THE DEVELOPMENT OF 'CHEMFUN' ANDROID-BASED APPLICATION TO EXPLORE STUDENTS' UNDERSTANDING OF CHEMICAL REPRESENTATION ON MATTER TOPIC

RESEARCH PAPER

Submitted as Requirement to Obtain Degree of *Sarjana Pendidikan* in
International Program on Science Education (IPSE) Study Program

Arranged by
Naufal Rabah Wahidin
NIM 1702721

INTERNATIONAL PROGRAM ON SCIENCE EDUCATION
FACULTY OF MATHEMATICS AND SCIENCE EDUCATION
UNIVERSITAS PENDIDIKAN INDONESIA
2021

THE DEVELOPMENT OF 'CHEMFUN' ANDROID-BASED APPLICATION TO EXPLORE STUDENTS' UNDERSTANDING OF CHEMICAL REPRESENTATION ON MATTER TOPIC

Oleh:
Naufal Rabah Wahidin

Skripsi ini diajukan untuk memenuhi salah satu syarat memperoleh gelar Sarjana Pendidikan pada Program Studi International Program on Science Education (IPSE) Fakultas Pendidikan Matematika dan Ilmu Pengetahuan Alam

Universitas Pendidikan Indonesia

Agustus 2021

APPROVAL SHEET

NAUFAL RABAH WAHIDIN

THE DEVELOPMENT OF 'CHEMFUN' ANDROID-BASED APPLICATION TO EXPLORE STUDENTS' UNDERSTANDING OF CHEMICAL REPRESENTATION ON MATTER TOPIC

Approved and confirmed by:

Supervisor I

Dr. Lala Septem Riza., M.T.

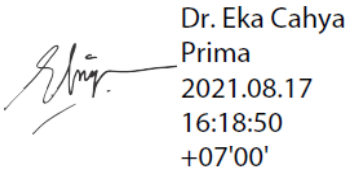
NIP. 197809262008121001

Supervisor II

Eliyawati, S.Pd., M.Pd.

NIP. 198610112015042001

Head of International Program on Science Education Study Program



Dr. Eka Cahya Prima, S.Pd., M.T.

NIP. 199006262014041001

DECLARATION

I hereby declare that every aspect is written in this research paper entitled “The Development of 'ChemFUN' Android-Based Application to Explore Students' Understanding of Chemical Representation on Matter Topic” genuinely results from my original idea, efforts, and works. The theories, finding of experts, opinions, and others in this paper have been quoted or referenced based on the scientific code from UPI and following scientific ethics that applies in scholarly society. This declaration is created truthfully and consciously. When an infringement towards scientific ethics subsequently is foundor if there is a claim of any others towards the authenticity of this research paper, hence I am willing to be responsible and accept academic sanctions correspond to the rules.

Bandung, August 2021

Declarant,

Naufal Rabah Wahidin
NIM. 1702721

ACKNOWLEDGEMENT

The Author praises the highest gratitude to Allah SWT for His blessing and His mercy in completing this research paper. On this occasion, the Author would like to express sincere gratitude and appreciation to the following parties:

1. To my family, especially Ayah, Ibu, and my two sisters who's pray never to stop. For all the love and care since Author was a child. For all the infinite patience raising Author until now. Thank you for being the most incredible parents, and thank you for being the most supportive person Author has ever known.
2. Mrs. Eliyawati, M.Pd., as a supervisor, academic advisor, and the kindest lecturer in IPSE. Thank you for all the help, love, and patience toward the Author from the beginning of the semester until now. Also, thank you for all the kind words and motivation toward the Author to finish this research paper.
3. Dr. Lala Septem Riza, M.T., as the first supervisor. Thank you for all the guidance and patience toward the Author, thank you for all the invaluable knowledge that has been shared with the Author, and thank you for all the motivation toward the Author to finish this research paper.
4. All IPSE lecturer; Sir Eka, Sir Ikmanda, Sir Nanang, Mrs Lilit, Mrs Rika, and Mrs Diana. Thank you for all the knowledge, all the fun, and all the laugh that has been shared. Thank you for making the Author's journey in Uni become the most memorable thing that ever happened. Four years in life that worth every single second.
5. All the lecturers from the first until the seventh semester. Thank you for all the knowledge that has been shared with the Author. Thank you for being a great lecturer in Author life.
6. Arsanti Satriani Salim, a partner since junior high school, the one who's always listening to every Author story, the one who's been a supportive

and kindest person Author ever known, thank you for being Author friend until now. For all the laugh, all the story, and all the tears that have been shared with the Author. Thank you for coming to Author life.

7. Annisa Fadhila Nur Fikriah, the most cheerful person ever known, the one who's always shared positive energy, the one who's always giving the affection until now, thank you for being a rainbow in the darkest cloud.
8. Nurs and Shafa, a partner from the internship program, thank you for all the help, joy, and tears that have been shared with the Author. Thank you for always giving meaningful suggestions throughout the internship program, and thank you for being a place to share all random things in the eight-semester.
9. All of IPSE 2017 friends, thank you for being a supportive environment for the Author since the first semester. Thank you for all the love, affection, and motivation that has been shared with the Author in finishing the research paper. Thank you for being such amazing friends in Author life, and Author life will never be the same without them.
10. Mariah Syifa Salsabila, a friend from far far away, thank you for all the story, joy, and random things that have been shared with the Author. Thank you for all the kind words and motivation towards the Author in finishing the research paper. Thank you for being exist in the most challenging time. Thank you for being such a kindest person Author has ever known.
11. All of IPSE 2018 and 2019, the Author's most incredible partners in Uni, thank you for all the memories in everyday life and SA-IPSE. Thank you for all the support that has been given to the Author until now.
12. All of the teachers and students from SMP Al-Azhar Syifa Budi Parahyangan, thank you for the great chance to be involved in one of the best schools in Bandung. Thank you for the good memories in one

semester and for letting the Author develop himself to be a better teacher.

13. Chaser UPI, the Islamic community that has been welcomed Author since the first semester, thank you for the precious knowledge that has been shared with the Author. Thank you for always reminding the Author to be a better person.
14. All senior high school friends, friends who have known the Author for a very long time, thank you for the good memories and warm support for the Author study in IPSE.
15. All of the teachers since the Author was in kindergarten, thank you for all of the knowledge that has been shared with the Author, thank you for always support the Author, and thank you for being a great teacher for the Author himself.

THE DEVELOPMENT OF 'CHEMFUN' ANDROID-BASED APPLICATION TO EXPLORE STUDENTS' UNDERSTANDING OF CHEMICAL REPRESENTATION ON MATTER TOPIC

Naufal Rabah Wahidin

International Program on Science Education

Universitas Pendidikan Indonesia

ABSTRACT

In the 21st century, technology is increasing rapidly. Besides all the adverse effects of technology, it can also positively impact, especially in education. One of the technologies that can bring a good impact on education is the smartphone. A smartphone can help students to visualize abstract concepts and objects in learning about chemistry of matter. This study aims to develop an Android-based application to explore students understanding of chemical representation on matter topics. This study used a DDD-E model of development as a research method, and it consists of deciding stage, designing stage, developing stage, and evaluating stage. The deciding stage begins with analyzing the content and the software used to develop it. The designing stage consists of drawing a flowchart and the storyboard. Then, in the developing stage, the application was developed based on the previous stage. The last is evaluating stage that involves five expert judges, six science teachers, and thirty-six students chosen to review the application by purposive sampling. The results from the expert judgment show a score of 3.64 on the content indicator, 3.65 on the language indicator, and 3.6 on the design indicator. The results from teachers and students show a score of 3.72 and 3.61 for the mobile connectivity indicator, 3.67 and 3.45 for the materials indicator, 3.67 and 3.62 for the user interface indicator, and 3.61 and 3.45 for the learning experiences indicator. Thus, the application was fully revised and developed, and ready to be used in learning Matter.

Key Words: *Chemical Representation, Android-Based Application, Matter.*

PENGEMBANGAN APLIKASI 'CHEMFUN' BERBASIS ANDROID UNTUK MENGEKSPORASI PEMAHAMAN SISWA TERHADAP REPRESENTASI KIMIA PADA TOPIK MATERI

Naufal Rabah Wahidin

International Program on Science Education

Universitas Pendidikan Indonesia

ABSTRAK

Pada abad ke-21 teknologi meningkat pesat. Selain segala dampak buruk teknologi, juga dapat berdampak positif khususnya dalam bidang pendidikan. Salah satu teknologi yang dapat membawa dampak baik bagi dunia pendidikan adalah smartphone. Smartphone dapat membantu siswa untuk memvisualisasikan konsep dan objek abstrak dalam pembelajaran kimia pada topik materi. Penelitian ini bertujuan untuk mengembangkan aplikasi berbasis android untuk menggali pemahaman siswa tentang representasi kimia pada topik materi. Penelitian ini menggunakan model pengembangan DDD-E sebagai metode penelitian, yang terdiri dari tahap penentuan, tahap perancangan, tahap pengembangan, dan tahap evaluasi. Tahap penentuan dimulai dengan menganalisis konten dan perangkat lunak yang digunakan untuk mengembangkannya. Tahap perancangan terdiri dari menggambar flowchart dan storyboard. Kemudian pada tahap develop, aplikasi dikembangkan berdasarkan tahap sebelumnya. Terakhir adalah tahap evaluasi yang melibatkan lima ahli, enam guru sains, dan tiga puluh enam siswa yang dipilih untuk meninjau aplikasi dengan purposive sampling. Hasil dari ahli menunjukkan skor 3,64 pada indikator konten, 3,65 pada indikator bahasa, dan 3,6 pada indikator desain. Hasil guru dan siswa menunjukkan skor 3,72 dan 3,61 untuk indikator konektivitas seluler, 3,67 dan 3,45 untuk indikator materi, 3,67 dan 3,62 untuk indikator antarmuka pengguna, serta 3,61 dan 3,45 untuk indikator pengalaman belajar. Aplikasi sudah sepenuhnya direvisi dan dikembangkan dan siap digunakan dalam pembelajaran materi.

Kata Kunci: *Representasi Kimia, Aplikasi Berbasis Android, Materi.*

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

REFERENCES

Ananda, L., Fahurrozi, F., & Simanihuruk, L. (2020). Development of Interactive Multimedia–Based Science Teaching Materials. *International Conference Community Research and Service Engagements*, 1-7. https://doi.org/10.4108/eai.4-12-2019.2293860

Anshari, M., Almunawar, M. N., Shahrill, M., Wicaksono, D. K., & Huda, M. (2017). Smartphones usage in the classrooms: Learning aid or interference? *Education and Information Technologies*, *22*(6), 3063–3079. https://doi.org/10.1007/s10639-017-9572-7

Astiningsih, A. D., & Partana, C. F. (2020). Using Android Media for Chemistry Learning Construction of Motivation and Metacognition Ability. *International Journal of Instruction*, *13*(1), 279–294. https://doi.org/10.29333/iji.2020.13119a

Aziz, A. K., & Khoukhi, F. (2018). A design requirements framework for mobile learning environment. *Lecture Notes in Networks and Systems*, *25*(4), 208–215. https://doi.org/10.1007/978-3-319-69137-4_19

Cairncross, S., & Mannion, M. (2001). Interactive multimedia and learning: Realizing the benefits. *Innovations in Education and Teaching International*, *38*(2), 156–164. https://doi.org/10.1080/14703290110035428

Chin, E., Felt, A. P., Greenwood, K., & Wagner, D. (2011). Analyzing inter-application communication in Android. *Proceedings of the 9th International Conference on Mobile Systems, Applications and Services and Co-Located Workshops*, 239–252. https://doi.org/10.1145/1999995.2000018

Davidowitz, B., & Chittleborough, G. (2009). Linking the Macroscopic and Sub-microscopic Levels: Diagrams. *Multiple Representations in Chemical Education*, 169–191. https://doi.org/10.1007/978-1-4020-8872-8_9

Djamas, D., & Padang, U. N. (2018). Development of Interactive Multimedia Learning Materials for Improving Critical Thinking Skills. *International Journal of Information and Communication Technology Education*, *14*(4), 66–84. https://doi.org/10.4018/IJICTE.2018100105

Eliyawati, E., Agustin, R. R., Sya'bandari, Y., & Putri, R. A. H. (2020). Smartchem: An Android Application for Learning Multiple Representations of Acid-Base Chemistry. *Journal of Science Learning*, *3*(3), 196–204. https://doi.org/10.17509/jsl.v3i3.23280

Eliyawati, Rohman, I., & Kadarohman, A. (2018). The effect of learning multimedia on students' understanding of macroscopic, sub-microscopic, and symbolic levels in electrolyte and nonelectrolyte. *Journal of Physics: Conference Series*, *1013*(1), 1–6. https://doi.org/10.1088/1742-6596/1013/1/012002

Etikan, I. (2016). Comparison of Convenience Sampling and Purposive Sampling. *American Journal of Theoretical and Applied Statistics*, *5*(1), 1. https://doi.org/10.11648/j.ajtas.20160501.11

Fook, C. Y., Narasuman, S., Aziz, N. A., Mustafa, S. M. S., & Han, C. T. (2021). Smartphone Usage among University Students. *Asian Journal of University Education*, *17*(1), 283–291. https://doi.org/10.24191/ajue.v17i1.12622

Forment, M. A., & Guerrero, J. C. (2008). MOODLBILE: Extending Moodle to the Mobile On/Offline Scenario. *International Conference on Mobile Learning.*, 11–18.

Gilbert, J. K., Boulter, C. J., & Elmer, R. (2021). Positioning Models in Science Education and In Design and Technology Education. *Constructing Worlds through Science Education*, *1982*, 125–135. https://doi.org/10.4324/9780203698778-15

Gilbert, J. K., & Treagust, D. F. (2009). Introduction: Macro, Submicro and Symbolic Representations and the Relationship Between Them: Key Models in Chemical Education. *Multiple Representations in Chemical Education*, 1–8. https://doi.org/10.1007/978-1-4020-8872-8_1

Gkitzia, V., Salta, K., & Tzougraki, C. (2011). Development and application of suitable criteria for the evaluation of chemical representations in school textbooks. *Chemistry Education Research and Practice*, *12*(1), 5–14. https://doi.org/10.1039/c1rp90003j

Hautala, J., Baker, D. L., Keurulainen, A., Ronimus, M., Richardson, U., & Cole, R. (2018). Early science learning with a virtual tutor through multimedia explanations and feedback on spoken questions. *Educational Technology Research and Development*, *66*(2), 403–428. https://doi.org/10.1007/s11423-017-9558-6

Holla, S., & Katti, M. M. (2012). Android Based Mobile Application Development and

Its Security. *International Journal of Computer Trends and Technology*, *3*(3), 486–490. https://doi.org/10.1080/10304312.2012.706462

Ifeanyi, I. P., & Chukwuere, J. E. (2018). The impact of using smartphones on the academic performance of undergraduate students. *Knowledge Management and E-Learning*, *10*(3), 290–308. https://doi.org/10.34105/j.kmel.2018.10.017

Irwansyah, F. S., Yusuf, Y. M., Farida, I., & Ramdhani, M. A. (2018). Augmented Reality (AR) Technology on the Android Operating System in Chemistry Learning. *IOP Conference Series: Materials Science and Engineering*, *288*(1), 1–7. https://doi.org/10.1088/1757-899X/288/1/012068

Islam, N., & Want, R. (2014). Smartphones: Past, present, and future. *IEEE Pervasive Computing*, *13*(4), 89–92. https://doi.org/10.1109/MPRV.2014.74

Ivers, K. S., & Barron, A. E. (2002). *Multimedia Projects in Education: Designing, Producing, and Assessing* (2nd ed.). Libraries Unlimited Teacher Ideas Press.

Jeno, L. M., Grytnes, J. A., & Vandvik, V. (2017). The effect of a mobile-application tool on biology students' motivation and achievement in species identification: A Self-Determination Theory perspective. *Computers and Education*, *107*, 1–12. https://doi.org/10.1016/j.compedu.2016.12.011

Kassim, H., Nicholas, H., & Ng, W. (2014). Using a multimedia learning tool to improve creative performance. *Thinking Skills and Creativity*, *13*, 9–19. https://doi.org/10.1016/j.tsc.2014.02.004

Kiger, D., Herro, D., & Prunty, D. (2012). Examining the influence of a mobile learning intervention on third grade math achievement. *Journal of Research on Technology in Education*, *45*(1), 61–82. https://doi.org/10.1080/15391523.2012.10782597

Komalasari, K. (2019). Living Values Based Interactive Multimedia in Civic Education Learning. *International Journal of Instruction*, *12*(1), 113–126. https://doi.org/10.29333/iji.2019.1218a

Kotevsk, Z., & Tasevska, I. (2017). Evaluating the Potentials of Educational Systems to Advance Implementing Multimedia Technologies. *International Journal of Modern Education and Computer Science*, *9*(1), 26–35. https://doi.org/10.5815/ijmecs.2017.01.03

Kulasekara, G., Jayatilleke, B., & Coomaraswamy, U. (2008). Designing Interface for Interactive Multimedia: Learner Perceptions on The Design Features. *AAOU Journal*, *3*(2), 83–98.

Lan, Y. F., & Sie, Y. S. (2009). Using RSS to support ubiquitous learning based on media richness theory. *2009 IEEE International Conference on Virtual Environments, Human-Computer Interfaces, and Measurements Systems*, 287–291. https://doi.org/10.1109/VECIMS.2009.5068910

Leacock, T. L., & Nesbit, J. C. (2007). A Framework for Evaluating the Quality of Multimedia Learning Resources. *Journal of Educational Technology & Society-*, *10*(2), 44–59.

Lee, Y., Kozar, K. A., & Larsen, K. R. T. (2003). The Technology Acceptance Model: Past, Present, and Future. *Communications of the Association for Information Systems*, *12*(50), 752–780. https://doi.org/10.17705/1cais.01250

Ma, L., Gu, L., & Wang, J. (2014). Research and Development of Mobile Application for Android Platform. *International Journal of Multimedia and Ubiquitous Engineering*, *9*(4), 187–198. https://doi.org/http://dx.doi.org/10.14257/ijmue.2014.9.4.20

Markic, S., & Childs, P. E. (2016). Language and the Teaching and Learning of Chemistry. *Chemistry Education Research and Practice*, *17*(3), 434–438. https://doi.org/10.1039/C6RP90006B

Naismith, L., Lonsdale, P., Vavoula, G., & Sharples, M. (2006). Mobile Technologies and Learning. In *Futurelab Literature Review Series* (pp. 1–44). Futurelab.

Nordin, N., Embi, M. A., & Yunus, M. M. (2010). Mobile learning framework for lifelong learning. *Procedia - Social and Behavioral Sciences*, *7*(C), 130–138. https://doi.org/10.1016/j.sbspro.2010.10.019

Nugraha, I., Athfyanti, N. N., & Prabawa, H. W. (2020). The development of computer-assisted instruction game on mirror reflection concepts for junior high school students. *Jurnal Inovasi Pendidikan IPA*, *6*(1), 1–10. https://doi.org/10.21831/jipi.v6i1.28927

O'Donnell, S., & Epstein, L. H. (2019). Smartphones are more reinforcing than food for students. *Addictive Behaviors*, *90*, 124–133. https://doi.org/10.1016/j.addbeh.2018.10.018

Ozdamli, F., & Cavus, N. (2011). Basic elements and characteristics of mobile learning. *Procedia - Social and Behavioral Sciences*, *28*, 937–942. https://doi.org/10.1016/j.sbspro.2011.11.173

Piaget, J. (1964). Part I: Cognitive development in children: Piaget development and learning. *Journal of Research in Science Teaching*, *2*(3), 176–186.

https://doi.org/10.1002/tea.3660020306

Putra, P. S., Asi, N. B., Anggraeni, M. E., & Karelius. (2020). Development of android-based chemistry learning media for experimenting. *Journal of Physics: Conference Series*, *1422*(1). https://doi.org/10.1088/1742-6596/1422/1/012037

Rachmadtullah, R., Zulela, M. S., & Syarif Sumantri, M. (2019). Computer-based interactive multimedia: A study on the effectiveness of integrative thematic learning in elementary schools. *Journal of Physics: Conference Series*, *1175*(1), 1–6. https://doi.org/10.1088/1742-6596/1175/1/012028

Saputra, D., Gürbüz, B., & Haryani, H. (2021). Android-based Animation for Chemical Elements and Experiments as an Interactive Learning Media. *Journal of Science Learning*, *4*(2), 185–191. https://doi.org/10.17509/jsl.v4i2.28787

Saputri, D. Y., Rukayah, & Indriayu, M. (2018). Need Assessment of Interactive Multimedia Based on Game in Elementary School: A Challenge into Learning in 21st Century. *International Journal of Educational Research Review*, *3*(3), 1–8. https://doi.org/10.24331/ijere.411329

Schuster, K., Groß, K., Vossen, R., Richert, A., & Jeschke, S. (2016). Preparing for Industry 4.0 - Collaborative Virtual Learning Environments in Engineering Education. *Engineering Education 4.0*, 477–487. https://doi.org/10.1007/978-3-319-46916-4

Syawaludin, A., Gunarhadi, & Rintayati, P. (2019). Development of augmented reality-based interactive multimedia to improve critical thinking skills in science learning. *International Journal of Instruction*, *12*(4), 331–344. https://doi.org/10.29333/iji.2019.12421a

Tan, K. C. D., Goh, N. K., Chia, L. S., & Treagust, D. F. (2009). Linking the Macroscopic, Sub-microscopic and Symbolic Levels: The Case of Inorganic Qualitative Analysis. *Multiple Representations in Chemical Education*, 137–150. https://doi.org/10.1007/978-1-4020-8872-8_7

Tsaparlis, G., Kolioulis, D., & Pappa, E. (2010). Lower-secondary introductory chemistry course: A novel approach based on science-education theories, with emphasis on the macroscopic approach, and the delayed meaningful teaching of the concepts of molecule and atom. *Chemistry Education Research and Practice*, *11*(2), 107–117. https://doi.org/10.1039/c005354f

Vanden Abeele, M. M. P. (2016). Mobile lifestyles: Conceptualizing heterogeneity in mobile youth culture. *New Media and Society*, *18*(6), 908–926. https://doi.org/10.1177/1461444814551349

Wan, X., Wang, W., Liu, J., & Tong, T. (2014). Estimating the sample mean and standard deviation from the sample size, median, range and/or interquartile range. *BMC Medical Research Methodology*, *14*(1), 1–13. https://doi.org/10.1186/1471-2288-14-135

Widodo, W., Sudibyo, E., Suryanti, Sari, D. A. P., Inzanah, & Setiawan, B. (2020). The effectiveness of gadget-based interactive multimedia in improving generation z's scientific literacy. *Jurnal Pendidikan IPA Indonesia*, *9*(2), 248–256. https://doi.org/10.15294/jpii.v9i2.23208

Wright, T. (2003). Images of atoms. *Australian Science Teachers Journal*, *49*(1), 18–24. https://doi.org/10.3316/aeipt.127605

Yuniarti, A., Yeni, L. F., & Yokhebed. (2017). Development of Virtual Laboratory Based on Interactive Multimedia on Planting and Painting Bacteria. *Journal of Physics: Conference Series*, *895*(1). https://doi.org/10.1088/1742-6596/895/1/012120

Yusuf, N. B. (2020). Colleges of Education Students' Awareness of Use of Multiple Representations in Explaining Chemistry Concepts in Kwara State, Nigeria. *Acta Didactica Napocensia*, *13*(1), 13–18. https://doi.org/10.24193/adn.13.1.2