Kuartet Biologi Digital Application to Build Digital Literacy and Cognitive Learning Outcomes of Students in High School

Debby Trisia Sari[1], Herawati Susilo[2], Balqis Balqis[3]
[1]Graduate program, Biology Education, State University of Malang, Indonesia
[2,3]Biology Education, State University of Malang, Indonesia

Article Info	ABSTRACT
	Digital literacy is understood as a person's way of thinking, attitude and skills in using electronic and digital devices appropriately to help with work. One of the efforts to integrate digital technology into learning is by using learning applications, namely the Kuartet Biologi application. This research focuses on building students' digital literacy and cognitive learning outcomes through the Kuartet Biologi application. This study involved 58 students of class XI IPA SMAS Elim Makassar, South Sulawesi using a pre-test-post-test design with a non-equivalent control group. The pretest score as a covariant to analyse students' cognitive learning outcomes. Digital literacy was done by observation from the observer as many as 15 statements. Digital literacy was analysed using ANOVA test. Cognitive learning outcomes were analysed using ANCOVA test. The results showed the effect of digital literacy is $0.00 < 0.05$ and cognitive learning outcomes of students who used the Biology Quartet application with classes did not use it is $0.00 < 0.05$. The Kuartet Biologi application is proven to be more effective in building digital literacy and cognitive learning outcomes of students to build cognitive, technical, social-emotional, and behavioural dimensions in using electronic devices while learning and helping students have better knowledge.

Corresponding Author:
Balqis Balqis,
Biology Education, State University of Malang
Jalan Semarang 5, Malang, Indonesia
Email: balqis.fmipa@um.ac.id

1. INTRODUCTION

The changing times in the era of globalisation and technology demand the development of skills for society, and education is no exception. This change no longer focuses on whether or not students are smart, but also whether or not they are able to do work. Students are required to build 21st-century skills in the learning process. One such change is the presence of technology in learning. Students will have changes in learning habits, one of which is the use of digital technology because it follows the times (Scott, 2015; Crisp, 2011). Therefore, students need digital usage skills in learning.

Digital literacy helps students face the challenges of 21st-century digital learning. Digital literacy is understood as an individual's awareness, attitude, and ability to use digital tools and facilities appropriately to identify, access, manage, integrate, evaluate, analyze, and synthesize digital resources to construct new knowledge (Lankshear & Knobel, 2015; Wahyudi, 2021; Martin, 2006). Digital literacy has three dimensional domains namely technical, cognitive, and social-emotional dimensions (Wahyudi, 2021; Ng, 2012). Students who apply digital literacy well will be able to process various messages in information and communicate effectively (Muhaemin, 2017) and become graduates who can compete in the world of work (Lubbe, 2016).

The use of digital technology in learning, especially biology, is not only to fulfil the demands of 21st-century learning (Jayawardana, 2017) but also as a means of delivering learning information. Digital learning in biology helps students to understand abstract concepts concretely and describe materials that cannot be observed directly such as the human body system (Aripin, 2018; Dinata, 2013), students can build better understanding because they are connected to the internet which offers more information sources (Fiteriani, 2017), and increase student learning motivation (Jeno et al., 2017). Digital learning can be done with educational games to attract

students' attention and activeness in learning (Boyle et al., 2016). Technology learning can be done with student smartphones and learning applications (Klimova, 2019).

The Kuartet Biologi application is one of the Android digital learning media to support 21st-century biology learning. The Kuartet Biologi application is in the form of digital cards containing the topics of Cells, Movement Systems, and Human Circulation Systems. The use of android-based card media helps students learn technology that is directed, grouped, and fun so that they can explore knowledge and reflect on what they learn to achieve better learning outcomes (Mavroudi et al., 2022). The use of applications and technology such as the Kuartet Biologi application in learning is an innovation made as a form of changing times (Sadikin & Hakim, 2019). Learning with the Kuartet Biologi application can increase student confidence, activeness, and skills in using digital media to find information while learning (Rezaei et al., 2014). Thus, the Kuartet Biologi application in this study is intended to build students' digital literacy in learning biology in high school.

2. RESEARCH METHOD

This study used a quasi-experimental design to see the effect of using the Kuartet Biologi application to build digital literacy and students cognitive learning outcomes. One of the designs used is pre-test-post-test non-equivalent control group (Aji Fahruli *et al.*, 2023). The research compares two classes, one of which will be taught using the Kuartet Biologi application (experimental class) and the other as a control class (learning without using the application). Both classes will be given an initial test and a final test after the learning process. Digital literacy and cognitive learning outcomes are the dependent variables and Kuartet Biologi application and conventional are the independent variables. The quasi-experimental design is presented in Table 1.

Table 1. Pre-Test-Post-Test Non-equivalent Control Groups Design

Pretest	Treatment Group	Posttest
O_1	X_1	O_3
O_2	X_2	O_4

The treatments in the study include X_1 a control class with the treatment of learning biology using books and teacher presentations in class and X_2 an experimental class with the treatment of learning biology using the Kuartet Biologi digital application. Both classes were taught with the same model, namely Problem-Based Learning (PBL) with the same topics, namely Cells, Movement Systems, and Human Circulation Systems. Pretest includes O_1 and O_2 as multiple-choice test questions. Posttest include O_3 and O_4 are digital literacy and multiple-choice questions as students' cognitive learning outcomes. Posttest were conducted by giving tests on each learning topic while students' digital literacy was taken using observations from observers. Validation of cognitive learning outcomes test questions was carried out by material expert validators while item analysis in classical theory (level of difficulty of questions, effectiveness of triggers, and differentiating power) using the ANATES application, was carried out on class XII students who had studied the topics of Cells, Motion Systems, and Human Circulatory Systems.

The population in the study was in class XI IPA SMAS Elim Makassar consisting of 3 classes. The sample in the study was determined randomly by lottery technique on the condition that the three classes fulfilled equality. The class equality test was carried out using the first and second-semester report card scores. The samples in the study were XI 1 science class as an experimental consisting of 28 students (13 boys and 15 girls). The control class is XI 2 science class consisting of 30 students (15 boys and 15 girls).

The indicators used in measuring students' digital literacy were adapted from Ng (2012), namely Cognitive, Technical, Social-emotional, and Behavioural as many as 15 statements. Students' digital literacy is taken using observations from observers who are filled in according to the specified categories. Digital literacy categories include 1 point (no), 2 points (fair), 3 points (good/like), and 4 points (very good/very like). The scores were then summed and averaged to be processed quantitatively. Data normality and homogeneity tests used Kolmogorov-Smirnov and Levene's tests, while ANOVA analysis to test the assumptions of the hypothesis of the application's influence on students' digital literacy was carried out using the SPSS application. The instrument used in the cognitive learning outcome variable was a multiple-choice test with 30 questions on each learning topic. The indicators used in the learning outcomes test refer to the revised Bloom's taxonomy cognitive domain covering C1 to C6. The scores were then processed quantitatively. Normality and homogeneity tests of the data were analyzed using Kolmogorov-Smirnov and Levene's test, while ANCOVA analysis to test the hypothesis of the effect of the application on students' cognitive learning outcomes was conducted using the SPSS application.

3. RESULT AND DISCUSSION

Digital literacy data was measured using an observation sheet conducted by an observer on each student in the group at each meeting. The ANOVA analysis and the mean scores of students' digital literacy are presented in Table 2 and Table 3.

Kuartet Biologi Digital Application to Build Digital Literacy and Cognitive Learning Outcomes of Students in High School (Debby Trisia Sari)

165

Table 2. ANOVA Analysis

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	171.272	1	171.272	22.992	1.242E-5
Within Groups	417.155	56	7.449		
Total	588.427	57			

Table 2 shows that the Biology Quartet application applied in the quasi-experimental study has a significant effect on students' digital literacy (F-count = 22.992, with a significance level of 0.000012 (1.242x10-5) < 0.05).

Table 3. Average of Digital Literacy

	N	Range	Minimum	Maximum	Mean	Std. Deviation
Control class	30	10.45	33.33	43.78	38.4143	3.05282
Experiment class	28	8.56	37.33	45.89	41.8532	2.33240
Valid N (listwise)	28					

Table 3 shows that the highest value of students' digital literacy during learning with the application is in the experimental class which is 45.89 and the lowest value is 37.33. In contrast, the control class had the highest score of 43.78 and the lowest score of 33.33. Based on these values, there is an average of 41.85 (experimental class) and 38.41 (control class). Therefore, the use of the Kuartet Biologi application builds students' digital literacy in learning biology.

Data on students' cognitive learning outcomes using pre-test and post-test scores on each learning topic. ANCOVA analysis and the mean score of students' cognitive learning outcomes are presented in Table 4 and Table 5.

Table 4. ANCOVA Analysis

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	3332.645[a]	2	1666.323	57.334	.000	.676
Intercept	606.109	1	606.109	20.855	.000	.275
Pre-test	1158.557	1	1158.557	39.863	.000	.420
Class	2665.557	1	2665.557	91.715	2.566E-13	.625
Error	1598.495	55	29.064			
Total	123271.120	58				
Corrected Total	4931.140	57				

Table 4 shows that the Kuartet Biologi application applied in the quasi-experimental study has a significant effect on students' cognitive learning outcomes (F-count = 91.715, with a significance level of 0.0000000000002 (2.566x10-13) < 0.05).

Table 5. Average of Students Cognitive Learning Outcome

	N	Range	Minimum	Maximum	Mean	Std. Deviation
Pre-test of Control class	30	22.22	18.89	41.11	30.8523	5.48677
Post-test of Control class	30	22.22	30.00	52.22	39.2553	6.30834
Pre-test of Experiment class	28	22.22	16.67	38.89	29.1279	4.89852
Post-test of Experiment class	28	26.66	37.78	64.44	51.5075	7.70520
Valid N (listwise)	28					

Table 5 shows the mean of students' cognitive learning outcomes on each learning topic during learning with the application. The highest mean in the experimental class is 51.51. In contrast to the control class with an

average value of 39.25. Therefore, the Kuartet Biologi application builds students to improve cognitive learning outcomes in biology learning.

The significant difference in the results of digital literacy and cognitive learning outcomes of students using the Kuartet Biologi application lies in the characteristics and components contained in the application to build digital literacy and cognitive learning outcomes of students. The first stage in problem-based learning is student orientation to the problem. The use of the Kuartet Biologi application in problem orientation is the case in the application that must be investigated by students in groups. Students listen to the case and then develop a problem to be solved in the group. The problem obtained by students in the group does not have to be the same as other groups so each group will make a different problem.

In the second and third stages of learning, the teacher invites students to learn by exploring the important concepts in the problem they have found, and then by conducting searches from videos and internet sites students take the important part. The process of investigating independently or in groups continues with students being able to choose internet sites that they trust to use as learning resources that support the results of their investigations. The Kuartet Biologi application has a reference component or link that is integrated with internet sites to make it easier for students to choose reliable reading sources to support their investigations. According to Durán et al., (2021), links that can be used to access video, audio, and internet sites in order to determine trusted learning resources can be used by students as information, so they are responsible for the sources they refer to.

The use of the Kuartet Biologi application in finding learning resources on the internet helps students have more diverse learning resources such as YouTube and articles. The use of the Kuartet Biologi application makes students more active in learning, building knowledge, developing problem-solving skills, and finding alternative solutions (Moehani, 2018; Setiyorini & Abdullah, 2013). Digital-based learning such as the use of the Kuartet Biologi application can also increase student engagement in learning (Dommett, 2018), increased student understanding of learning materials (Braghirolli et al., 2016; Wang et al., 2018), improvement in problem-solving because the application has cases to discuss (Hwang et al., 2012; Sánchez et al., 2011), and improved student learning outcomes (Hwang et al., 2012; Philpot et al., 2005; Topalli et al., 2018).

The use of the Kuartet Biologi application not only increases students' knowledge with more diverse learning resources but also students the right attitude when using technology while learning (Ng, 2012). Students become aware of plagiarism when quoting other people's opinions so that every learning resource used for investigation is always recorded properly. The investigation stage in app-based learning also builds students' knowledge of problems with electronic devices (Šćepanović et al., 2015). Some students who had problems with network connections chose to share network connections with their group mates. Students were also able to overcome problems related to poor network connection by creating smaller groups (only two persons) so that the application could be used quickly. Students who have good digital literacy scores help them to be skilled in solving problems related to technological problems, crimes that occur on the internet (cyberspace), and skilled in using electronic devices (Knobel & Lankshear, 2006; Jones dan Hafner, 2012).

In stages four and five of learning using the app, students present the results of their group discussions in front of the class. The presentation of the discussion results is closed with some questions and reinforcement of the topics learned. The submission of questions and reinforcement is used by students as a reflection of learning outcomes. The reflection activity helps students to evaluate the results of the discussion presented and the internet sources used as well as evaluate the work in the group. The Kuartet Biologi application not only helps students obtain good learning outcomes but also provides an enhanced learning experience for students as they collaborate (Liu et al., 2011). Learning using the Kuartet Biologi application not only contributes to students' cognitive but also social-emotional and technical skills.

Students who learn using the Kuartet Biologi application have good social relationships in learning. Learning using the app motivates students, making learning more fun and interactive (Drigas et al., 2015). Learning using online application-based media leads to a large proportion of students who are actively involved and cooperatively using their mobile phones to carry out tasks during learning activities (Jelatu, et al., 2019). Students who have good digital literacy can encourage students to have good learning outcomes because they know to better connect one concept with another (Durall et al., 2020). So, to build students' digital literacy and improve students' cognitive learning outcomes, it is necessary to make innovations in learning, namely by using the Kuartet Biologi application.

4. CONCLUSION

Based on the data and facts that have been explained, the Kuartet Biologi application in problem-based learning is proven to build digital literacy and cognitive learning outcomes of students compared to learning that does not use the application. The use of the Kuartet Biologi application supports problem-based learning because it has a feature to display cases that are discussed in groups. The application builds students' digital literacy in the cognitive dimension because it provides questions and learning resources that are integrated with the internet so that students have more learning resources. The search results conducted by students help them have better learning resources for knowledge thus improving cognitive learning outcomes. The use of apps also builds

students' technical dimension by being skilful in using technological tools such as smartphones and knowing digital crimes. It also builds students' social-emotional learning by engaging in discussions using their smartphones to search for learning resources and discuss solutions. Therefore, the Kuartet Biologi app is highly recommended in 21st-century biology learning that builds students' digital literacy and cognitive learning outcomes. Consistent influence of the Kuartet Biologi application to build skills in 21st-century learning needs to be done on diverse variables.

5. ACKNOWLEDGEMENT

6. REFERENCES

Aji Fahruli, M. T., Biruni, I. B., Choirunnisa', N., Karomika, D., Sofyan, M. A., & Rahmana, A. Y. (2023). RICOSRE FOR THE EMPOWERMENT OF STUDENTS' SCIENTIFIC LITERACY IN A ISLAMIC BOARDING SCHOOL. *BIOEDUKASI*, *21*(1), 52. https://doi.org/10.19184/bioedu.v21i1.32399

Aripin, Ipin. (2018). Konsep dan Aplikasi Mobile Learning dalam Pembelajaran Biologi. *Jurnal Bio Educatio*, 3(1), 2018, 1-9. 2541-2280.

Boyle, E. A., Hainey, T., Connolly, T. M., Gray, G., Earp, J., Ott, M., Lim, T., Ninaus, M., Ribeiro, C., & Pereira, J. (2016). An update to the systematic literature review of empirical evidence of the impacts and outcomes of computer games and serious games. *Computers & Education*, *94*, 178–192. https://doi.org/10.1016/j.compedu.2015.11.003

Braghirolli, L. F., Ribeiro, J. L. D., Weise, A. D., & Pizzolato, M. (2016). Benefits of educational games as an introductory activity in industrial engineering education. *Computers in Human Behavior, 58*, 315–324.

Crisp, G. (2011). Teacher's handbook on e-Assessment. *Transforming Assessment-An ALTC Fellowship Activity*, 1-18.

Dinata, Yogi Nurcahyo. (2013). *Penggunaan Media Pembelajaran Video Tutorial untuk Meningkatkan Hasil Belajar Siswa Teknik Gambar Bangunan SMK N 1 Seyegan pada Mata Pelajaran Menggambar dengan Autocad*. Skripsi. Yogyakarta: UNY

Drigas, A. S., & Pappas, M. A. (2015). A review of mobile learning applications for mathematics. *iJIM*, *3*(3), 18-23. http://dx.doi.org/10.3991/ijim.v9i3.4420.

Durall, E., Virnes, M., Leinonen, T., & Gros, B. (2020). Ownership of learning in monitoring technology. *Interaction Design and Architecture(s)*, *45*, 133–154. https://doi.org/10.55612/s-5002-045-006

Durán, L., Almeida, A. M., & Figueiredo-Braga, M. (2021). Digital audiovisual contents for literacy in depression: a pilot study with university students. *Procedia Computer Science, 181, 239–246.* https://doi.org/10.1016/j.procs.2021.01.140

Dommett, E. J. (2018). *Learner ownership of technology-enhanced learning. Interactive Technology and Smart Education, 15(1), 79–86.* doi:10.1108/itse-08-2017-0042. 10.1108/ITSE-08-20.

Fiteriani, I. & Baharudin, B. (2017). Analisis Perbedaan Hasil Belajar Kognitif Menggunakan Metode Pembelajran Kooperatif yang Berkombinasikan pada Materi IPA di MIN Bandar Lampung. *TERAMPIL Jurnal Pendidikan dan Pembelajaran Dasar*, 4(2), 1-30

Hwang, G.-J., Wu, P.-H., & Chen, C.-C. (2012). An online game approach for improving students' learning performance in web-based problem-solving activities. *Computers & Education, 59*(4), 1246–1256. https://doi.org/10.1016/j.compe du.2012.05.009.

Jayawardana, H. B. A. (2017). PARADIGMA PEMBELAJARAN BIOLOGI DI ERA DIGITAL. *JURNAL BIOEDUKATIKA*, *5*(1), 12. https://doi.org/10.26555/bioedukatika.v5i1.5628

Kuartet Biologi Digital Application to Build Digital Literacy and Cognitive Learning Outcomes of Students in High School (Debby Trisia Sari)

168

Jelatu, S., Kurniawan, Y., Kurnila, V. S., Mandur, K., & Jundu, R. (2019). Collaboration TPS Learning Model and m-Learning Based on Android for Understanding of Trigonometry Concepts with Different Cognitive Style. *International Journal of Instruction*, 12(4), 545-560. https://doi.org/10.29333/iji.2019.12435a

Jeno, Lucas Matias & Grytnes, John Arvid & Vandvik, Vigdis. (2017). The effect of a mobile-application tool on biology students' motivation and achievement in species identification: A Self-Determination Theory perspective. *Computers & Education*. 107. 1-12. 10.1016/j.compedu.2016.12.011.

Jones, R. H., & Hafner, C. A. (2012). *Understanding digital literacies*. London and New York: Routledge.

Klimova, B. (2019). Impact of Mobile Learning on Students' Achievement Results. *Education Sciences*, 9(2), 90. https://doi.org/10.3390/educsci9020090

Knobel, M., & Lankshear, C. (2006). Digital Literacy and Digital Literacies: Policy, Pedagogy and Research Considerations for Education. *Nordic Journal of Digital Literacy*, 1(1), 12–24. https://doi.org/10.18261/ISSN1891-943X-2006-01-03

Lankshear, Colin., & Knobel, Michele. (2015). Digital Literacy and Digital Literacies: Policy, Pedagogy and Research Considerations for Education. *Nordic Journal of Digital Literacy*, no. 4 : 8–20. https://doi.org/10.18261/issn1891-943x-2015-jubileumsnummer-02.

Liu, C.-C., Cheng, Y.-B., & Huang, C.-W. (2011). The effect of simulation games on the learning of computational problem solving. *Computers & Education, 57*(3), 1907–1918. https://doi.org/10.1016/j.compedu.2011.04.002

Lubbe, J. C. (Irene). (2016). Digital fluency of faculty members at an ODL institution. *Progressio*, 38(2), 63–83. https://doi.org/10.25159/02568853/1505

Martin, A. (2006). A european framework for digital literacy. *Nordic Journal of Digital Literacy*, 1(2), 151–161. https://doi.org/10.18261/ISSN1891-943X-2006-02-06

Mavroudi, A., Almeida, T., Frennert, S., Laaksolahti, J., & Viberg, O. (2022). A card game for designing activities for technology-enhanced learning in higher education. *Education and Information Technologies*, 27(2), 2367–2383. https://doi.org/10.1007/s10639-021-10668-z

Muhaemin, B. (2017). Kebijakan pengembangan pendidikan: Pra kemerdekaan era reformasi dalam konteks perubahan sosial. *Jurnal Studi Pendidikan Vol XV | No.1 Januari – Juni 2017.*

Moehani, Dwi Kirana. 2018. "The Impact Of The Use Of Materials-Based Multicultural Media With The Quartet Card Towards The Attitude Of Student." 212: 61–67. DOI:10.2991/icei-18.2018.14

Ng, W. (2012). Can we teach digital natives digital literacy? *Computers & Education*, 59(3), 1065–1078. https://doi.org/10.1016/j.compedu.2012.04.016

Philpot, T. A., Hall, R. H., Hubing, N., & Flori, R. E. (2005). Using games to teach statics calculation procedures: Application and assessment. *Computer Applications in Engineering Education, 13*(3), 222–232. https://doi.org/10.1002/cae.20043

Rezaei, A., Mai, N., & Pesaranghader, A. (2014). The Effect of Mobile Applications on English Vocabulary Acquisition. *Jurnal Teknologi*, 68(2). https://doi.org/10.11113/jt.v68.2912

Sadikin, A., & Hakim, N. (2019). Pengembangan Media E-Learning Interaktif Dalam Menyongsong Revolusi Industri 4.0 Pada Materi Ekosistem Untuk Siswa SMA: Interactive Media Development of E-Learning in Welcoming 4.0 Industrial Revolution on Ecosystem Material for High School Students. *BIODIK*, 5(2), 131–138. https://doi.org/10.22437/bio.v5i2.7590

Sánchez, J., & Olivares, R. (2011). Problem solving and collaboration using mobile serious games. *Computers & Education, 57*(3), 1943–1952. https://doi.org/10.1016/j.compedu.2011.04.012.

Kuartet Biologi Digital Application to Build Digital Literacy and Cognitive Learning Outcomes of Students in High School (Debby Trisia Sari)

169

Setiyorini, I., & Abdullah, M. H. (2013). Penggunaan Media Permainan Kartu Kuartet Pada Mata Pelajaran IPS Untuk Peningkatan Hasil Belajar Siswa di Sekolah Dasar. *Jurnal Penelitian Pendidikan Guru Sekolah Dasar*, *1 (2)*, 1–10.

Šćepanović, S., Vujičić, T., Matijević, T., & Radunović, P. (2015). GAME BASED MOBILE LEARNING – APPLICATION DEVELOPMENT AND EVALUATION. *The Sixth International Conference on e-Learning* 24-25 September 2015, Belgrade, Serbia

Scott, C. L. (2015). *The Futures of learning 1: Why Must Learning Content and Methods Change in The 21st Century*. Paris: UNESCO: Education Research and Foresight.

Topalli, D., & Cagiltay, N. E. (2018). Improving programming skills in engineering education through problem-based game projects with Scratch. *Computers & Education, 120*, 64–74. https://doi.org/10.1016/j.compedu.2018.01.011.

Wahyudi, T. (2021). Penguatan Literasi Digital Generasi Muda Muslim Dalam Kerangka Konsep Ulul Albab. *Al-Mutharahah: Jurnal Penelitian Dan Kajian Sosial Keagamaan*, *18 (2),* 161-178. DOI: 10.46781/al-mutharahah.v18i2.368

Wang, Q., & Abbas, M. (2018). Designing web-games for transportation engineering education. *Computer Applications in Engineering Education, 26*(5), 1699–1710. https ://doi.org/10.1002/CAE.22031