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Sanusi Hasibuan 
Medan State University, Indonesia

Muhammad Chairad 
Medan State University, Indonesia

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The Development of Augmented Reality (AR) in Anatomy Course

Sanusi Hasibuan, Muhammad Chairad

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Abstract

The development of Augmented Reality (AR) media is the goal of this research. The research method used in this research activity is development research. This method is carried out in nine steps. Research data were collected through interviews, observation and questionnaires. The instruments used to measure the quality of teaching materials are assessments from material and media experts and student response questionnaires. Based on the validation results by learning media and material experts, the categories "Good", or 79.05% and "Very Good", or 87.67%, were obtained. In a small-scale trial involving ten students, 81.6% was obtained, while in a large group test involving 30 students, 88.8% was obtained. Student responses also showed satisfaction with the developed Augmented Reality (AR) media, namely the "very interesting" criterion. This research is limited to product revisions, and further research should consider mass products. This research has a novelty in learning media: Augmented Reality (AR) in anatomy courses.

Introduction

In the century, many changes have happened in public through developments. Such changes also occur in developing countries like Indonesia (Hapsoro & Bangun, 2020). Hence, society must be aware of this wave of changes. With continuous development, it is important to ensure the quality of education. The quality of education needs to be improved. Enhancement of quality education is considered important because it is an activity or business for improvements to more direction (Agama, 2017; Moore, 2021; Oustous et al., 2021; Sarıtaş, Börekci, & Demirel, 2022). Therefore, educational institutions should focus on education quality improvement. Innovation can help improve the quality of education. Innovation in teaching has been used to improve the learning process and to increase students' quality, engagement and retention (Villaverde & Otman, 2022). Thus, educational institutions should employ innovations in teaching and learning activities. Adequate design of technological innovation in education can benefit both teachers and students in teaching and learning activities (Ghosh, Jansz, & Ghosh, 2022; Hu & Huang, 2022; Latifi & Noroozi, 2021; Noroozi & Sahin, 2022a, 2022b; Noroozi et al., 2012, 2020)

Innovations are needed in the education sector to improve the quality of education. Technology is one of the bases that can be used in the teaching and learning process. The following statement supports it: "The use of technology

has become an important part of the learning process" (Ahmadi & Reza, 2018). With technology, teachers can design learning more varied and effective. One of the technologies that can be used in learning is Augmented Reality (AR) technology. Augmented Reality (AR) is an emerging technology that has rapidly been incorporated into the education sphere due to its diverse possibilities (Aimiwu, 2022; Alper et al., 2021; Cabero-Almendra et al., 2019).

AR is a unique system in information technology. It is the synthesis of real and virtual parables. AR applications have been used in various fields of life. AR is used as an application concept that combines the physical world (real objects) with the digital world without changing the shape of the physical object (Johnson & Westbrooks, 2021; Roo & Hachet, 2017; Talan & Kalnkara, 2022). Object recognition (text and images) displays information about an object. AR is a cognitive system that can fully understand the user's perceptions.

Anatomy is one of the courses taught in the Department of Physical Education for Health and Recreation (Physical Education for Health and Recreation), Faculty of Sport Science, Medan State University. Anatomy is the study of the structure and parts of the body of living things, in this case, the human body. The structure of the human body is very complex, so it is not easy to understand. The name of each part is also very difficult to pronounce, even more so to memorize it by rote. Therefore, we need media that can help with difficulties in studying anatomy.

Presently, the Physical Education for Health and Recreation Department uses teaching aids to teach students, such as 2D pictures and videos. However, it is appropriate to introduce other technologies as means of learning. An interactive learning system that utilizes AR learning media technology has never been used in the Physical Education for Health and Recreation Department, especially in the anatomy course. It is something new for students. AR technology-based learning media stored in app files provide good flexibility. By using AR, students can see the entire human bone structure in real-time, and there are many more advantages possessed by learning media based on AR. When viewed from a practical point of view, AR learning media is also more practical because it is easy to carry, and learning takes place not only with the display of 3D objects but there is a material player button that can be used as a learning aid while viewing 3D objects.

The study of Augmented Reality (AR) learning media is very important because learning occurs with 3D objects and animation displays through the technology being developed. It is hoped that students will be able to understand the material well by using AR learning media technology. This technology may sound foreign to some people, but others are used to seeing the learning media. The learning media based on AR displays new features, so it is unique compared to existing media. Generally, the application is developed on desktop PCs, but AR technology has been adapted to the smartphone as technology advances. Applications that apply AR technology aim to provide information to users in a clear, real-time and interactive manner.

The application of AR improves the real space for collaboration and contributes to education. Augmented reality learning media in the anatomy course enhances the learning process and facilitates users' understanding of the structure of the human body. This method increases the understanding of the human body's anatomy. The need for visualization and interaction can be optimized by applying AR technology. Based on the background of the

study, the researchers plan to develop AR learning media for anatomy courses in the Physical Education, Health and Recreation Department, Sport Science Faculty, Medan State University.

Method

This study was conducted for research and development. The study method refers to the Borg and Gall model, which Sugiyono has modified. Generally, it is shown as follows:

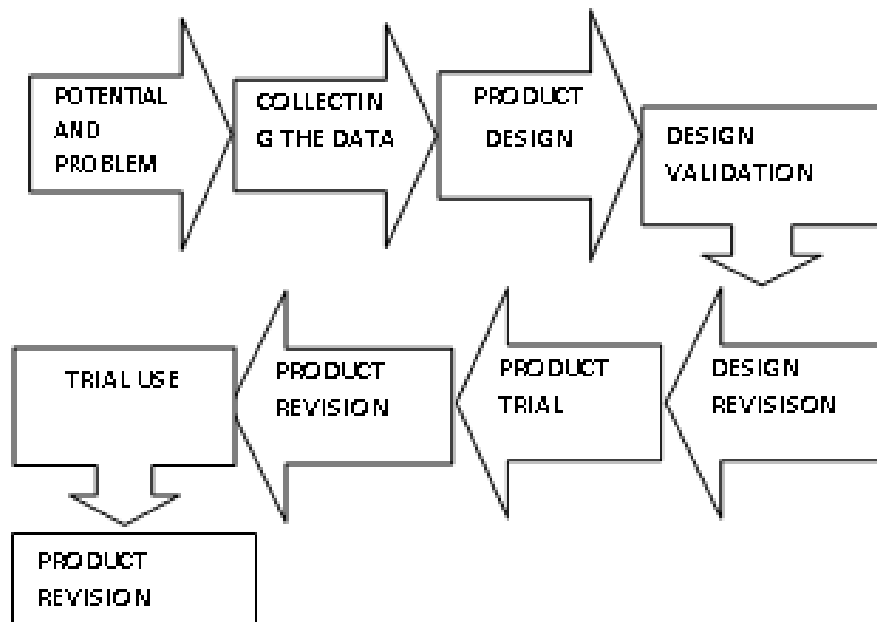


Figure 1. Steps for using the Research and Development (R&D) Method

The research and development steps in this research are:

- 1) potentials and problems
- 2) collect the data
- 3) product design
- 4) design validity
- 5) testing usage
- 6) product revisions
- 7) product trials
- 8) design revisions
- 9) product revision

The data collection was done using a quantitative method, from questionnaires given to students with their scores. Qualitative data were obtained from various criticisms and suggestions regarding the products developed by researchers and how product trials were carried out. Data collection techniques include interviews, documentation and questionnaires.

Results

Description of Product Development Results

The results of developing learning media based on AR in the Physical Education, Health and Recreation Department, Sport Science Faculty, Medan State University are outlined in the steps as follows:

Potentials and Problems

Based on the results of the interviews conducted by the researchers, it is known to the lecturer who teaches the anatomy subject that students experience quite basic problems in studying the anatomy course: The lecturer still needs to use media suitable for the anatomy course. Hence, students are less able to understand and master the anatomy of the human body. The medium that is often used is the mannequin/human body sculpture. However, this media has yet to perfectly explain all the parts of the muscles, bones and nerves that exist in the human body. The media is less attractive to students, so students tend to be passive in learning.

Data Collection

Dates were collected from journal articles, books and sources related to anatomy and learning media.

Product Design

Early products were designed by creating 3D animation.

Design of Learning Media Validation Results by Experts

Experts validated the products made by these researchers in order to create good and quality products. The assessment was carried out by four experts, consisting of material and media experts.

Description of Learning Media Validation Results by Material Experts

Validation by material experts is carried out to test the quality of content, accuracy of coverage, and language in learning media. As material experts in this study, the validators were Dr. (Mr.) Miftahul Ikhsan and Dr. (Mrs.) Rika Naylufar Sinaga, M. Biomed. Data from the material expert validation are shown in Table 1.

Table 1. Material Experts Validation Results

Aspect	Percentage	Criteria
Content Quality	82.5 %	Very Good
Achievement Coverage	85 %	Very Good
Language	69.7 %	good
Means	79.1 %	good

The assessment of the two validators in content quality was 82.5%. In the aspect of coverage accuracy, the assessment was 85%, while the language aspect was 69.7%. So, the average percentage obtained from content quality, coverage, and language accuracy was 79.1%.

Description of Learning Media Validation Results by Media Experts

Validation by instructional media experts is carried out to test the quality of content, language, and presentation of learning media with AR. As media experts in this study, the validators were Mr. Rifqi Aufan, M.Pd, and Mr. Faisal Ansari, M.Pd. Data from the media expert validation results are shown in the following table.

Table 2. Medial Experts Validation Results

Aspect	Percentage	Criteria
Content Quality	90%	Very Good
Language	85 %	Very Good
AR Media	88.7 %	Very Good
Means	87.7 %	Very Good

The assessment of the two validators on content quality was 90%. In the linguistic aspect, the assessment was 85%, and in the presentation of educational games, 88% was obtained. So the average percentage obtained regarding content quality, language and educational game presentation was 87.7%.

Design Revisions

The results of the validation by the experts provide suggestions regarding the learning media made by researchers, including the following: It is necessary to add some explanation to the bone structure presented. The advice given by the media experts is used in the product improvement process.



Figure 2. Media after Revision

Furthermore, based on validation by material experts, it was stated that the material displayed on each media is by the Learning Outcomes of Anatomy Course (CPMK) at the Sport Sciences Faculty, Medan State University.

Description and Analysis of Trials by Students and Educational Practitioners

The trial was conducted in two ways: small class and large class trials. The trials were conducted for students taking anatomy courses at the Sports Science Faculty, Medan State University.

Small Class Trials

Small class trials involving ten students. The steps taken by students were to fill out a questionnaire that had been distributed by providing a link.

Table 3. The Result of Small Class Trial

Aspect	Percentage	Criteria
Content Quality	80.8 %	Very Good
Language	83 %	Very Good
AR Media	81.7 %	Very Good
Means	81.6 %	Very Good

The aspects that were assessed were the quality of the content, the appearance of AR media, and language: 80.8% was the result for content quality, 83% was the result for the AR game display, and 81% was for the language aspect. All three have very good criteria. Overall, the result was 81.60%. The conclusion is that this medium was very good to use.

Large Class Trial

For the trials in large classes, 30 students were involved. Furthermore, students provided an assessment of the learning media in the questionnaire that was given. The results are shown in the table below.

Table 4. The result of Large Class Trial

Aspect	Percentage	Criteria
Content Quality	88 %	Very Good
Language	85.7 %	Very Good
AR Media	92.7 %	Very Good
Means	88.8 %	Very Good

The aspects assessed are the same: the quality of content, the appearance of AR media and language: 88.0% was the result for quality content, 85.7% was the result for the AR media display, and 92.71% was for the value of the language aspect. All three have very good criteria. Overall, the result was 88.8%. The conclusion is that this

learning media is very good to use.

Product Revisions

After conducting product revisions and trials on students, information was obtained that students felt happy learning with AR media. In addition, through a feasibility analysis of the three aspects, it was concluded that AR media is suitable for learning.

Discussion and Conclusion

In this study, AR technology-based learning media was developed. This learning media product was produced through design, revision, validation, small trials to monitor the product, large trials to monitor usage and product revisions to obtain final products. After being validated by material and media experts, they tried out. The analysis showed that the learning media based on AR technology was good, and it was declared fit for use in anatomy courses, which means that according to the two material experts, the content of the material in this AR media is by the purpose of teaching the anatomy course. AR media is feasible to use.

The results of the overall data analysis showed that the material and media are appropriate and can be used in learning anatomy subjects at the Sport Sciences Faculty of Medan State University. Once the product is finished, it will be used as intended, as disclosed. The development of a media or application to assist activities in recording and providing an assessment of the results of motion on a basic component is needed.

There are Lots of relevant research on the theme of Augmented Reality (AR) and Anatomy. One is the effective use of Augmented Reality (AR) in Anatomy education views from the system and its meta-analysis. This research in the meta-analysis shows that there is not enough proof to conclude that AR significantly affects the results (Bölek et al., 2021). This study only reviews research results that indicated no significant results for using Augmented Reality in Anatomy education.

Furthermore, there is research on Augmented Reality (AR) in the world of Anatomy. It is in the field of medicine. Research results show that Virtual AR modelling and deep 3D medical education are growing. Especially, AR can increase approach-based learning and interaction through interactive tools, such as the Mixed Reality Toolkit in HoloLens 2, which makes it possible for users to interact with a projected 3D hologram (Cercenelli et al., 2022). Appropriate model development will contribute to development and achievement (Priyambada et al., 2022). There is also research titled "Augmented Reality in Anatomy", which finds that the Virtual application is portable with innovative reality. This finding can make students utilize technology so that students look forward to the day in utilizing technology (Kashinath et al., 2022). Besides noticing sophistication tool as supporters of learning and practice, it is necessary to notice some matters among them: media safety and convenience (Ritonga et al., 2022).

Augmented Reality (AR) and Anatomy studies also bring more positive results. However, they still seldom study anatomy, especially in Higher Education. Through this study, the findings can become input for researchers.

Furthermore, it advances using Augmented Reality (AR) in Anatomy learning.

Using technology is very helpful in making learning more effective. Technology progress in digitalization and artificial intelligence can offer a solution for overcoming various problems, including learning (Koyuncuoğlu, 2022). Research that has been done on utilizing technology as a learning medium makes the learning process more effective. It means that students are more active and happy in responding to learning delivered by the teacher (Frisnoiry, 2020). Furthermore, this anatomy study involves technology, where using technology as a learning medium in the eye Sports Anatomy course increases students' achievements (Hasibuan, 2020). Moreover, the results are consistent with research findings on using learning media technology (Ariffin et al., 2022; Supriadi et al., 2022; Alkhaza'leh et al., 2022; Nemorin et al., 2023; Siregar & Frisnoiry, 2019). It can be concluded that Augmented Reality (AR) as technology can be an effective medium for studying Anatomy.

The development of appropriate technology is based on several problems faced by academics. It is fundamentally known that some conditions require attention to obtain optimal results—the development of learning media to support the performance of students and teachers for several things and subjects. In learning about anatomy material, it is felt that the right technology is needed to support accuracy in several terms and the layout intended for learning. Technology, in this case, has diversity and adapts to the functions and implications of learning. Motion-based learning in sports requires several media that help basic and precise performance and analysis.

Human anatomy in the context of lessons in courses is the basis for students learning about the structure of the human body. It is intended so as not to experience fatal errors in various situations, especially in the context of learning media, which tends to be broad in its discussion that involves several components and thinking. The role of technology, in this case, is intended to make a contribution that can make the material easier to understand and minimize fatal errors.

The results of this study indicate that Augmented Reality (AR) media is appropriate for learning anatomy courses. Students feel happy with this media, and lecturers feel very helpful by the media developed based on AR. Moreover, these results can be used as input for further research, especially in teaching Anatomy courses in Higher Education.

References

- Ahmadi, D., & Reza, M. (2018). The use of technology in English language learning: A literature review. *International Journal of Research in English Education*, 3(2), 115-125.
- Aimiuwu, E. E. (2022). Preventing Pandemic Diseases: An Augmented Reality & Artificial Intelligence Model. *International Journal of Technology in Education (IJTE)*, 5(2), 321-332. <https://doi.org/10.46328/ijte.231>
- Alkhaza'leh, R.M.A., Alzboon, M.S., AlKhudari, M.N., & Almashaqbeh, S.S.S. (2022). Implementing entrepreneurship education in extracurricular activity (ECA) for students. *International Journal of Education in Mathematics, Science, and Technology (IJEMST)*, 10(4), 989-1002.

- <https://doi.org/10.46328/ijemst.2696>
- Alper, A., Oztas, E. S., Atun, H., Cinar, D., & Moyenga, M. (2021). A Systematic Literature Review towards the Research of Game-Based Learning with Augmented Reality. *International Journal of Technology in Education and Science (IJTES)*, 5(2), 224-244. <https://doi.org/10.46328/ijtes.176>
- Ariffin, N. H. M., Mazlin, I., Zakaria, M. Z., Yusoff, F. H. & Nasrudin, Z. A. (2022). Edutourism Augmented Reality Mobile Application for Forest Conservation. In M. Shelley, H. Akcay, & O. T. Ozturk (Eds.), *Proceedings of ICRES 2022-- International Conference on Research in Education and Science* (pp. 207-219), Antalya, TURKEY. ISTES Organization.
- Bölek, K. A., Jong, G. De, & Henssen, D. (2021). The effectiveness of the use of augmented reality in anatomy education: a systematic review and meta-analysis. *Scientific Reports*, 1–10. <https://doi.org/10.1038/s41598-021-94721-4>
- Cabero-almenara, J., Barroso-osuna, J., Llorente-cejudo, C., & Fern, M. (2019). *Educational Uses of Augmented Reality (AR): Experiences in Educational Science*, 1–18.
- Cercenelli, L., De Stefano, A., Billi, A. M., Ruggeri, A., Marcelli, E., Marchetti, C., ... & Badiali, G. (2022). AEducaAR, anatomical education in augmented reality: A pilot experience of an innovative educational tool combining AR technology and 3D printing. *International Journal of Environmental Research and Public Health*, 19(3), 1024.
- Fadli, M. (2017). Manajemen Peningkatan Mutu Pendidikan Muhammad Fadhli Pendahuluan Mutu merupakan sesuatu yang dianggap salah satu bagian penting, karena mutu pada dasarnya menunjukkan keunggulan suatu produk jika dibandingkan dengan produk lainnya. *Jurnal Studi Management Pendidikan*, 1, 02-26.
- Frisnoiry, S., Siregar, T. M., & Taufik, I. (2020). E-Learning Technology: Kahoot Application as a Learning Evaluation Tool. *Solid State Technology*, 63(5), 4396-4404.
- Ghosh, M., Jansz, J., & Ghosh, A. (2022). Effect of COVID-19 Pandemic on Traditional Teaching. *International Journal on Studies in Education (IJonSE)*, 4(2), 107-129. <https://doi.org/10.46328/ijonse.63>
- Hapsoro, N. A., & Bangun, K. (2020). Perkembangan Pembangunan Berkelanjutan Dilihat Dari Aspek Ekonomi Di Indonesia. *Lakar: Jurnal Arsitektur*, 3(2), 88. <https://doi.org/10.30998/lja.v3i2.7046>
- Hasibuan, S., Chairad, M., & Nugraha, T. (2020). Developing IT-based learning media in sports anatomy. *International Sports Studies (ISS)*, 42(03), 43-49.
- Hu, H. & Huang, F. (2022). Application of Universal Design for Learning into Remote English Education in Australia amid COVID-19 Pandemic. *International Journal on Studies in Education (IJonSE)*, 4(1), 55-69. <https://doi.org/10.46328/ijonse.59>
- Johnson, K. L., & Westbrook, K. (2021). Quelling the Boredom with Alternative Instruction: Augmented Reality, Escape Kits, and Scavenger Hunts. *International Journal on Social and Education Sciences (IJonSES)*, 3(1), 180-196. <https://doi.org/10.46328/ijonSES.65>
- Kashinath, K. A., Ambadas, K. B., Rajendra, D. R., Sanjay, A. S., & Shimant, S. V. (2022). *Augmented Reality in Anatomy*, 11(05), 78–82.
- Koyuncuoglu, D. (2022). Analysis of digital and technological competencies of university students. *International Journal of Education in Mathematics, Science, and Technology (IJEMST)*, 10(4), 971-988. <https://doi.org/10.46328/ijemst.2583>
- Latifi, S., & Noroozi, O. (2021). Supporting argumentative essay writing through an online supported peer-review


- script. *Innovations in Education and Teaching International*, 58(5), 501-511. <https://doi.org/10.1080/14703297.2021.1961097>.
- Moore, S. W. (2021). Adopting a project-based learning framework in an online course to enhance the quality of student projects. In V. Akerson & M. Shelley (Eds.), *Proceedings of IConSES 2021-- International Conference on Social and Education Sciences* (pp. 144-149), Chicago, USA. ISTES Organization.
- Noroozi, O. & Sahin, I. (Eds.). (2022a). *Studies on Education, Science, and Technology 2022*. ISTES.
- Noroozi, O. & Sahin, I. (Eds.). (2022b). *Proceedings of International Conference on Humanities, Social and Education Sciences 2022*. ISTES.
- Noroozi, O., Dehghanzadeh, H., & Talae, E. (2020). A systematic review on the impacts of game-based learning on argumentation skills. *Entertainment Computing*, 35, 100369. <https://doi.org/10.1016/j.entcom.2020.100369>.
- Noroozi, O., Weinberger, A., Biemans, H.J.A., Mulder, M., & Chizari, M. (2012). Argumentation-based computer supported collaborative learning (ABCSCCL). A systematic review and synthesis of fifteen years of research. *Educational Research Review*, 7(2), 79-106. <http://dx.doi.org/10.1016/j.edurev.2011.11.006>.
- Nemorin, S., Vlachidis, A., Ayerakwa, H. M., & Andriotis, P. (2022). AI hyped? A horizon scan of discourse on artificial intelligence in education (AIED) and development. *Learning, Media and Technology*, 1-14.
- Oustous, O., Ihichr, A., El Idrissi, Y. E. B. & Lahcen, A. A (2021). Evaluation and quality assurance for higher education in Morocco: the ANEAQ as the main actor. In S. Jackowicz & I. Sahin (Eds.), *Proceedings of IHSES 2021-- International Conference on Humanities, Social and Education Sciences* (pp. 206-218), New York, USA. ISTES Organization.
- Priyambada, G., Prayoga, A. S., Utomo, A. W. B., Saputro, D. P., & Hartono, R. (2022). Sports App: Digitalization of Sports Basic Movement. *International Journal of Human Movement and Sports Sciences*, 10(1), 85–89. <https://doi.org/10.13189/saj.2022.100112>
- Ritonga, D. A., Damanik, S., Damanik, S. A., Suprayitno, & Priyambada, G. (2022). Development of Learning Variations to Improve Basic Jumping Skills and Play Approaches of Elementary School Students. *International Journal of Education in Mathematics, Science and Technology*, 10(2), 360–371. <https://doi.org/10.46328/ijemst.2246>
- Roo, J. S., & Hachet, M. (2017). One reality: Augmenting how the physical world is experienced by combining multiple mixed reality modalities. *UIST 2017 - Proceedings of the 30th Annual ACM Symposium on User Interface Software and Technology*, 787–795. <https://doi.org/10.1145/3126594.3126638>
- Sarıtaş, M. T., Börekci, C., & Demirel, S. (2022). Quality Assurance in Distance Education through Data Mining. *International Journal of Technology in Education and Science (IJTES)*, 6(3), 443-457. <https://doi.org/10.46328/ijtes.396>
- Siregar, T. M., & Frisnoiry, S. (2019). Blog-based learning innovation with powtoon application in facing industrial revolution 4.0. *Britain International of Linguistics Arts and Education (BioLAE) Journal*, 1(2), 291-295.
- Supriadi, A., Mesnan, Akhmad, I., Dewi, R., & Suprayitno. (2022). The Effect of Learning Manipulative Skills Using Ball Thrower Learning Media on the Ability to Throw and Catch the Ball in Elementary School Students. *International Journal of Education in Mathematics, Science and Technology*, 10(3), 590–603. <https://doi.org/10.46328/ijemst.2441>

Talan, T., & Kalınkara, Y. (2022). Students' Opinions about the Educational Use of the Metaverse. *International Journal of Technology in Education and Science (IJTES)*, 6(2), 333-346. <https://doi.org/10.46328/ijtes.385>

Villaverde, Á. B., & Otman, N. M. M. (2022). Higher Education: The Impact of Innovation on Quality. *Journal of Positive Psychology and Wellbeing*, 6(2), 2058-2069.

Author Information

Sanusi Hasibuan

 <https://orcid.org/0000-0001-5125-5263>


Medan State University

North Sumatra

Indonesia

Contact e-mail: sanusihhasibuan@unimed.ac.id

Muhammad Chairad

 <https://orcid.org/0000-0001-7724-4781>

Medan State University

North Sumatra

Indonesia