employing this technology in research may change depending on the type. Their study presents an overview of augmented reality technologies in the educational setting.

Papanastasiou, Drigas, Skianis and Lytras [1] proposed that the goal of this review article is to showcase cutting-edge techniques and examples of augmented reality (AR) systems, apps, and experiences that increase student learning and skill transfer to the real world. According to the literature, there are encouraging data demonstrating that AR environments increase learning outcomes and provide multiple benefits for spending time and money in K-12, higher, and tertiary educational settings. AR supplements standard courses to meet kids' different learning demands.

Faith Marcel [10] said that the mobile AR platform *HP Reveal* is used to examine the benefits of mobile AR and LOs in higher education. The affordances of AR technology in educational organizations and institutions, as well as their possible consequences in fields of higher education, were investigated using digital trail data from publicly shared and published AR users' LOs. A quantitative comparison examination of system data and content from 632 AR LOs was performed twice over a 2-year period for this purpose. To determine multimodal functions and traits, each LO was thematically tagged. The results also demonstrated a rise in the usage of recorded and online video content, as well as the use of three-dimensional (3D) characters for instructional purposes, over time. An analysis of the AR platform's affordances highlighted potential for educators to explore more interactive and collaborative applications of AR with their pupils for educational goals in higher education.

Kerr and Lawson [8] entitled in their paper about the fast and continual development of digital technology continues to open up new educational opportunities. AR has enabled the construction of blended learning methodologies and online education throughout the previous decade. Their research looks at the learning potential and advantages of augmented reality technology, with a particular emphasis on developing new methods in digital storytelling across placed encounters.

Rabia M. Yilmaz [4] narrated in her article that the study offers a survey of the literature on the use of augmented reality (AR) in higher education. The level of education, field of education, and material kinds of AR utilized in education, as well as the purported educational benefits of AR, have all been researched. All studies in her article are classified into target categories, which creates better learning outcome.

Murat Akçayır and Gökçe Akçayır [2] presented in their paper that their research provides a thorough overview of the literature on the application of augmented reality (AR) in educational contexts. The data show that the number of AR research has increased during the previous four years. The most frequently mentioned advantage of AR is that it promotes improved learning achievement. Usability concerns and frequent technical problems have been identified as some of the obstacles faced by AR. They also found numerous possibilities for AR in educational platforms.

Saidin, Halim and Yahaya of Malaysia University [6] reviewed in their study that, technology in education may inspire and drive pupils to study actively, resulting in an effective learning process. This is due to its superior technology, which allows users to engage with virtual and real-time apps and provides them with natural experiences. Furthermore, the use of augmented reality (AR) into education has lately piqued the interest of researchers due to its capacity to immerse pupils in genuine situations. As a result, this concept paper examines the research on AR that has been undertaken. An analysis of the research findings reveals that, overall, AR technologies offer a favorable potential and benefits that may be applied in education. The analysis also highlights AR's shortcomings, which should be addressed in future research.

Kesim and Ozarslan [5] reviewed that in higher education system, although the physical world is three-dimensional, two-dimensional media is most commonly used. When AR technology is combined with educational information, it generates new types of automated applications that improve the efficacy provides one-of-a-kind affordances by

integrating real and virtual worlds, as well as continuous and implicit user control of the point of view and interactivity.

Kesim and Ozarslan [7] again reviewed their study that although the physical world is three-dimensional, two-dimensional media is commonly used in education. When AR technology is combined with educational information, it generates new types of automated applications that improve the efficacy and its educational applications. In the framework of education, key technologies and methodologies are explored.

All these review papers discussed above are related to our thesis work and other related activities. We have seen and reviewed that they have done tremendous work in AR based education. We are inspired by their ideas and we have come up with new different ideas that are related to our thesis work. We used an AR based application named “Insight Lung” for higher school or 11th grade students in tertiary education of our country for a better future in field work which is completely a new approach. We used the app to test among two groups of students to determine whether AR based education is better or non-AR based education is better. We analyzed the results and came up with the outcome of our research work which is definitely new than other related research works. Thus our research work varies from other related research works.

Chapter 2: Methods and experiments

2.1 Domain selection

For our thesis work we reviewed many Computers Science (CS) background domains considering the ones which are on high demand. We selected 3 domains in initial and after discussion and review, we came up with the decision of selecting Augmented Reality as our thesis domain. Augmented Reality (AR) is known as the overlay of computer visuals over the real world. AR is used to provide a more engaging and dynamic consumer experience by combining input from various gear such as smart glasses, smart lenses, and smartphones. After selecting the domain, we discussed among our group members and then selected tertiary education sector to implement the AR. We selected high school students and we proposed better education facility in tertiary education by using the AR.

2.2 Review of paper

We searched for a large number of journal and conference articles that were relevant to our study and read literature reviews. We considered keywords like AR in education in 2021 and AR in education for Finland in our search. Then, for paper evaluation, we chose several papers that were relevant to our study. We studied papers that were relevant to our thesis work and acquired information about augmented reality and its applications in education. Then we began analyzing the papers that had been reviewed.

2.3 Analysis of paper

We looked at papers that had already been reviewed and analyzed them. We will get benefits from analysis since it will help us improve critical thinking and research abilities. For analyzing the papers, initially we identified logical reasons for conducting our work, reviewed the description of the methodology applied for the research, a concise report of the findings and a logical conclusion based on the result. Then we reviewed the papers. For reviewing the papers, first we got ourselves familiar with the title, abstract and introduction. Then we read the headings of each sections, looked through the conclusions and scanned the references. We also did critical analysis by retrieving answers of questions like what type of paper, what is the research topic of the paper, information's provided in the paper are valid or not etc. Then we examined the contents. We reviewed thesis statement, author's arguments, checked the evidences and limits of the study, and tried to establish the author's perspective. We also checked the format and presentation of papers by checking first-level, mid-level and deep-level sentences. In last we did critique and evaluation of the papers. For this purpose we assessed crucial aspects like reviewing

author's objective and its engagement, in broader context what role it plays. We checked grammar and organization of the papers. We also identified what the readers will learn from those papers.

2.4 Selection of an AR-based app

We did analysis of several relevant papers by reviewing their descriptions of the title, abstract, introduction and methodology. We also identified crucial findings regarding our research area. After doing the analysis, we selected an AR-based app to test whether learning from an AR-Based educational material is better rather than learning from a non-AR based educational material like books. We selected "Insight Lungs" app for our research work. Inside the app, we found two mode for learning about lungs, one is AR mode and another is non-AR mode. For our research purpose we used only AR mode. After that we identified and reviewed key findings related to our research work.

2.5 App analysis

Augmented reality is a technology that displays a virtual image on real-world objects. As a technology, augmented reality is breaking into new sectors and bringing previously unthinkable concepts to life. After selecting the "Insight Lung" app, we reviewed the whole app and identified the key findings for our research work. We inspected AR mode of the app and reviewed it's properties. Special algorithms and sensors are used to detect the position and orientation of the AR model in augmented reality. In AR mode, an anatomical view of human body is found where by clicking the anatomical view, a human lungs can be viewed showing basic information's. In the app we found options for "Asthma" and "COPD" where we can know about various diseases and visual affects related to the mentioned two terms. For Asthma, we can know about mild, severe, moderated and Asthma Exacerbation. For COPD, we can know about mild, moderate, severe and very severe. Also we can know about the FEV1 regarding Asthma and COPD of our own lungs. After doing the analysis we introduced the app to the students for the test so that we can determine which medium of learning is better, medium of AR or medium of non-AR.

2.6 Introducing the app

We reviewed various aspects of the "Insight Lung" app and tried to identify details about Asthma, COPD, FEV1 measurement thru the app. The app can explore the human lungs in augmented reality and learn more about asthma and COPD. This app is built and designed for the aim of medical education. The purpose is to make medical education interesting, exploratory, and enjoyable for students and professionals, as well as accessible to patients, in and out of the classroom, lecture hall, or living room. The app is dedicated to taking medical education to the next level by creating aesthetically appealing and highly interactive information based on real-world medical and scientific requirements.

The app INSIGHT LUNG uses ARCore to allow users to scan their surroundings and position for the three-dimensional lung without the need of pre-defined markers. The virtual assistant ANI demonstrates through the various lung conditions. The virtual Assistant has the ability to rotate and resize the high-resolution lung hovering in front, allowing users to get the real-world example on incredibly intricate textures. Besides visualizations of the healthy lung, asthma, and COPD, the app has also the feature of monitoring lung condition and severity level.



Fig. 2-1: Insight Lung app.

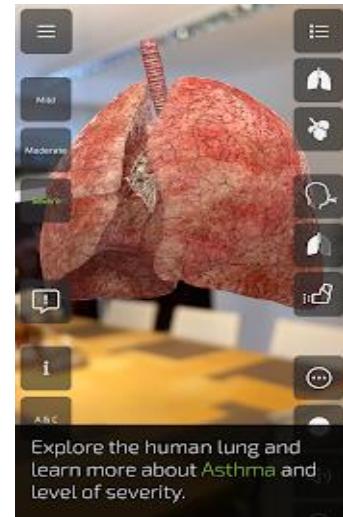


Fig. 2-2: Healthy lung view.

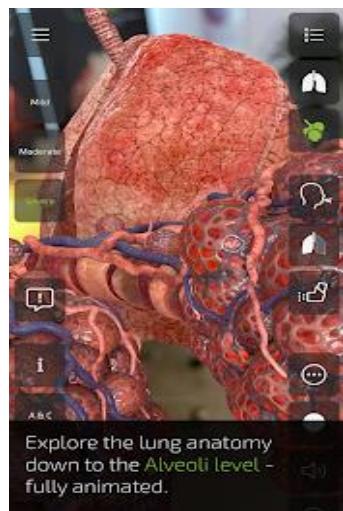


Fig. 2-3: Alveoli level view.



Fig. 2-4: COPD detailed view.

2.7 Book creation with the same content as in the app

We have selected “Insight Lung” app for our research work and to test whether AR based media for educational learning is better or not. We created a physical book and taught the students from the book. In the book, we inserted narrated details from the app and inserted images as necessary. We created the book as much as like the book of 1st year medical students for high school or 11th grade students so that they can get a head start for their upcoming career. We also reviewed the book from a medical student to check whether all information’s put in the book are valid or not. We also reviewed and compared the main app with the book and tried to put the details in the book as much as stated in the app. After that we decided to take a small evaluation of 30 marks so that we can judge whether AR based learning is better or non-AR based learning.

2.8 Starting the evaluation

The attention created in commercial and industrial circles, as well as discussion in popular publications and research papers in the education and training sectors, tends to suggest that AR has a bright future as a visualization technology. The evaluation has been segmented into starling steps- planning, data-collection, dealing with the results and drawing up the terms of reference, dealing with the results and declaration and so on. Each of these main steps has been documented in a reference. For the evaluation, we have used 2(two) Google forms, one for AR app based learners and another for AR book based learners. We selected two forms so that from the histogram we can easily differentiate the difference of AR app based and AR book based methods.

2.9 Conducting evaluation

In the realm of international research, evaluations are becoming more essential. Firstly, searching the research papers, analyzing them and assembled knowledge, we then selected an AR based application which is called “Insight Lung”. Then we showed some students in HSC or 11th grade about this AR based application. Then we collected information from the application and made a book from it. Then we taught some students of HSC or 11th grade with the book for 1 week so that we could decide if learning from an AR application is better or learning the same things from a regular book is better. In order to test which learning medium is better, we decided to evaluate the students of both groups by taking a multiple-choice questions (MCQ) exam in Google forms. To take the MCQ exam, we have generated two set of questions from the book. Then we arranged some students from HSC or 11th grade and conducted MCQ exam among them. We have taken an exam of one group containing 3 boys and 3 girls regarding AR based application and simultaneously we have taken other 3 boys and 3 girls regarding book made by the information of that AR application. The exam continued for 35 minutes and of 30 marks. Then we collected the results using Google forms, analyzed the results from the exam

and took our decision that AR based applications are better than textbooks or non-AR based applications.

2.10 Result accumulation

To determine whether AR based learning is better or non-AR based, we took examination of 6 boys and 6 girls in two groups. We created google form to take the exam. There were two parts in form, one part is for non-image based aka non-analytical part based test and another part is for image based aka analytical part based test. These two parts were created so that we can get nearly accurate assumption about our findings. We took one day for testing and after test, we collected the results from google forms. From google forms, we collected various data, bar charts and histograms regarding our research. We collected average of all respondents so that we can get a better view of the perspective. We also collected median and range from the forms. We collected total points distribution in graphical view from forms. We reviewed frequently missed questions from respondents with marking of correct responses. In scores section of form, we reviewed graphs aka histograms which were generated from responds of individual options of questions. Graphs are created so that we can know the frequency that how much percentage of respondents answered which option. The options in questions were shuffled to ensure better exam environment. Two google sheets are also auto-generated from forms where we can track of time, email address, score, personal details, and selected options, which makes our data collection much easier.

2.11 Outcome analysis

We took the help of google forms for collecting test data so that we can assume from the exam that which method is better for high school or 11th grade students. We took many types of data, graphical charts, and histograms and reviewed them. For a better outcome, we divided the data into ourselves and reviewed them accordingly. From AR and non-AR lungs exam, we gathered 6 responses (3 male and 3 female) from the same institution. From non-AR lungs exam, we noted average of 23 out of 30, median of 21 out of 30 and range between 19-27 points. From AR lungs exam, we noted average of 25.83 out of 30, median of 24 out of 30 and range between 22-29 points, which shows great progress than non-AR lungs exam. We also consulted with our honorable supervisor about our future leads. Then we merged all reviews and finally draw our outcome. We finally came to a decision that, learning thru interactive media is better than learning with books. AR based application is better than non-AR based applications like books, hand notes. We can relate our outcome with a former US memory champion. He can tell total 100 digits of pi without an error. For doing such amazing work, he divided numbers into some words and represented them with some characters. Then he plotted those characters into a residential house and memorized them accordingly. Thus when he read the numbers, he just

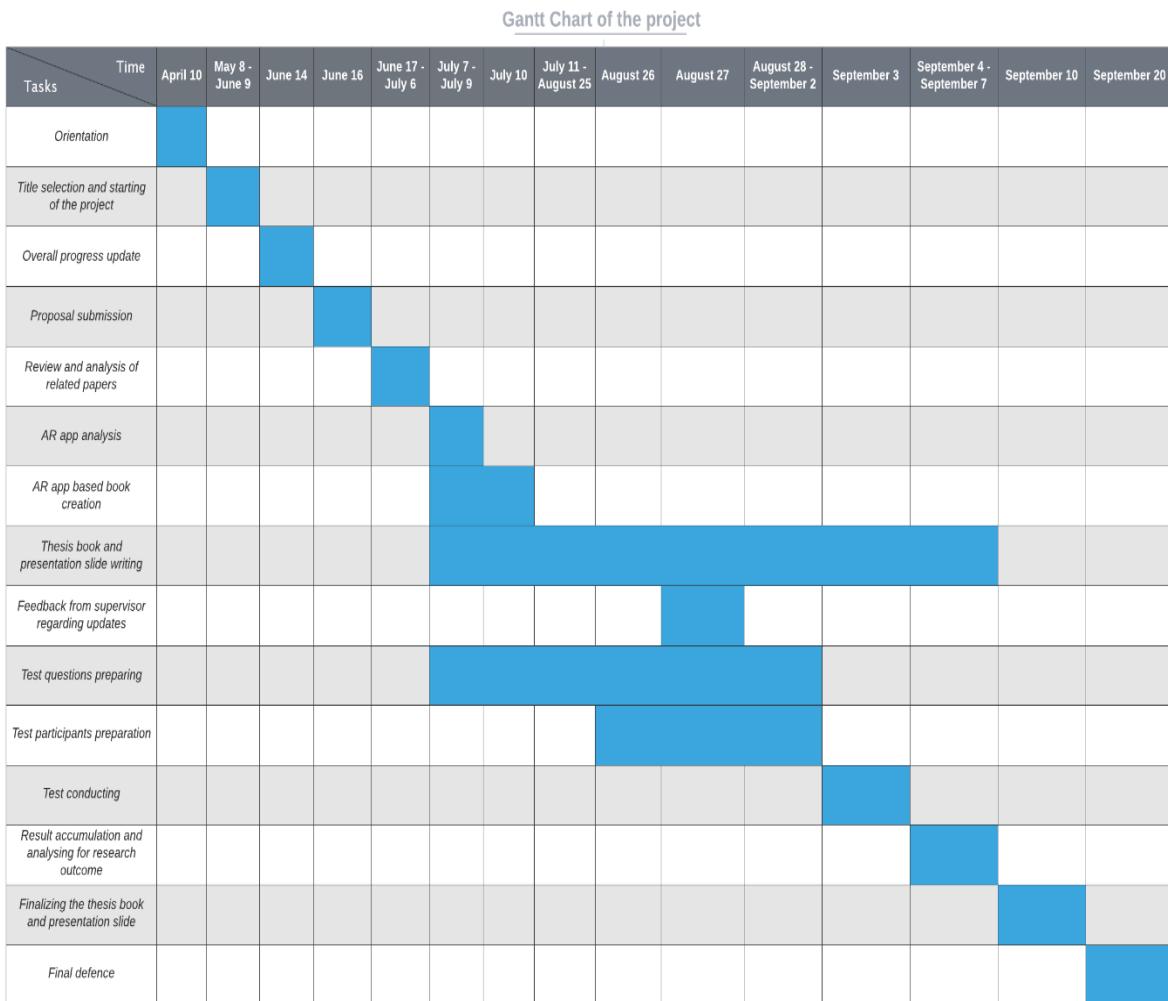
converted the words into numbers simply. Thus graphical learning is better than fuzzy textbook learning.

2.12 Declaration

Analyzing the data from the google form we came to a solution that, learning with Augmented Reality (AR) is better than learning with random/ text books. AR represents a graphical overview in front of the user or students so that they can learn the things into real time environment. Already in many developed countries AR is used for sophisticated learning and training. But AR has also some disadvantages too. Devices requires high processing and battery power to perform the apps smoothly. Even if the battery optimizer is on, some apps will shut down automatically or crash down. To buy such devices, extra amount of money is required which not every student can barely even manage. Also some of the apps injects spyware into devices that steals the data of the device user anonymously. Which creates big safety risk too. So we have to eradicate the disadvantages so that every one of the students can have the fun of an AR based learning. Also we need skillful developers so that apps can consume less power and resources, apps can be used ensuring no harm to the apps users, apps stability will be ensured, also the price of the devices should be reasonable. We can easily have a quick overview of the whole project timeline simply by seeing the Gantt chart. Gantt chart describes the details of the activities of the whole project in x-y axis where tasks are placed in x axis and time for those tasks are placed in y axis. Tasks and time are arranged in time based ascending order.

The Gantt chart is given below,

Table 2-A: The Gantt chart of the project.



Chapter 3: Results and discussions

3.1 Result

Augmented Reality creates a virtual platform where we can roam and emerge freely using specified handheld devices. In many nations it is used widely. To test whether AR can be beneficial for 11th grade or high school students, a test is been conducted among 6 boys and girls. They were taught in two separate groups where for one group AR based “Insight Lung” app is used directly and on the other hand, book made of same extracted data from the app which is used to taught. A google form containing questions of 30 marks is delivered to the students and data were collected and distributed among research group members for better evaluation of the research work.

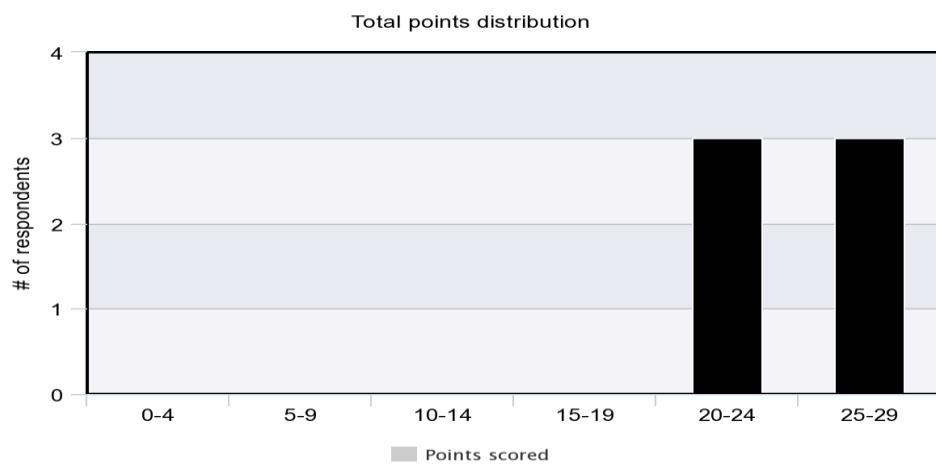


Fig. 3-1: Total points distribution for AR_Lungs-Exam.

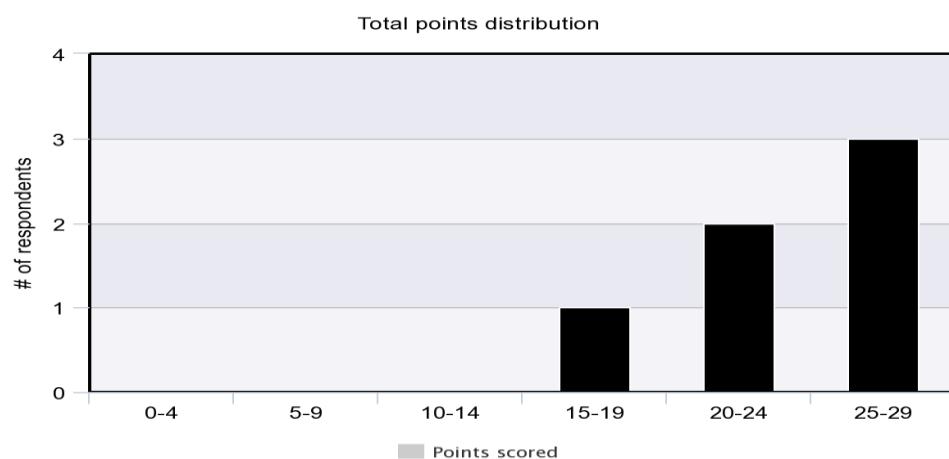


Fig. 3-2: Total points distribution for Non-AR_Lungs-Exam.

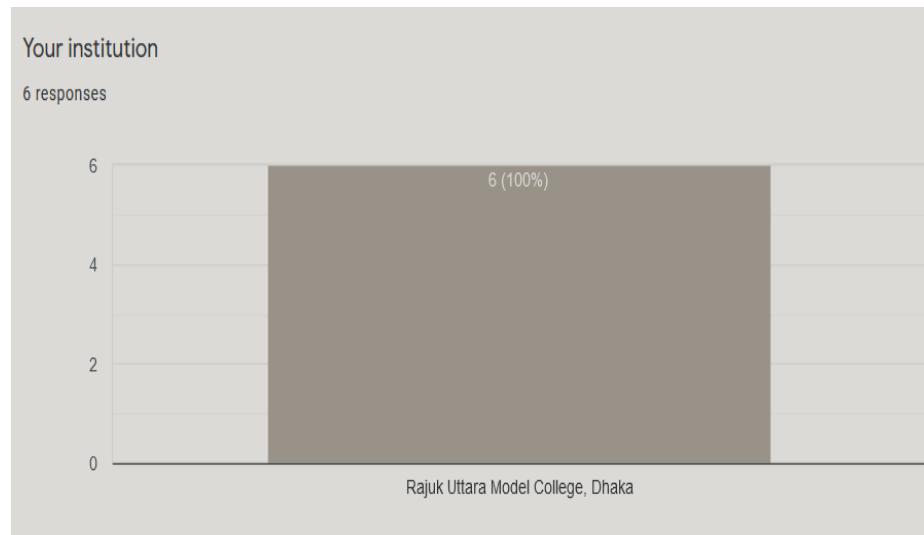


Fig. 3-3: Institution for AR_Lungs-Exam participants.

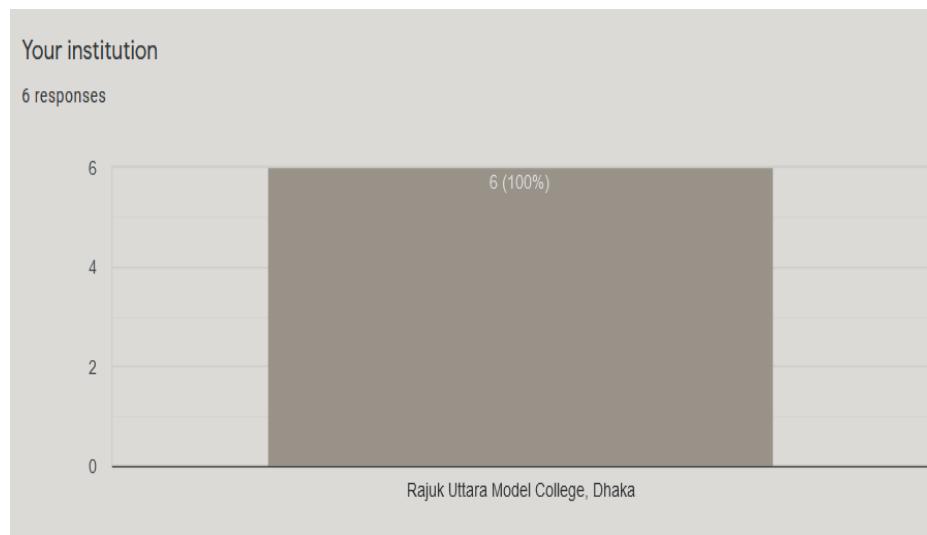
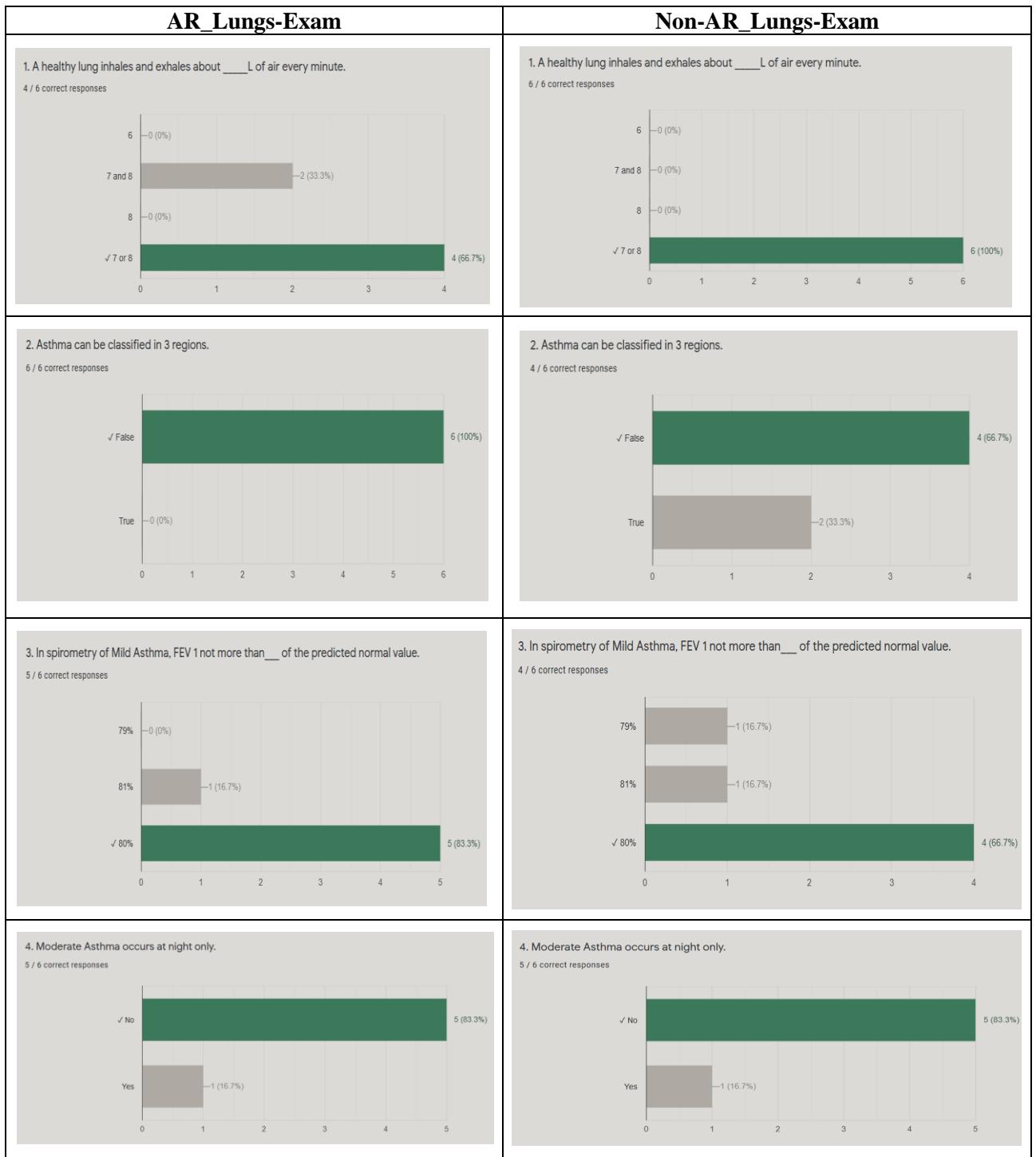


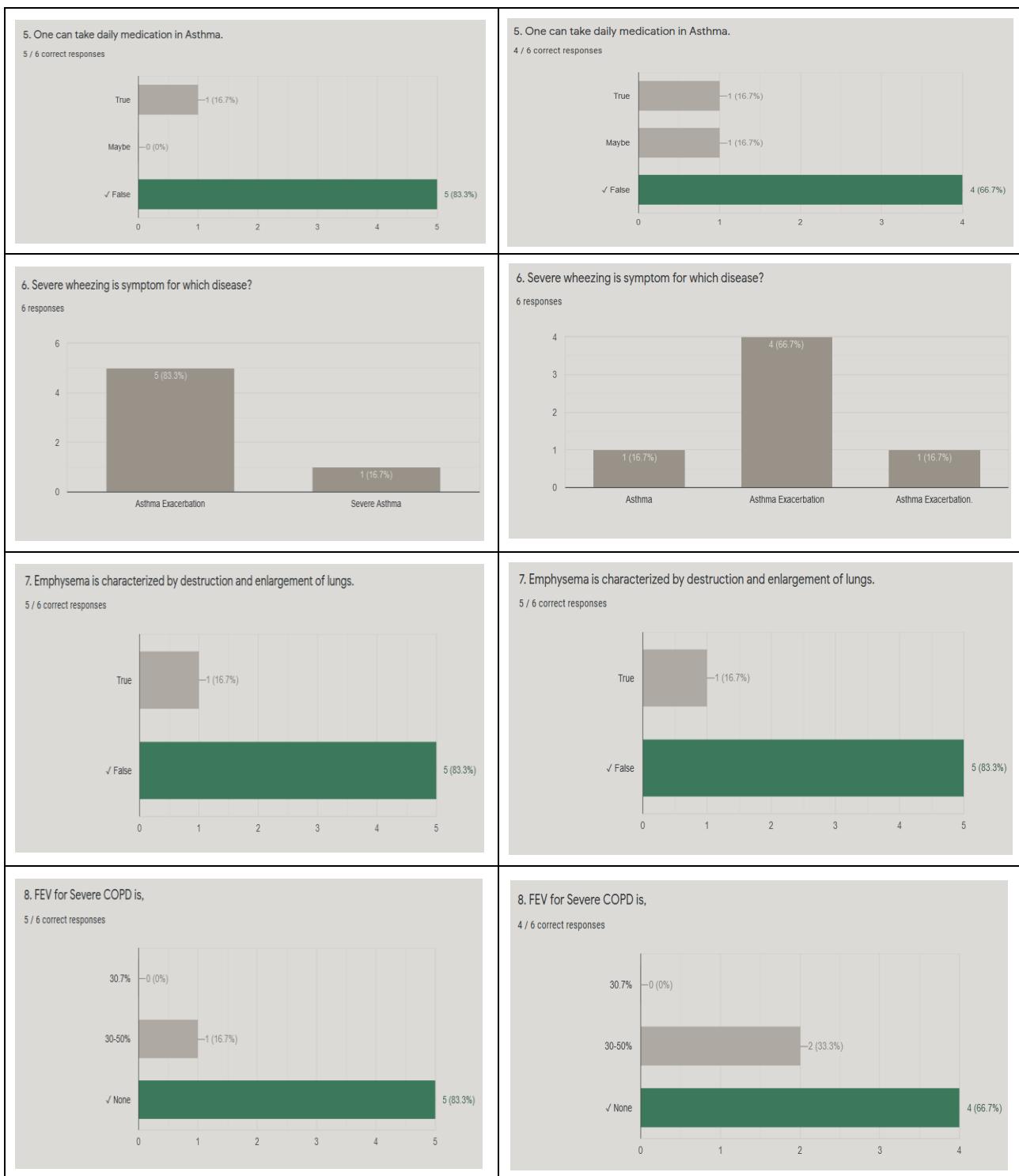
Fig. 3-4: Institution for Non-AR_Lungs-Exam participants.

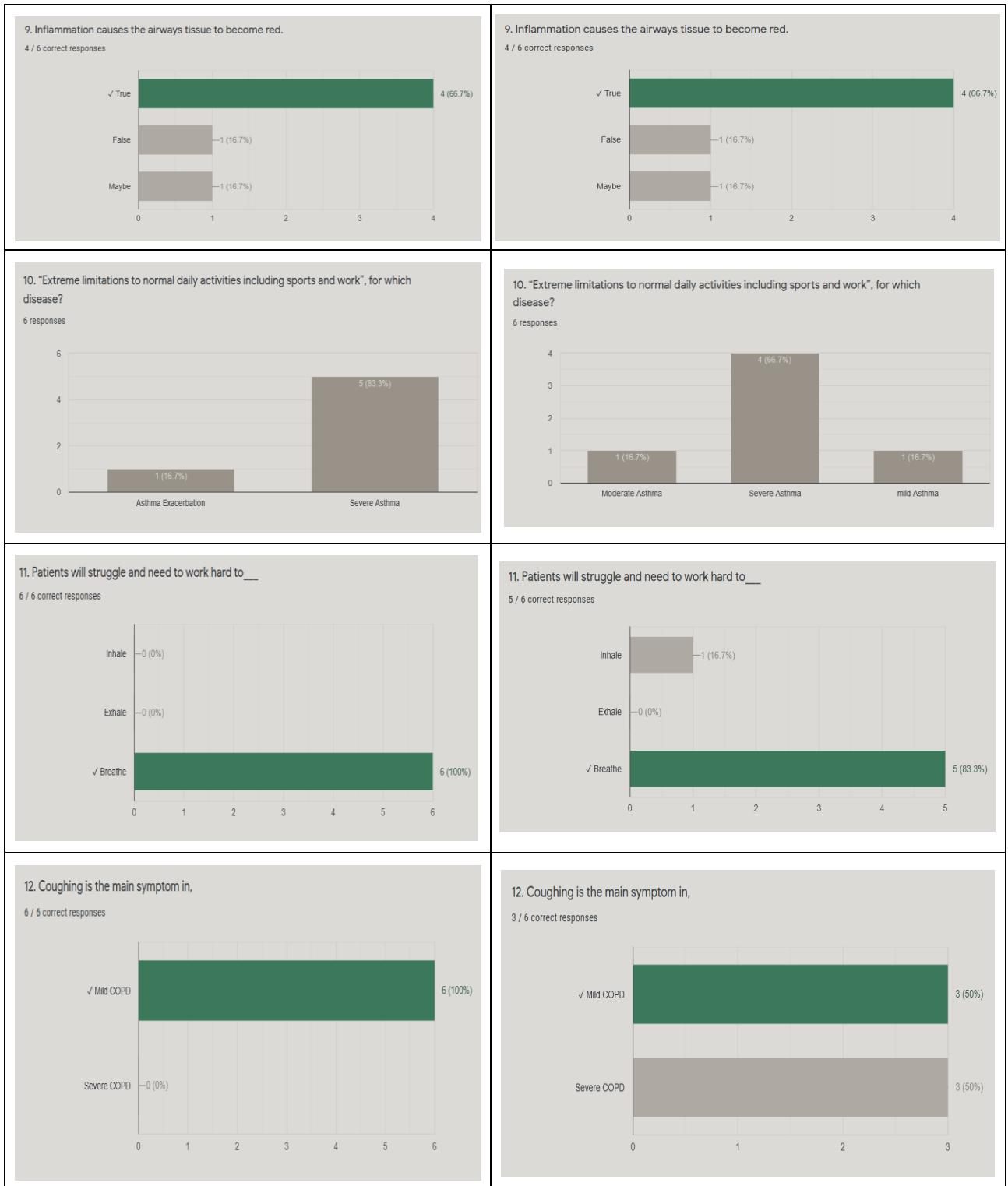
We also collected histogram for both tests and analyzed them accordingly. Histogram is an approximate representation of the distribution of numerical data or representation of some numerical values according to x-y axis.

Histogram for both tests given below,

Table 4-A: Histogram for both tests.

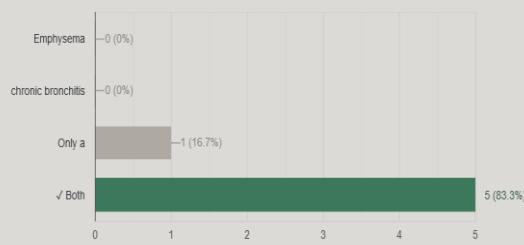






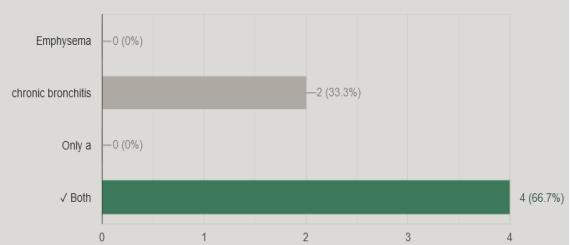
13. _ and _ are the two most common conditions that contribute to COPD.

5 / 6 correct responses



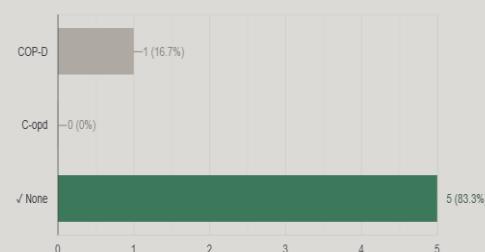
13. _ and _ are the two most common conditions that contribute to COPD.

4 / 6 correct responses



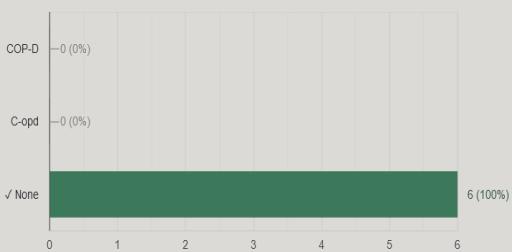
14. Breath, chronic cough, and sputum production are caused for,

5 / 6 correct responses



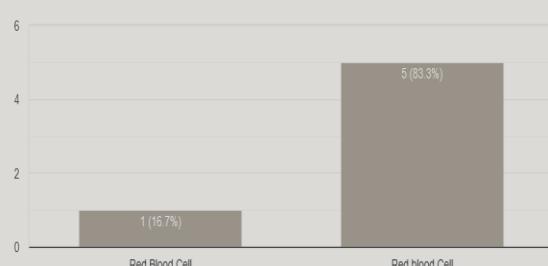
14. Breath, chronic cough, and sputum production are caused for,

6 / 6 correct responses



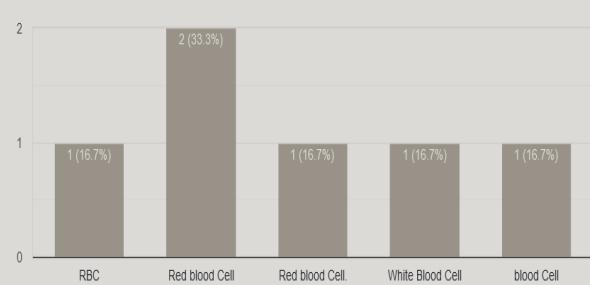
15. _ carries oxygen.

6 responses



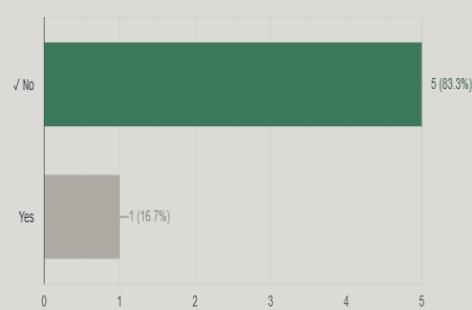
15. _ carries oxygen.

6 responses



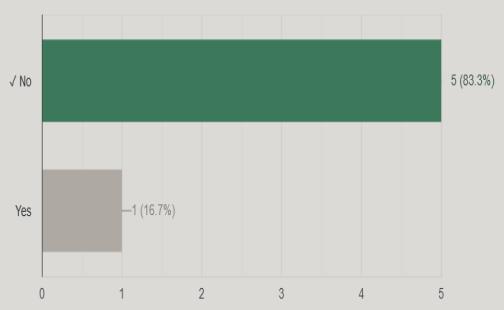
16. Tertiary bronchi is in the lungs.

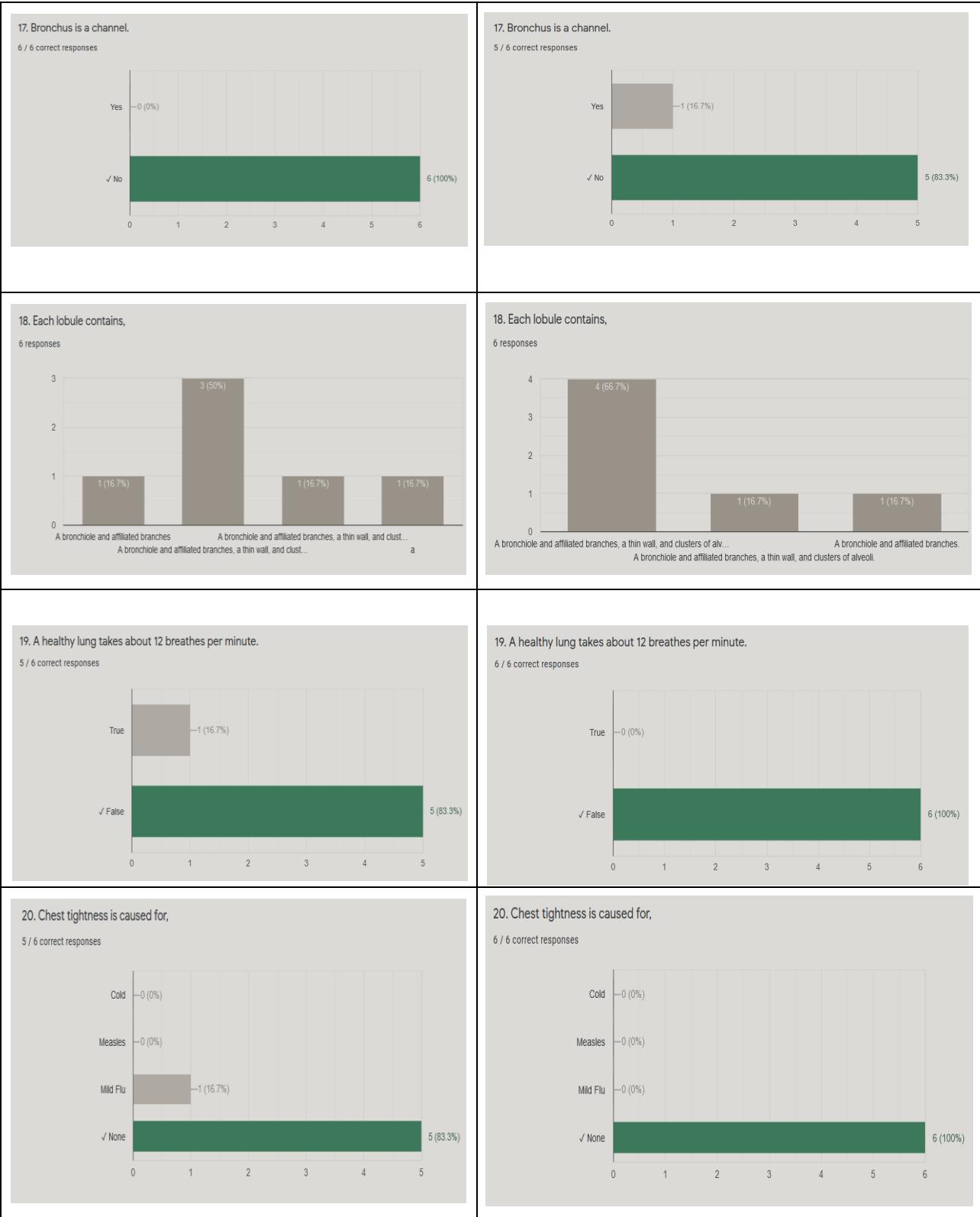
5 / 6 correct responses



16. Tertiary bronchi is in the lungs.

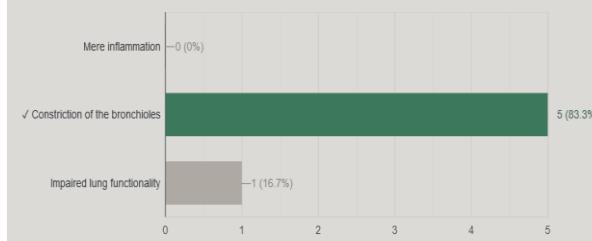
5 / 6 correct responses





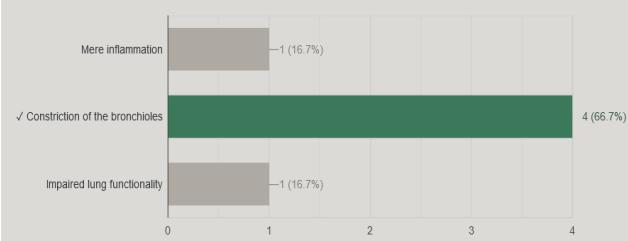
21. Which symptom can be found in the mentioned picture?

5 / 6 correct responses



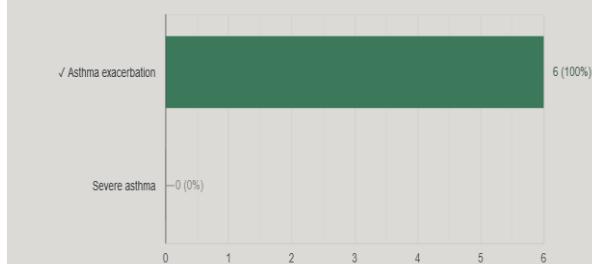
21. Which symptom can be found in the mentioned picture?

4 / 6 correct responses



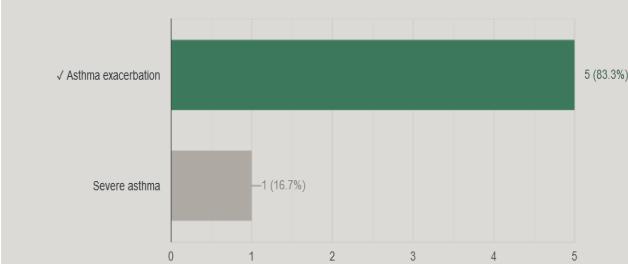
22. The mentioned picture represents,

6 / 6 correct responses



22. The mentioned picture represents,

5 / 6 correct responses



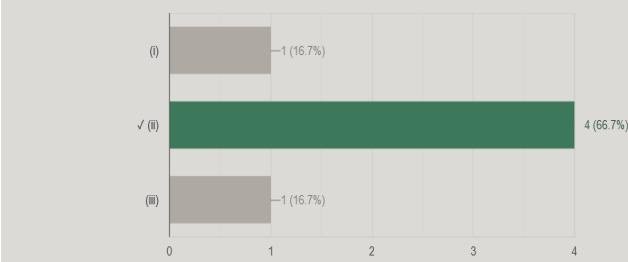
23. Which one represents asthma?

5 / 6 correct responses



23. Which one represents asthma?

4 / 6 correct responses



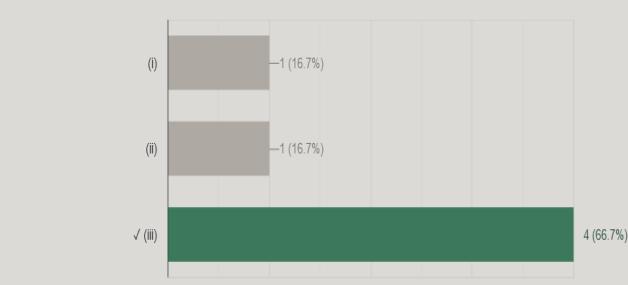
24. Which one represents COPD?

6 / 6 correct responses



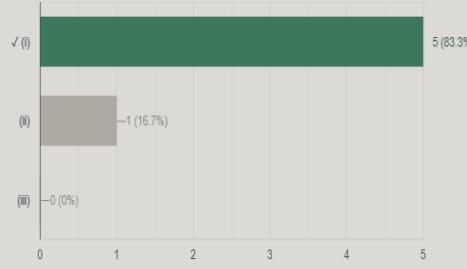
24. Which one represents COPD?

4 / 6 correct responses



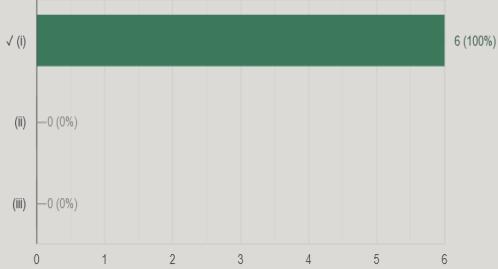
25. Which one represents a healthy lungs?

5 / 6 correct responses



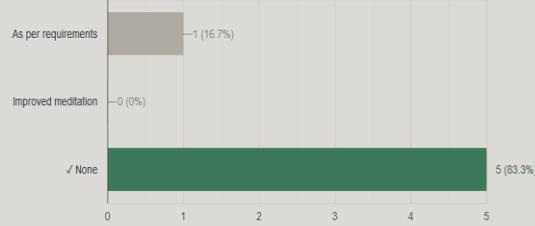
25. Which one represents a healthy lungs?

6 / 6 correct responses



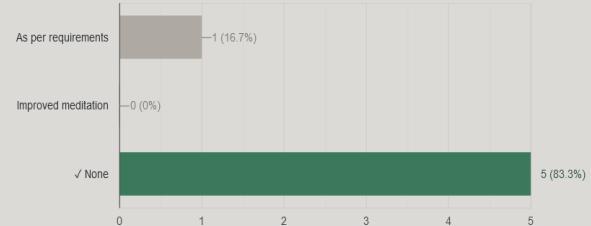
26. Which treatment can be applied for the mentioned picture?

5 / 6 correct responses



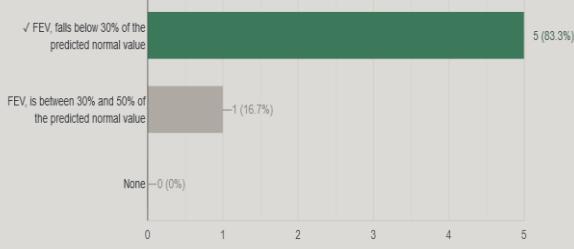
26. Which treatment can be applied for the mentioned picture?

5 / 6 correct responses



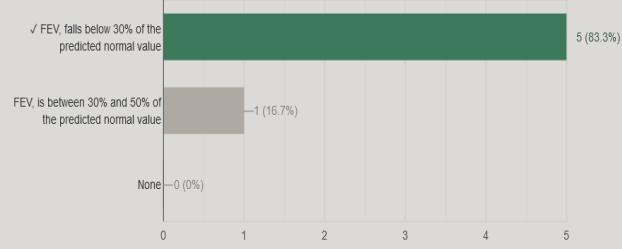
27. Lung state, mentioned in the picture of question no. 26 is,

5 / 6 correct responses



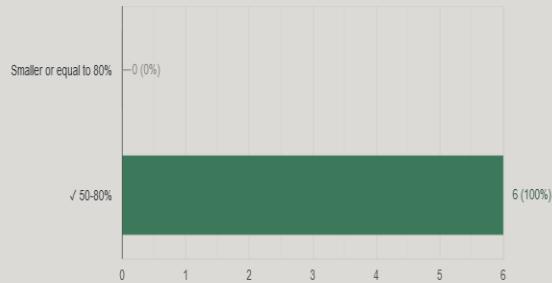
27. Lung state, mentioned in the picture of question no. 26 is,

5 / 6 correct responses



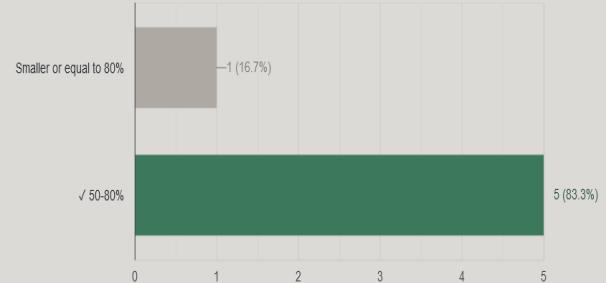
28. FEV rate for the mentioned picture is,

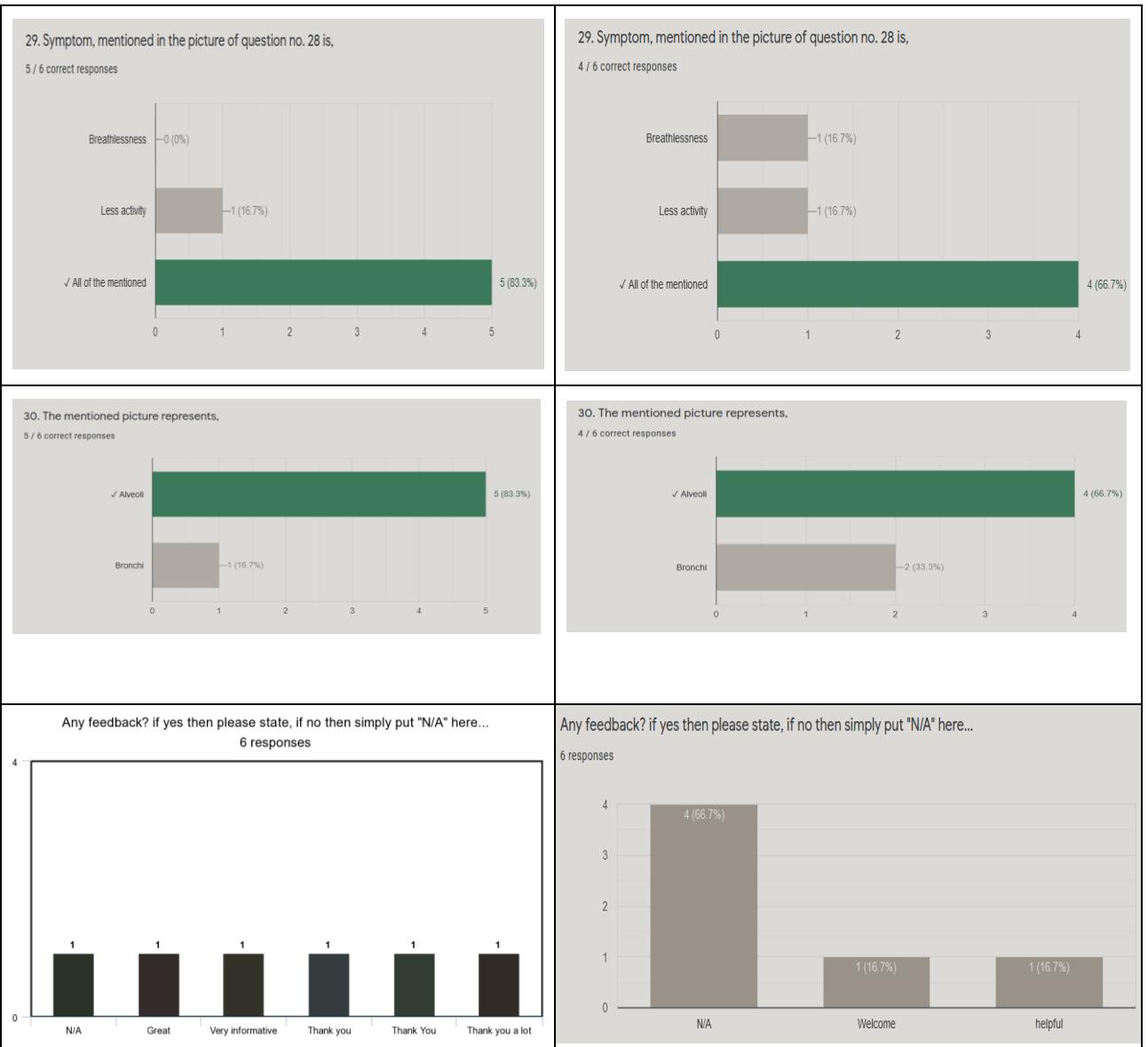
6 / 6 correct responses



28. FEV rate for the mentioned picture is,

5 / 6 correct responses





We can also see some of the major changes of the research outcome with the help of average variance and median variance. In median and average variance, variation in both tests are represented in percentages using pie chart.

Pie charts are given below,

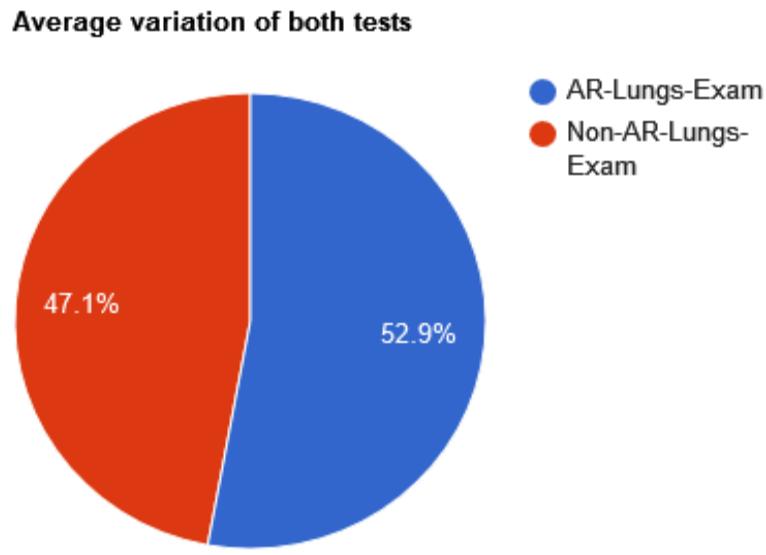


Fig. 3-5: Average variance.

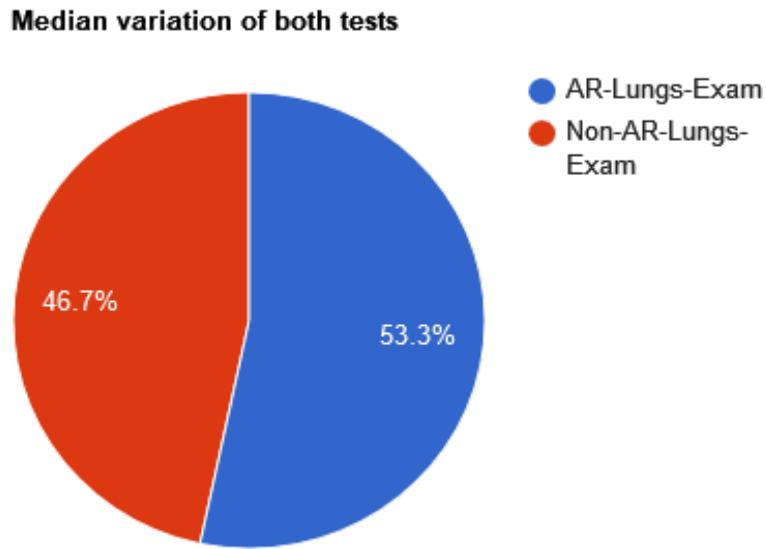


Fig. 3-6: Median variance.

After doing the review and analysis of the collected data, it is seen that students taught using book gained less marks than students taught using AR based app. Also the percentage of correct answers for individual response of the questions are also at peak for

the AR based learners. After evaluation feedback was collected from the participants. The feedback also seems quite well for the AR-based learners. Despite of having some issues like high-end device, big display device, the overall success of AR-based learning is far better than non-AR based learning.

3.2 Discussions

Augmented Reality can definitely add a new dimension for tertiary education. Students can learn more complex stuffs very easily. In AR based learning, students don't need to carry heavy weight of books for nearly 4-5 hours. One AR based device and a note paper will be enough to conduct full-day classes. Teachers can teach the students by sending the reference materials through the email of students. Students can download it and use AR or non-AR mode to study as per their requirement. Synchronization will be available through Wi-Fi in campus area and students can easily connect two devices with one account using auto-synchronization mode in the device as well. Portable space facility through cloud network will be available as a virtual drive to access files with one single account. To ensure better learning environment, online monitoring can be applicable. And last but very important thing is, better understanding through free or minimally paid workshops and training programs can be beneficial for both teachers and students to understand the full functionality of AR. Due to COVID situation, considering the typical health issues of students, we weren't able to test among many students. But we ensured proper test environment among the selected number of students. Test results derived from the experiment is not influenced by the number of participants in any ways. Overall test conducted from the students is fruitful for our research work and derives that AR based learning is much advanced, much secure and much study-friendly than non-AR based learning.

Chapter 4: Conclusion and future works

4.1 Conclusion

We set out to understand the practicality of AR in preparing high school students for undergraduate studies. We conducted experiments on students with an AR based book and a text-based book on human lungs. An exam was conducted to investigate the differences in comprehension among students of both groups. The results of the exams clearly demonstrated the power of the AR based book over the non-AR book. Though the group size was small, it has strongly established the base for further research on usage of AR for high school students to prepare them for higher studies.

4.2 Future works

Due to pandemic situation, the sample size that could be gathered was substantially small. In the future, the same experiment needs to be conducted on a larger student population.

No Memory Retention Test (MRT) could have been performed due to pandemic and the time constraints. Studies need to be carried out to check how much knowledge students can retain for after studying both AR based and non-AR book.

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Appendix A

AR Book

Augmented Reality in Action: getting high schoolers an early start with tertiary education

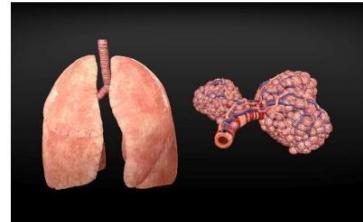
Lung

Lung is indicated in the Human skeleton.



What is Lung?

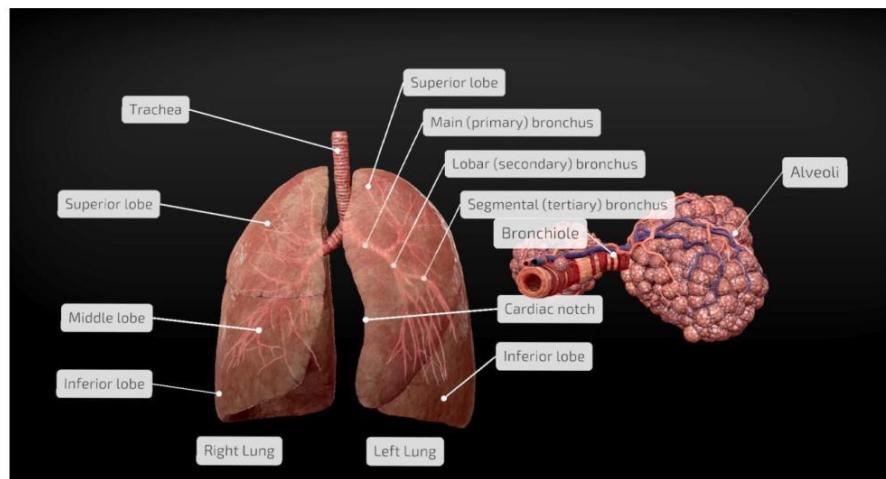
The lungs are a pair of spongy, air-filled organs located on either side of the chest (thorax). The trachea (windpipe) conducts inhaled air into the lungs through its tubular branches, called bronchi.



What are lungs and its function?

The lungs' main function is to help oxygen from the air we breathe enter the red cells in the blood. Red blood cells then carry oxygen around the body to be used in the cells found in our body. The lungs also help the body to get rid of CO₂ gas when we breathe out.

The lungs' structure



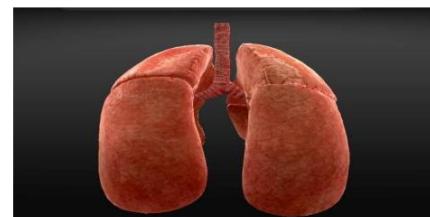
The lungs begin at the bottom of your trachea (windpipe). The trachea is a tube that carries the air in and out of our lungs. Each lung has a tube called a bronchus that connects to the trachea. Each lung is divided into lobes separated from one another by a tissue **fissure**. The right lung has three major lobes; the left lung, which is slightly smaller because of the asymmetrical placement of the heart, has two lobes. Internally, each lobe further subdivides into hundreds of lobules. Each lobule contains a bronchiole and affiliated branches, a thin wall, and clusters of alveoli.

Healthy Lung

A healthy adult at rest takes about 12 breaths per minute, inhaling and exhaling about 7 or 8 L of air every minute. The total surface area of all alveoli in a healthy set of adult lungs is approximately 70 m² or the size of half a tennis court.



Front View



Back View



Right View



Left View

Asthma

What is Asthma?

Asthma is an inflammatory disease that affects the airways of the lung. The symptoms of asthma are cough, wheezing, chest tightness and shortness of breath.

In an asthmatic lung three significant changes occur within the airways:

- Inflammation causes the airways tissue to become red, swollen and highly sensitive to irritants.
- Tightening of the muscles that surround the airways (bronchoconstriction) contributes to narrowing of the airway.
- Overproduction of mucus can block the airways.

Asthma can be classified as mild, moderate or severe.

Mild Asthma

- **Symptoms:** mostly free of symptoms (e.g., coughing and breathlessness)
- **Lung:** some inflammation and constriction of the bronchioles is seen and some mucus production
- **Night-time awakenings:** not usually a problem
- **Activity:** patients have a reasonable level of daily activity.
- **Spirometry:** usually normal and only mildly impaired. FEV1, not more than 80% of the predicted normal value.
- **Rescue medication:** more than twice a week (but not daily)



- **Controller/ maintenance medication:** as per guidelines in your country.

Moderate Asthma

- **Symptoms:** occur more than twice a week or at night
- **Lung:** increased inflammation, constriction of the bronchioles, mucus production.
- **Night-time awakenings:** at least once a week
- **Activity:** some limitations to normal daily activities including exercise and work
- **Spirometry:** an obstructive pattern will be seen, with air flowing out of the lungs more slowly than it should (FEV₁, between 60%-80% of the predicted normal value).
- **Rescue medication:** daily
- **Controller/ maintenance medication:** as per guidelines in your country.



Severe Asthma

- **Symptoms:** patients suffer from shortness of breath and coughing every day.
- **Lung:** lung function is impaired nearly all the time and often severely. A lot of inflammation, bronchoconstriction, mucus production



- **Night-time awakenings:** may occur as often as nightly
- **Activity:** extreme limitations to normal daily activities including sports and work.
- **Spirometry:** an obstructive pattern will be seen, with air flowing out the lungs more slowly than it should. FEV1, not more than 60% of the predicted normal value.
- **Rescue medication:** may be required several times a day.
- **Controller/ maintenance medication:** as per guidelines in your country.

Asthma Exacerbation

- **Symptoms:** severe wheezing, chest tightness, coughing difficulty speaking, very rapid breathing
- **Lung:** in an attack (exacerbation) the airways get very narrow or closed due to muscle spasms around the airways, more and thicker mucus, and swelling of the internal bronchus lining (mucosa)
- **Activity:** normal activity is not possible. The patient is in a crisis
- **Breathing:** patients will struggle and need to work hard to breathe. potentially life-threatening
- **Treatment:** as per guidelines in your country



What is COPD?

Chronic obstructive pulmonary disease (COPD) is a progressive lung disease that blocks airflow through the lungs, making it difficult to breathe. Emphysema and chronic bronchitis are the two most common conditions that contribute to COPD. Emphysema is characterized by destruction and enlargement of lung air spaces, and bronchitis by increased mucus and inflammation of the bronchial tubes.

The typical symptoms of COPD are shortness of breath, chronic cough, and sputum production. COPD causes narrowing of the airways, decreasing the flow of air in and out of the lungs. Lung alveoli lose their elasticity making it difficult to exhale. Air becomes trapped in the lungs and mucus is produced causing a chronic cough.

Mild COPD

- **Symptoms:** coughing is the main symptom; breathlessness only occurs with more vigorous Physical Activity.
- **Lung:** FEV, at least 80% of the predicted normal value; the obstruction is only slightly reversible.
- **Treatment:** as per guidelines in your country.



Moderate COPD:

- **Symptoms:** Breathlessness allows less and less activity. Quick walking or climbing a flight of stairs becomes increasingly difficult.
- **Lung:** FEV, is between 50% and 80% of the predicted normal value.
- **Treatment:** As per guidelines in your country.



Severe COPD

- **Symptoms:** Breathlessness is the main symptom of severe COPD. Only limited physical activity is possible. Activities like eating or the daily morning routine take much longer. Walking is possible only at a slow pace. Sleep is often interrupted due to breathlessness or coughing.
- **Lung:** FEV, is between 30% and 50% of the predicted normal value. Oxygen saturation of the blood is reduced.
- **Treatment:** As per guidelines in your country.



Very Severe COPD

- **Symptoms:** Breathlessness all the time and everyday activities are severely limited. Quality of life is greatly reduced because of shortness of breath.
- **Lung:** The airways are narrow and collapsing. Large parts of the lung do not function properly.



Augmented Reality in Action: getting high schoolers an early start with tertiary education

Severe damage to the lungs causes high pressure in the arteries of the lungs and on the heart as it sends blood to the lungs. Oxygen support is necessary all the time and this time may require additional non-invasive ventilation. FEV, falls below 30% of the predicted normal value.

- **Treatment:** As per guidelines in your country.

Appendix B

Questions for AR app based learners

AR_Lungs-Exam

Fill-up all the information's CAREFULLY.
Answer all the questions BELOW (from 1 - 30).

The purpose of this task is to determine whether learning from AR applications is better or learning from the physical book is better. Data collected from this task will be used for RESEARCH PURPOSE ONLY.

Research supervised by: Raihan Uddin Ahmed.
Research conducted by: Ibrahim Khan Shuvo,
Faeiq Hamim, Sadia Jahan Badhon and
Md. Emran Hossain.

Time:35 minutes | Full Marks:30 marks

khanshuvo7444@gmail.com [Switch account](#)



* Required

Email *

Your email

Your name *

Your answer

Your institution *

Your answer

1. A healthy lung inhales and exhales about ____L of air every minute. *

1 point

- 7 or 8
- 6
- 8
- 7 and 8

2. Asthma can be classified in 3 regions. *

1 point

- False
- True

3. In spirometry of Mild Asthma, 1 point
FEV 1 not more than ___ of the
predicted normal value. *

- 81%
- 79%
- 80%

4. Moderate Asthma occurs at night 1 point
only. *

- Yes
- No

5. One can take daily medication in 1 point
Asthma. *

- False
- Maybe
- True

6. Severe wheezing is symptom for 1 point
which disease? *

Your answer _____

7. Emphysema is characterized by 1 point
destruction and enlargement of
lungs. *

- False
- True

8. FEV for Severe COPD is, * 1 point

- 30.7%
- None
- 30-50%

9. Inflammation causes the airways 1 point
tissue to become red. *

- True
- Maybe
- False

10. "Extreme limitations to normal daily activities including sports and work", for which disease? * 1 point

Your answer _____

11. Patients will struggle and need to work hard to____ * 1 point

- Inhale
- Exhale
- Breathe

12. Coughing is the main symptom in, * 1 point

- Mild COPD
- Severe COPD

13. _ and _ are the two most common conditions that contribute to COPD. * 1 point

- Both
- Only a
- chronic bronchitis
- Emphysema

14. Breath, chronic cough, and sputum production are caused for, * 1 point

- None
- C-opd
- COP-D

15. _ carries oxygen. * 1 point

Your answer _____

16. Tertiary bronchi is in the lungs. * 1 point

- Yes
- No

17. Bronchus is a channel. * 1 point

Yes

No

18. Each lobule contains, *

1 point

Your answer _____

19. A healthy lung takes about 12 breathes per minute. *

1 point

False

True

20. Chest tightness is caused for, * 1 point

Mild Flu

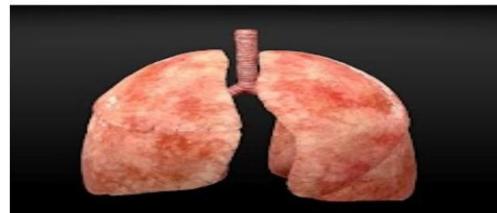
Measles

None

Cold

21. Which symptom can be found in the mentioned picture? *

1 point



Impaired lung functionality

Mere inflammation

Constriction of the bronchioles

22. The mentioned picture represents, *

1 point



Asthma exacerbation

Severe asthma

23. Which one represents asthma? * 1 point



- (i)
- (ii)
- (iii)

24. Which one represents COPD? * 1 point



- (iii)
- (ii)
- (i)

25. Which one represents a healthy lungs? * 1 point



- (iii)
- (ii)
- (i)

26. Which treatment can be applied 1 point for the mentioned picture? *



- Improved meditation
- As per requirements
- None

27. Lung state, mentioned in the 1 point picture of question no. 26 is, *

- FEV, falls below 30% of the predicted normal value
- FEV, is between 30% and 50% of the predicted normal value
- None

28. FEV rate for the mentioned picture is. *

1 point



- Smaller or equal to 80%
- 50-80%

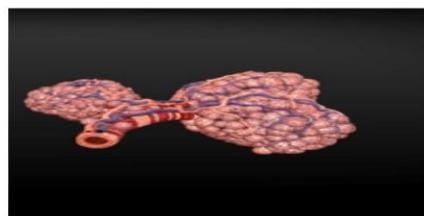
29. Symptom, mentioned in the picture of question no. 28 is. *

1 point

- All of the mentioned
- Less activity
- Breathlessness

30. The mentioned picture represents. *

1 point



- Alveoli
- Bronchi

Any feedback? if yes then please state, if no then simply put "N/A" here... *

THANK YOU
for your participation!

Your answer

Questions prepared by,

Sabrina

Sabrina Farha
Final year M.B.B.S student
Popular Medical College, Dhaka

Submit

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Questions for AR book based learners

Non-AR_Lungs-Exam

Fill-up all the information's CAREFULLY.
Answer all the questions BELOW (from 1 - 30).

The purpose of this task is to determine whether learning from AR applications is better or learning from the physical book is better. Data collected from this task will be used for RESEARCH PURPOSE ONLY.

Research supervised by: Raihan Uddin Ahmed.
Research conducted by: Ibrahim Khan Shuvo, Faieq Hamim, Sadia Jahan Badhon and Md. Emran Hossain.

Time:35 minutes | Full Marks:30 marks

sadijahahn20@gmail.com [Switch account](#)



* Required

Email *

Your email

Your name *

Your answer

Your institution *

Your answer

1. A healthy lung inhales and exhales about ____L of air every minute. * 1 point

6

8

7 and 8

7 or 8

2. Asthma can be classified in 3 regions.*

1 point

True

False

3. In spirometry of Mild Asthma, FEV 1 not more than__ of the predicted normal value.*

1 point

80%

81%

79%

4. Moderate Asthma occurs at night only.*

1 point

No

Yes

5. One can take daily medication in Asthma.*

1 point

False

Maybe

True

6. Severe wheezing is symptom for which disease?*

1 point

Your answer _____

7. Emphysema is characterized by destruction and enlargement of lungs.*

1 point

True

False

8. FEV for Severe COPD is,*

1 point

- 30.7%
- 30-50%
- None

9. Inflammation causes the airways tissue to become red.*

1 point

- True
- False
- Maybe

10. "Extreme limitations to normal daily activities including sports and work", for which disease? *

1 point

Your answer

11. Patients will struggle and need to work hard to___*

1 point

- Breathe
- Exhale
- Inhale

12. Coughing is the main symptom in, *

1 point

- Severe COPD
- Mild COPD

13. _ and _ are the two most common conditions that contribute to COPD. * 1 point

- chronic bronchitis
- Both
- Emphysema
- Only a

14. Breath, chronic cough, and sputum production are caused for, * 1 point

COP-D

C-opd

None

15. _ carries oxygen. * 1 point

Your answer _____

16. Tertiary bronchi is in the lungs. * 1 point

Yes

No

17. Bronchus is a channel. * 1 point

No

Yes

18. Each lobule contains, * 1 point

Your answer _____

19. A healthy lung takes about 12 breathes per minute. * 1 point

True

False

20. Chest tightness is caused for, * 1 point

None Measles

Mild Flu Cold

21. Which symptom can be found in the mentioned picture? *

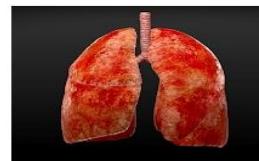
1 point



- Impaired lung functionality
- Mere inflammation
- Constriction of the bronchioles

22. The mentioned picture represents, *

1 point



- Asthma exacerbation
- Severe asthma

23. Which one represents asthma? *

1 point



(i)



(ii)



(iii)

- (i)
- (iii)
- (ii)

24. Which one represents COPD? *

1 point



(i)



(ii)



(iii)

- (ii)
- (iii)
- (i)

25. Which one represents a healthy lungs? *

1 point



(i)



(ii)



(iii)

- (iii)
- (i)
- (ii)

26. Which treatment can be applied for the mentioned picture? *

1 point



- Improved meditation
- None
- As per requirements

27. Lung state, mentioned in the picture of question no. 26 is, *

1 point

- FEV₁ falls below 30% of the predicted normal value
- FEV₁ is between 30% and 50% of the predicted normal value
- None

28. FEV₁ rate for the mentioned picture is, *

1 point



- 50-80%
- Smaller or equal to 80%

29. Symptom, mentioned in the picture of question no. 28 is, *

1 point

- Less activity
- All of the mentioned
- Breathlessness

30. The mentioned picture represents, *

1 point



- Bronchi
- Alveoli

Any feedback? if yes then please state, if no then simply put "N/A" here... *

THANK YOU
for your participation!

Your answer

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