The Effectiveness of Online Simulation with GDL and PBL toward Students' Digital Literacy Skill

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ABSTRACT
This study aimed to investigate the impact of online simulation in physics learning toward students' digital literacy skills. There are 106 randomly students Grade XII Science from West Borneo and Riau Province, Indonesia as participants in this study. The level of digital literacy skill of all participants in the classes before and after the learning process was determined to assess the effectiveness of two models with online simulation learning. We used comparative –descriptive, pre-test and post-test experimental design, and Anova Mixed Design to analysis data. The result of this study was: (1) Students' digital literacy skill of students in two groups initially are at very low level and increased after learning; (2) there was a significant difference in the level of digital literacy skill of the students online simulation with GDL class; (3) in this study, the online simulation with GDL model is more effective than online simulation with PBL model in enhancing students' digital literacy skill in senior high school. For the conclusion, in this study students' digital literacy skill in Indonesia is rather below. Model PBL with online simulation is one of the teaching models that can be used in enhancing students' digital literacy skills.

Keywords: digital literacy skill; online simulation; PBL-GDL Model; Learning

INTRODUCTION

The ultimate goal of the discipline of physics is to describe the behavior of the universe and its contents (Volkwyn, Airey, Gregorcic, & Heijkenskjöld, 2019). But, a common problem in many schools is the lack of equipment and materials in their science laboratories due to both limited budget available to the school and high maintenance cost of the lab (Bogusevschi, Muntean, & Muntean, 2019). Now, technology has been increasingly adopted in science education and more innovative use of technology leads to a greater learning outcome (Zhai, Zhang, Li, & Zhang, 2019).

The digital revolution is profoundly modifying our lifestyle habits, our means of understanding the world (Gomez-Galan, 2018). The 21st century is centered on the digital economy and society as an extension of the development of the industrial society that expanded throughout the 20th century

(Techataweewan & Prasertsin, 2018). A digital-based, knowledge-based society is demanding new future capabilities (Kim, 2019). In considering current developments recent research will assess the acquisition of digital literacy and the variables influencing perceptions on digital literacy (Shala & Grajcevci, 2018).

The critical need for digital literacy development in higher education is evident through the strategic priorities expressed by the highest levels of governance, both nationally and internationally (McGuinness & Fulton, 2019). While students' conceptions of digital literacy development can likewise be expected to be associated with behaviors, including effort expenditure, help-seeking, and social engagement, these have been considered in the literature only to a limited extent (List, 2019). The approach to this skill draws from a multidisciplinary lineage in education, communication, social sciences, and the humanities (Hobbs & Coiro, 2019).

Research into digital literacy/literacies has sought to address the development of tools and methods to students in becoming more situated and adept digital citizens (Talib, 2018). The digital divide is characterized by two crucial problems, viz., (1) limited and costly infrastructure and (2) limited digital literacy in low/middle income communities (Josie et al., 2018). The lack of physical presence in digital learning environments has challenged adult educators to cultivate web-based learning environments that provide rigorous academic experiences and promote student success (Sharp Asst & O, 2018).

Web-based learning has been developed by the majority of academic institutions and organizations worldwide due to its obvious benefits for both educators and learners (Mkrttchian et al., 2018). The development of modern computing technologies provides new opportunities for organizing large scale population studies of the psychological characteristics of students (Nikulchev et al., 2019). Web-based learning has some advantages. It is convenient as the user only has to open a browser or click the hyperlink to play with the models, inherently interactive and the system can utilize a plenty of forms of interaction available in the browser to create the specific user experience (Thio, Liu, Yeh, & Yang, 2019).

It is an education utilizing multimedia computers or porTable computing devices enabling access to materials posted on a website (Leszczyński et al., 2018). Web-based learning is not only use in the classroom. To describe and demonstrate the quality and local profiles of educational programs, web-based curriculum mapping tools of the last decade started to use techniques for big data handling and/or visual analytics for describing the so-called "big picture" (Fritze et al., 2018). To support the leaning with web base environment we need an innovative model. In this study the innovative model that used are guided discovery and problem based learning. After that, we compare both model, to know the effectiveness of them. For the novelty, there is no many study that focus on enhancing the digital literacy skill of students. We used the online environment learning based on innovative model and compare two model, PBL and GDL.The research objectives are (1) to asses students digital literacy skill, (2) to investigate the effect of onine simulation learning with innovative model in enhancing the students' digital literacy skill, (3) to compare the effectiveness of PBL and GDL toward students' digital literacy skill .

METHOD

*Model of Research.*The study utilized the pretest posttest experimental designs and descriptive-comparative research. The comparative part involved the comparison of their digital literacy skill levels during the pre- and post-test. The experimental part of the study involved the students' performance in physics after exposure to guided discovery and problem based-learning model. The descriptive part of the research involved the profiling of the student and determining their levels of digital literacy skills. Qualitative and quantitative approaches were utilized in determining the level of digital literacy skill of students. Quantitative analysis was used to determine any difference between the pretest and posttest means of the GDL and PBL groups with online simulation learning.

The study was conducted to randomly selected classes of Grade XII Integrated Science students of senior high school in the West Borneo and Riau Province under the Revised Curriculum 13 for the school year 2019 – 2020 by purposive sampling technique. At the beginning, test was administrated to 65 students, to determine the reliability and validity of the test. For the GDL group consist of 24 students with 7 males and 19 females. For the PBL group consist of 22 students with 7 males and 15 females. Overall, there were

111 students as participant in this study. Students had their classes 3 sessions and 90 minutes per session.

The research tools used were the (1) GDL and PBL learning plan which contained the desired learning competencies for the learning activities and assessment. This learning plan was validated by experts (2) GDL and PBL student's worksheet which was a learner's module developed by the researchers. (3) Digital Literacy Skill Test (DLST) for assessing the level of digital literacy skills of the learners. Students were asked to solve a set of 10 items under sufficient amount of time. The items in the digital literacy skill were also validated by experts. The rubric used the 0-3 levels. The Table 1 below shows the equivalence of the levels.

The aspect of digital literacy skill in this study based on (Bawden, 2008) were: (1) internet searching, (2) hyper textual navigation, (3) content evaluation and (4) knowledge assembly

In this study, we used SPSS version 16 to analyze data. To determine the effectiveness level of each model, we use the gain score analysis with (Hake, Wakeland, & Bhattacharyya, A. Sirochman, 1994) equation. The profile of students' digital literacy skills was analyzed by descriptive statistics using frequency and percent. To determine the significant difference in the level of digital literacy skills of students exposed to GDL and PBL models, we used mixed design ANOVA analysis. Finally, the difference in the level of students' digital literacy skills in the pre-test and post-test was analyzed using paired sample t-test.

RESULT AND DISCUSSION

Result

Online Simulation with PBL Model. In the digital literacy test, students were given 10 items in their pre-test and post-test. The result of their pre-and-post-test is shown in Table 2. The Table shows the level of their responses in the pre-test and post-test of their digital literacy skills test.

Table 2 shows the level of digital literacy skill of the students in PBL Class. Based on the pre-test, the mean of digital literacy skill are very low (mean = 0.95, SD = 1.31). Among 10 items of digital literacy test, the higher score is aspect hyper textual navigation with mean 1.48 (very low). The lowest score on the aspect knowledge assembly with mean 0.46 (very low). In this class, overall the level of digital literacy skill shows that their skill have not been improved.

Table 3 present the level of digital literacy skill before and after they were taught using the online simulation with PBL model of teaching physics concepts in Science XII.

Tabel 1 Level of Digital Literacy Skill

Level	Description
2.70 – 3.00	Very high
2.40 – 2.69	High
2.10 – 2.39	Average
1.80 – 2.09	Low
0.00 – 1.79	Very low

Tabel 2 The Level of Digital Literacy Skill of The Online Simulation With PBL Class

Aspect	Pre-test		Description			Description
	Mean	**SD**		**Mean**	**SD**	
1	0.65	0.00	Very low	0.87	0.41	Very low
2	1.48	0.08	Very low	1.84	0.05	Very low
3	0.96	0.67	Very low	2.21	0.29	Very low
4	0.46	0.43	Very low	0.55	0.85	Very low
Overall	1.11	1.32	Very low	1.50	1.29	Very low

Tabel 3   Level of Digital Literacy Skill of the PBL Class Before and After Learning Process

Aspect	Before (N = 19)		After (N = 19)	
	F	%	F	%
Bb	-	-	-	-
High	-	-	-	-
Average	1	5.26	2	10.52
Low	2	10.52	4	21.04
Very low	16	84.21	13	68.42
Overall	Mean = 1.15 (very low), SD = 0.51		Mean = 1.5 (very low), SD = 1.29	

It can be seen from the Table 3 that the students of the PBL Class have very low digital literacy skill (mean = 1.15, SD = 0.51), before they were exposed to online simulation with PBL model of teaching. Most (84.21% of the total 19 students) of the students have very low level of digital literacy skill while few (10.52%) students have low level and another student (5.26%) has average level of digital literacy skills.

After exposure to online simulation with PBL model in learning physics concepts, the number of student in the low level increased (21.04%) while the number of students in very low level decreased (68.42%). However, the level of digital literacy skill of PBL class still at very low level with a mean 1.50 (SD = 1.29). This shows that the online simulation with PBL used in teaching did not have an effect in enhancing the student's level of digital literacy skills.

The level of digital literacy skill of the Grade XII students in PBL class during their pre-tests was compared to their level during the post-test. In this study, we used paired sample t-test to know the significant difference of their digital literacy skill during their pre-test and post-test is determined as present in Table 4.

Table 4 shows that there is a significant difference in the pre-test and post-test levels of digital literacy skill of the online simulation with PBL Class after they were taught in learning physics. The post-test mean level (1.50) difference of 0.35 over the pre-test mean level (1.15) indicates that the online simulation with PBL Model of teaching among the students in the class significantly helped in improving the level of student's digital literacy skills.

Online Simulation with GDL Model. During the pre-test and post-test of students' digital literacy skills, they were given the same 10 items to answer in the online simulation with

GDL class. Their responses were analyzed and the result is shown in Table 5.ZA

Table 5 shows that Grade XII students under online simulation with GDL class exhibited very low level of digital literacy skill during the pre-test of digital literacy skill test which surfaced a mean 0.69. Among the 10 items given during the pre-test, responses of students showed highest level of digital literacy skill in aspect internet searching with a mean of 1.09 (very low). The responses of students in aspect knowledge assembly exhibit the lowest level with a mean of 0.16 (very low). The very low level of digital literacy skill of students in the online simulation with GDL Class prior to their exposure to the learning suggest that their skills in digital literacy skill are not yet improved.

The level of digital literacy skill of students under the online simulation with GDL Class before and after they taught using the learning is shown in Table 6.

As gleaned from Table 6, the level of digital literacy skills of students under the online simulation with GDL Class before they were exposure of learning the physics concepts was very low (100%). Generally, they have very low level of digital literacy skill with average of mean level of 0.69 with SD = 0.35 during the pre-test. None among students exhibited higher level of digital literacy skills.

Moreover, the level of digital literacy skills during the post-test after they were taught was average level, with mean 2.28 with standard deviation of 0.16. Specially, only 4.54% at low level and 13/63% at very low level. On the other hand, the higher number of students in average, high and very high level comparatively increased during the post-test. This implies that the intervention made provided a positive effect in developing and improving the digital literacy

skills of the students.

The significant difference of level of digital literacy skill of students under the online simulation with GDL Class before and after they were taught was determined using paired sample t-test. The results are presented in Table 7.

Tabel 4. Paired Sample T-Test (Pre-Test and Post-Test) of the Digital Literacy Skill of PBL Class

	Mean	SD	t-value	df	Sig
Pre-test	1.15	0.51	-2.667	18	0.016
Post-test	1.50	0.53			

Tabel 5. The Level of Digital Literacy Skill of The Online Simulation With GDL Class

Aspect	Pre-test		Description	Post-test		Description
	Mean	SD		Mean	SD	
1	1.09	0.57	Very low	2.07	0.41	Low
2	1.08	0.69	Very low	2.44	0.05	High
3	0.38	0.87	Very low	2.26	0.29	Average
4	0.16	0.39	Very low	2.30	0.85	Average
Overall	0.69	0.35	Very low	2.28	0.16	Average

Tabel 6. Level of Digital Literacy Skill of the GDL Class Before and After Learning Process

Aspect	Before (N = 19)		After (N = 19)	
	F	%	F	%
Very high	-	-	6	27.27
High	-	-	6	27.27
Average	-		6	27.27
Low	-		1	4.54
Very low	19	100	3	13.63
Overall	Mean = 1.15 (very low), SD = 0.51		Mean = 1.5 (very low), SD = 1.29	

Tabel 7. Paired Sample T-Test (Pre-Test and Post-Test) of the Digital Literacy Skill of GDL Class

	Mean	SD	t-value	df	Sig
Pre-test	0.68	0.34	-11.109	21	0.000
Post-test	2.28	0.64			

As gleaned from Table 7, there is a significant difference in the pre-test and post-test result of level of digital literacy skill of the online simulation with PBL Class of Grade XII students. The post-test mean level (2.28) difference of 1.60 over the pre-test mean level (0.68) indicates that the learning used in teaching online simulation with GDL Class of Grade XII students significantly helped in enhancing their level of digital literacy skills.

Comparison of Two Classes. In this research, we used ANOVA Mixed Design to determine the influenced between online simulation with PBL Class and online simulation with GDL Class. The result of the analysis are shown in Table 8.

Based on Table 8, the score of partial eta square of each class are PBL = 0.130 and GDL = 0.785. According to (Leech, Barret, & Morgan, 2005) the values of PES shows that online simulation with PBL model can enhance the student's digital literacy skill by 13%. While the online simulation with GDL model can enhance by 78.5%. This implies that online simulation with GDL model is more effective to enhance the student's digital literacy skill than online simulation with PBL Model. It should be noted that the students were grouped in heterogeneous classes such as the figure 1.

From the figure 1, we know that all

students from the class has different level at initially. After learning process, the students in online simulation with GDL class have better level than online simulation with PBL class. Data analysis on the gain scores of students in the online simulation with PBL class and online simulation with GDL class depending on their scores is presented in Table 9.

Table 9 shows that there is an increase score from two classes. As state by (Hake et al., 1994), the effectiveness of online simulation with PBL model only at low category (0.09) while the online simulation with GDL model at medium level (0.48).

Tabel 8 Analysis of Anova Mixed Design

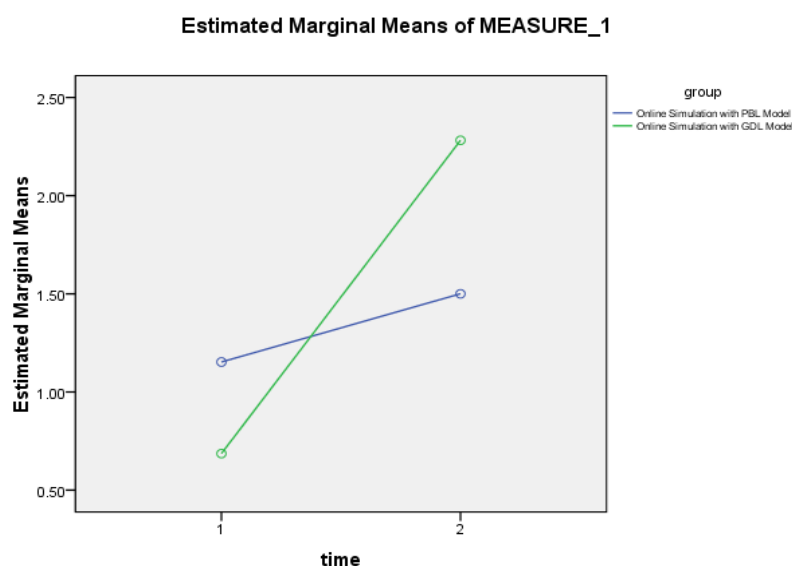| Class	Sig	Partial Eta Square
Online simulation with PBL model	0.021	0.130
Online simulation with GDL model	0.000	0.785

Figure 1 Initial and Final Digital Literacy Skill of the Classes

Discussion

In this study online simulatio learning with GDL model more effective than PBL model in enhancing students' digital literacy skill. Online simulation learning effectively improves students' digital literacy skills. It is needed to foster positive attitudes and digital literacy skills (Prior, Mazanov, Meacheam, Heaslip, & Hanson, 2016). In this study, the results are similar to the findings (Perdana, Riwayani, Jumadi, & Rosana, 2019) that online simulation learning can improve students' digital literacy skills by 28.3% than conventional learning 0.2%. Other study show that web-based online learning has a positive effect on digital literacy skills of students with an average of 83.75% (Elmunsvah, Nur Hidayat, & Patmantara, 2018).

In guided discovery-based learning, scaffolding and facilitation are distributed to students among tools, artifacts, and social resources from the learning environment (Rebecca Reynolds & Chiu, 2016). The source of information is provided throughout the GDL and shows that students are more involved with previous units that do not have a curriculum (R. Reynolds & Leeder, 2017). The results are not so maximal with the GDL model indicating that students may need greater learning scaffolding for information literacy and independent use of resources in learning (Rebecca Reynolds, 2016).

The impact of development of science based on this study is, it can become a prereference to develop education science learning and what skill that considered to develop. Although, this skill is much needed, the

students appear not really ready to entrance technology world in education systems. Students' digital literacy skill as the 21ˢᵗ century skill as rather below. No many research focus on developing this skill and just consider other topics such on students' achievement and think skill.

CONCLUSION AND SUGGESTION

With the findings of the research, it was proven in this study the online simulation with GDL model has been effective in improving the digital literacy skill of the students at average level. Moreover, the online simulation with GDL model is more effective than online simulation with PBL model in improving the level of digital literacy skills of students. As the suggestion and recommendation for the next study, researcher should consider the students' digital literacy skill before hold the learning based technology environtment. Holding the special learning in enhancing students digital literacy skill with other model is needed to make sure they ready to learn with technology. For the teachers, they must guide the students when teach by e-learning method. The policy makers, should integrate the ICT learning on the curriculum and focus to delevop digital skill as the one of the ability in 21ˢᵗ century skill.

REFERENCES

Bawden, D. (2008). Origins and concepts of digital literacy. *Digital Literacies: Concepts, Policies and Practices.* https://doi.org/10.1093/elt/ccr077

Bogusevschi, D., Muntean, C., & Muntean, G. M. (2019). Teaching and Learning Physics using 3D Virtual Learning Environment: A Case Study of Combined Virtual Reality and Virtual Laboratory in Secondary School. In *In Society for Information Technology & Teacher Education International Conference* (pp. 464–474). Association for the Advancement of Computing in Education (AACE).

Elmunsvah, H., Nur Hidayat, W., & Patmantara, S. (2018). Digital Literacy Skills of Informatics Engineering Education Students as the Basis for Online Learning Implementation. In *Proceedings - 2018 International Seminar on Application for Technology of Information and Communication: Creative Technology for Human Life, iSemantic 2018.* https://doi.org/10.1109/ISEMANTIC.2018.8549753

Fritze, O., Lammerding-Koeppel, M., Boeker, M., Narciss, E., Wosnik, A., Zipfel, S., & Griewatz, J. (2018). Boosting competence-orientation in undergraduate medical education–A web-based tool linking curricular mapping and visual analytics. *Medical Teacher.* https://doi.org/10.1080/0142159X.2018.1487047

Gomez-Galan, J. (2018). (2018). Media Education as Theoretical and Practical Paradigm for Digital Literacy: An Interdisciplinary Analysis.

Hake, R. R., Wakeland, R., & Bhattacharyya, A. Sirochman, R. (1994). Assessment of individual student performance in an introductory mechanics course. *AAPT Announcer*, *24*(4), 76.

Hobbs, R., & Coiro, J. (2019). Design Features of a Professional Development Program in Digital Literacy. *Journal of Adolescent and Adult Literacy.* https://doi.org/10.1002/jaal.907

Josie, J., Fang, C., Chetty, K., Qigui, L., Gcora, N., & Wenwei, L. (2018). Bridging the digital divide: measuring digital literacy. *Economics: The Open-Access, Open-Assessment E-Journal.* https://doi.org/10.5018/economics-ejournal.ja.2018-23

Kim, K. T. (2019). The Structural Relationship among Digital Literacy, Learning Strategies, and Core Competencies among South Korean College Students. *Educational Sciences: Theory & Practice.* https://doi.org/10.12738/estp.2019.2.001

Leszczyński, P., Gotlib, J., Kopański, Z., Wejnarski, A., Świezewski, S., & Gałazkowski, R. (2018). Analysis of Web-based learning methods in emergency medicine: Randomized controlled trial. *Archives of Medical Science.* https://doi.org/10.5114/aoms.2015.56422

List, A. (2019). Defining digital literacy

development: An examination of pre-service teachers' beliefs. *Computers and Education*. https://doi.org/10.1016/j.compedu.2019.03.009

McGuinness, C., & Fulton, C. (2019). Digital Literacy In Higher Education: A Case Study Of Student Engagement With E-Tutorials Using Blended Learning. *Journal of Information Technology Education: Innovations in Practice*, *18*, 1–28.

Mkrttchian, V., Krevskiy, I., Bershadsky, A., Glotova, T., Gamidullaeva, L., & Vasin, S. (2018). Web-Based Learning and Development of University's Electronic Informational Educational Environment. *International Journal of Web-Based Learning and Teaching Technologies*. https://doi.org/10.4018/ijwltt.2019010103

Nikulchev, Evgeny, Ilin, D., Kolyasnikov, P., Zakharov, I., & Malykh, S. (2019). Programming Technologies for the Development of Web-Based Platform for Digital Psychological Tools. *ArXiv Preprint ArXiv:1906.05276*.

Perdana, R., Riwayani, R., Jumadi, J., & Rosana, D. (2019). Web-Based Simulation on Physics Learning to Enhance Digital Literacy Skill of High School Students. *JIPF (Jurnal Ilmu Pendidikan Fisika)*. https://doi.org/10.26737/jipf.v4i2.1048

Prior, D. D., Mazanov, J., Meacheam, D., Heaslip, G., & Hanson, J. (2016). Attitude, digital literacy and self efficacy: Flow-on effects for online learning behavior. *Internet and Higher Education*. https://doi.org/10.1016/j.iheduc.2016.01.001

Reynolds, R., & Leeder, C. (2017). Information Uses and Learning Outcomes During Guided Discovery in a Blended E-Learning Game Design Program for Secondary Computer Science Education. In *In Proceedings of the 50th Hawaii International Conference on System Sciences.* (pp. 2076–2085).

Reynolds, Rebecca. (2016). Defining, designing for, and measuring "social constructivist digital literacy" development in learners: a proposed framework. *Educational Technology Research and Development*. https://doi.org/10.1007/s11423-015-9423-4

Reynolds, Rebecca, & Chiu, M. M. (2016). Reducing digital divide effects through student engagement in coordinated game design, online resource use, and social computing activities in school. *Journal of the Association for Information Science and Technology*. https://doi.org/10.1002/asi.23504

Shala, A., & Grajcevci, A. (2018). Digital competencies among student populations in Kosovo: the impact of inclusion, socioeconomic status, ethnicity and type of residence. *Education and Information Technologies*. https://doi.org/10.1007/s10639-017-9657-3

Sharp Asst, L. A., & O, J. G. (2018). Collaborative Digital Literacy Practices among Adult Learners: Levels of Confidence and Perceptions of Importance. *International Journal of Instruction*. https://doi.org/10.12973/iji.2018.11111a

Talib, S. (2018). Social media pedagogy: Applying an interdisciplinary approach to teach multimodal critical digital literacy. *E-Learning and Digital Media*. https://doi.org/10.1177/2042753018756904

Techataweewan, W., & Prasertsin, U. (2018). Development of digital literacy indicators for Thai undergraduate students using mixed method research. *Kasetsart Journal of Social Sciences*. https://doi.org/10.1016/j.kjss.2017.07.001

Thio, V., Liu, H. M., Yeh, Y. C., & Yang, Y. H. (2019). A minimal template for interactive web-based demonstrations of musical machine learning. In *CEUR Workshop Proceedings*.

Volkwyn, T. S., Airey, J., Gregorcic, B., & Heijkenskjöld, F. (2019). Transduction and Science Learning: Multimodality in the Physics Laboratory. *Designs for Learning*. https://doi.org/10.16993/dfl.118

Zhai, X., Zhang, M., Li, M., & Zhang, X. (2019). Understanding the relationship between levels of mobile technology use in high

school physics classrooms and the learning outcome. *British Journal of Educational Technology*. https://doi.org/10.1111/bjet.12700