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# Investigating Biology Pre-service Teacher Perception of General Biology and Digital Literacy

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**Abstract.** Biology and technology are rapidly growing field of study in recent years. This condition poses challenges and opportunities for the pre-service biology teacher to integrate the development of biology with the technology. Several previous studies have focused only on the dimensions of learning outcomes. Therefore this article examines the perception of pre-service biology teacher in biology and learning using technology. The survey conducted by 195 biology pre-service teachers and interviews with four lecturers of biology. The results show that respondents feel essential and need to master the latest technology to be integrated into biology learning. 95% of respondents thought that biology learning with technology is more exciting and fun. This condition indicates that respondents are ready to be taught biology using the latest technology.

**Keywords:** Biology Pre-service Teacher, General Biology, Digital Literacy

## 1. Introduction

Education across the world in recent years has undergone drastic changes. The changes are driven by the science and technology education lead to era disruption [1]. The disruption era for the 21st century is a challenge, and an opportunity for continuing education in some developing countries, the article The developed nations are the center of development of science and technology changing very quickly and even unchallenged [2].

Science and the latest technology brings drastic changes in all areas of life including education. The education sector, notably higher education, has a very strategic role in engaging in thinking and problem solving and has a role in creating opportunities to bridge these disruptive changes [1].

One area of concern in the development of science and technology in the 21st century is STEM ( Science, Technology, Engineering, and Mathematics ) [3], [4]. Specific in the field of science has three central study areas including biology [5], [6], physics [7], and chemistry [8]. Fields with each other



on STEM complement each other to create innovation. For example, the development of biology, in general, cannot be separated by various mathematical calculations, the complexity of the chemical formula, and of course the use of technology in it. The STEM has a vital role in world civilization, therefore must be inherited with the latest technology to the next generation.

Biological education is part of STEM education globally [3], [4]. The function of biology education to create biologists [5]. The development of biology education cannot separate from technological developments. The use of technology in biology education dramatically influences the process of conveying biology concepts in biology learning.

Biology is one branch of science that describes the various studies of concepts, experimental techniques and research approaches from life [9]. So far, the development of biology is so fast and requires the right media to teach some of its sub-disciplines such as molecular, cellular, biological, physiological, ecological, and evolutionary development [9].

General biology is one of the subjects taught in biology education program. Although the characteristic of a study in general, students are encouraged to be able to analyze the concepts within them. The reason is that students will describe the idea in more detail in the specific courses, such as plant physiology, animal physiology, human physiology, genetics, microbiology, a bio cell, ecology, and biotechnology [10]. General biology lectures are not only limited to the study of living things, further studying the processes that occur in living things such as the processes of chemical reactions and physics [11].

Advances in technology facilitate the process of forming the learning environment and the method of biological science itself. One of the technologies in this digital age that can establish a new learning environment is online learning. The carrying capacity of the internet in providing information can increase the amount of its use in the learning process. Such circumstances alter the general biology lecture paradigm accustomed to practicum traditionally towards recent lectures [10]–[12].

This research discusses how the perception of biology pre-service teacher to the concept of general biology and the use of technology used as a model of learning cycle in general biology lectures.

## 2. Method

A total of 195 biologies pre-service teacher were involved in the study. They are students from four universities in east java Indonesia who take a general biology course in academic year 2017/2018. Data collection techniques used questionnaires adapted from [13] and [14] with Likert-scale entries: "Strongly Agree:5", "Agree:4", "Undecided:3", "Disagree:2", and "Strongly Disagree:1".

## 3. Result

The statements below are two dimensions used to investigate biology teacher candidates related to general biology lectures and digital literacy

**Table 1.** Statement of investigation of general biology lectures and attitudes and digital literacy.

<b>Lecture of General Biology</b>	<b>Attitude and Digital Literacy</b>
Lecturer centered learning	ICT enhances creativity
Media diversity	ICT accelerates the completion of work
Bored without media variety	Access information anywhere, everywhere
Online learning	Internet as a learning tool
Access E-learning and E-book	E-Book as a learning tool
General biology using ICT is fun	I can operate my laptop/computer
General biology using ICT is interesting	I can utilize the internet

General biology using ICT is real	Lecturers use LMS (Learning Management System)
I am satisfied using ICT in general biology	Lecturer guides the creation of an LMS account
I prefer to study general biology independently through online learning	Lecturers use LMS for discussion / practice questions / quiz / tasks online

Table 1 above is a variety of statements used to investigate biology pre-service teacher on general biology lectures and their digital literacy attitudes toward the use of ICT in general biology lectures.

Twenty statements into two dimensions, namely the aspects of general biology lectures and dimensions of digital attitudes and literacy. This two-dimensional division is based on research [13]–[15]. The first dimensions of general biology lectures to explore facts in the field related to how the general biology lectures, learning media used, the implementation of online learning to the statement of what method is favorite biology pre-service teacher in general biology lecture. The second dimension is the attitude and digital literacy of biology teacher candidates. The purpose of this dimension is to know how the biology teacher's attitude toward the latest technology and the extent to which biology teacher candidates master the most recent technique often used in biology learning.

The results in table 2 below are the first dimensions to investigate biology teacher candidates for general biology lectures.

**Table 2.** Students perception of general biology lectures.

Item	Agree	Undecided	Disagree	Unresponsive
Lecturer centered learning	44.1	44.1	10.8	1.0
Learning media diversity	84.1	10.26	5.1	0.5
Bored without media variety	59.4	17.4	23.1	0
Online learning	62.6	18.9	17.4	1.0
Access E-learning and E-book	98.4	1.0	0.5	0.0
General biology using ICT is fun	95.4	4.1	0.5	0.0
General biology using ICT is interesting	95.9	4.1	0.0	0.0
General biology using ICT is real	86.1	11.8	2.0	0.0
I am satisfied using ICT in general biology	86.7	10.3	2.6	0.5
I prefer to study general biology independently through online learning	52.8	41.5	5.6	0.0

The second dimension is the attitude and digital literacy of biology teacher candidates toward general biology lectures using information and communication technology tools. It is the results of its investigation in table 3 below.

**Table 3.** Investigate the attitudes and digital literacy of biology pre-service teacher.

Item	Agree	Undecided	Disagree	Unresponsive
ICT enhances creativity	88.7	9.7	1.0	0.5
ICT accelerates the completion of work	90.3	7.7	1.5	0.5
Access information anywhere, everywhere	80.5	14.9	4.1	0.5
Internet as a learning tool	94.4	4.6	0.5	0.5
E-Book as a learning tool	72.3	25.1	1.5	1.0
I am able to operate my laptop / computer	92.3	5.6	0.0	2.0
I am able to utilize the internet	97.4	2.0	0.5	0.0

Lecturers use LMS (Learning Management System)	43.6	25.6	8.7	22.0
Lecturer guides the creation of an LMS account	42.0	22.0	13.3	22.6
Lecturers use LMS for discussion / practice questions / quiz / tasks online	44.1	23.6	11.8	20.5

#### 4. Discussion

Based on the results of the investigations in Table 1 and Table 2 above, various opinions of biology teacher candidates both on general biology lectures and digital literacy. The first statement is about lecturer centered learning where biology pre-service teacher wants general biology lectures conducted by lecturer-centered method (44.1%) and other methods besides lecturer (44.1%). It is unusual to discuss because it is not usually a lecture in the field of science is still there who want traditional learning with a centralized lecturer. The learner-centered teaching method is part of the direct teaching model [16]. Effective teaching is useful for learners with low achievement and learning difficulties [16]–[18]. Although much criticized traditional passive learning is still widely used [16], conventional methods can help students obtain information that is difficult to access, integrate data from multiple sources, limited planning time to organize the material and be flexible to apply across all types of content. On the contrary, this method also has weaknesses, among others: passive students, do not attract students attention, give heavy burden on students' working memory [16].

The second statement related to the media in which biology pre-service teacher expect the media used varies (84.1%) the goal in addition to not easily bored in following the learning, learning will be more meaningful if using a variety of media. Through varied media means, instructional does not only do one approach but some approaches. If only one instructional media used will result in the less meaningful learning process because learning only uses one method [19]. Deep and meaningful knowledge can be done using varied mediums by providing collaborative tasks, stimulation or stimuli and group work [20], attitude and motivational approaches can also support meaningful learning [21].

Online learning is also in demand by prospective biology teachers (62.6%). Although not too many explicitly stated it, can also be seen in the next state who want access to E-learning and E-book (98.4%). E-learning or electronic learning continues to proliferate in recent years along with the development of science and technology [22], [23]. E-learning means as a way of delivering messages through electronic media, such as the internet, intranet, extranet, satellite, video, radio [23]–[25].

E-learning has many enthusiasts because it is accessed wherever and whenever [24], [26] in line with the results of investigations of biology pre-service teacher stating information can be obtained anytime and anywhere (80.5 %). E-learning not only access to accurate data [27], [28]; enhancing the ability of independent learning and problem solving [29], [30] but also increasing students' self-confidence [31], [32]. Also, material memorable e-learning students in the long term [33]; e-learning can be performed on a large scale [34], [35]; enhancing academic interaction between students and lecturers [36], [37]. Moreover, e-learning improving collaboration, both among students and among professors [38]; facilitated in updating the contents of learning materials [39]. Furthermore, e-learning enhancing motivation to learn and student creativity [40], [41] is in line with the results of the investigation prospective biology pre-service teachers are lecturing general biology using ICT more fun (95.4%). E-learning more attractive (95.9%), more real (86.1%), increase creativity (88.7%), speed completion of work (90.3%), and satisfied general biology lecture using ICT (86.7%). Even biology teacher candidates who say prefer to study general biology independently through online learning more than half of the respondents (52.8%).

Learning through online learning have some drawbacks that are: First, required quality assurance of a good internet connection [42], [43]. Second, need additional skills to operate the application of e-learning [44], [45]. Third, the design and production of instructional materials online learning tended to be

similar to the previous periods [46]. Fourth, the reduced role of the teacher to clarify and explain stuff that cannot be communicated online [46]. Fifth, adverse effect on the development of communication skills of teachers [47]. Sixth, need regular maintenance of devices used as computer/laptop [46]. Seventh, overall lack of human relationships between faculty and students, or between each other [48].

More than 90% of biology teacher candidates can use laptops (92.3%) and use the internet for learning (97.4% and 94.4%). Also, they are also able to use the e-book as a learning tool. Of course from the results of this investigation, it appears that prospective biology teachers as a whole want the general biology lectures conducted with the help of ICT, in particular, the application of electronic learning.

The most exciting side discussed the results of these investigations is the profound understanding of general biology lecturers and biology pre-service teacher of LMS (Learning Management System). The latest statement in the survey evidences it; it appears that 43.6% of biology teacher candidates declare general biology lecturers using LMS, but in the same report there are 22% of biology teachers who do not answer the comment. This condition proves that between general biology lecturer and biology teacher candidate do not understand what LMS is. Supported also by the last two reports asking about the lecturer guiding the creation of an LMS account and using LMS for discussions, quizzes, and online assignments.

LMS is not a new thing because in developed countries LMS has proliferated into MOOCs (Massive Open Online Course) which is a unique learning style online centered on students using technology that can be accessed anytime and anywhere [1]. LMS means as a learning management system using the internet to develop more accessible learning methods and to complement or collaborate learning in a traditional way (face-to-face in class) with advanced education [49], [50].

## 5. Conclusion

The results of the investigation biology teacher candidates to the overall general biology lectures are that the prospective biology teachers have an attitude and high digital literacy. It is evidenced by almost entirely having interest in online learning and being able to utilize the internet in education. They also want a general biology course done by applying online learning using the help of an LMS learning management. The weakness of prospective biology teacher does not fully understand the use of LMS in learning so that guidance is needed to use it. The results of this investigation are expected to be input for biology education as an institution of building biology teacher.

## References

- [1] Oey-Gardiner M *et al.*, 2017 *ERA DISRUPSI Peluang dan Tantangan Pendidikan Tinggi Indonesia* Jakarta Pusat: Akademi Ilmu Pengetahuan Indonesia.
- [2] Barber M Donnelly K and Rizvi S, 2013 An Avalanche is Coming: Higher Education and the Revolution Ahead *Inst. Public Policy Res.* March p. 1–67.
- [3] Montgomery C and Fernández-Cárdenas J M, 2018 Teaching STEM education through dialogue and transformative learning: global significance and local interactions in Mexico and the UK *J. Educ. Teach.* **44**, 1 p. 2–13.
- [4] Zeidler D L, 2016 STEM education: A deficit framework for the twenty first century? A sociocultural socioscientific response *Cult. Stud. Sci. Educ.* **11**, 1 p. 11–26.
- [5] Coley J D and Tanner K, 2015 Relations between intuitive biological thinking and biological misconceptions in biology majors and nonmajors *CBE Life Sci. Educ.* **14**, 1 p. 1–19.
- [6] Coley J D and Tanner K D, 2012 Common origins of diverse misconceptions: Cognitive principles and the development of biology thinking *CBE Life Sci. Educ.* **11**, 3 p. 209–215.
- [7] Vosniadou S and Brewer W F, 1992 Mental Models of the Earth : A Study of Conceptual Change in Childhood *Cogn. Psychol.* **24** p. 535–585.

- [8] Maeyer J and Talanquer V, 2010 The role of intuitive heuristics in students' thinking: Ranking chemical substances *Sci. Educ.* **94**, 6 p. 963–984.
- [9] Brownell S E Freeman S Wenderoth M P and Crowe A J, 2014 BioCore Guide: A tool for interpreting the core concepts of vision and change for biology majors *CBE Life Sci. Educ.* **13**, 2 p. 200–211.
- [10] Khodor J Halme D G and Walker G C, 2004 A Hierarchical Biology Concept Framework: A Tool for Course Design *Cell Biol. Educ.* **3**, 2 p. 111–121.
- [11] NRC, 2003 *BIO 2010 Transforming Undergraduate Education For Future Research Biologists* New York: The National Academies Press.
- [12] Armbruster P Patel M Johnson E and Weiss M, 2009 Active Learning and Student-centered Pedagogy Improve Student Attitudes and Performance in Introductory Biology *Life Sci. Educ.* **8** p. 203–213.
- [13] Prior D D Mazanov J Meacheam D Heaslip G and Hanson J, 2016 Attitude, digital literacy and self efficacy: Flow-on effects for online learning behavior *Internet High. Educ.* **29** p. 91–97.
- [14] Ng W, 2012 Can we teach digital natives digital literacy? *Comput. Educ.* **59**, 3 p. 1065–1078.
- [15] Jahnke I Bergström P Mårell-Olsson E Häll L and Kumar S, 2017 Digital Didactical Designs as research framework: iPad integration in Nordic schools *Comput. Educ.* **113** p. 1–15.
- [16] Eggen P and Kauchak D, 2012 *Strategies for Teachers: Teaching Content and Thinking Skills* Boston: Pearson Education, Inc.
- [17] Flores M M and Kaylor M, 2007 The effects of a direct instruction program on the fraction performance of middle school students at-risk for failure in mathematics *J. Instr. Psychol.* **34**, 2 p. 84–94.
- [18] Leno L C and Dougherty L A, 2007 Using direct instruction to teach content vocabulary *Sci. Scope* **31**, 1 p. 63–66.
- [19] Johnson C *et al.*, 2017 Using Design-Based Research to Develop Meaningful Online Discussions in Undergraduate Field Experience Courses *Int. Rev. Res. Open Distance Learn.* **18**, 6 p. 36–53.
- [20] Chatti M A Jarke M and Specht M, 2010 The 3P Learning Model Success Factors for TEL Models The 3P Learning Model **13** p. 74–85.
- [21] Bälter O Cleveland-innes M Pettersson K Scheja M and Svedin M, 2013 Student approaches to learning in relation to online course completion **43**, 3 p. 1–18.
- [22] Elsaadani M A, 2015 Green ICT Practices among Egyptian HEI ' Students **2**, 6 p. 8–13.
- [23] Soper T, 2017 Knowledge into learning: comparing lecture, e-learning and self-study take-home packet instructional methodologies with nurses. *Nurs. open* **4**, 2 p. 76–83.
- [24] Atiyah J M El Sherbiny M M and Guirguis S K, 2015 Evaluation of E-Learning Program versus Traditional Education Instruction for Undergraduate *Int. J. Adv. Res. Sci. Eng. Technol.* **2**, 7 p. 776–786.
- [25] Sung Y-T Chang K-E and Liu T-C, 2016 The effects of integrating mobile devices with teaching and learning on students' learning performance: A meta-analysis and research synthesis *Comput. Educ.* **94** p. 252–275.
- [26] Krull G E and Duarte J D, 2017 Research Trends in Mobile Learning in Higher Education: A Systematic Review of Articles (2011-2015) *Int. Rev. Res. Open Distrib. Learn.* **18**, 7.
- [27] Lau K H Lam T Kam B H Nkhoma M Richardson J and Thomas S, Mar. 2018 The role of textbook learning resources in e-learning: A taxonomic study *Comput. Educ.* **118** p. 10–24.
- [28] Klačnja-Milićević A Vesin B and Ivanović M, Mar. 2018 Social tagging strategy for enhancing e-learning experience *Comput. Educ.* **118** p. 166–181.
- [29] Broadbent J, 2017 Comparing online and blended learner's self-regulated learning strategies and academic performance *Internet High. Educ.* **33** p. 24–32.
- [30] Sha L Looi C-K Chen W Seow P and Wong L-H, 2012 Recognizing and measuring self-regulated learning in a mobile learning environment *Comput. Hum. Behav.* **28**, 2 p. 718–728.
- [31] Chapman-Waterhouse E Silva-Fletcher A and Whittlestone K, 2017 The Use of Reusable Learning

- Objects to Enhance the Delivery of Veterinary Education *Int. J. Mob. Blended Learn.* **9**, 3 p. 24–36.
- [32] Chiang T H C Yang S J H and Hwang G J, 2014 An augmented reality-based mobile learning system to improve students' learning achievements and motivations in natural science inquiry activities *Educ. Technol. Soc.* **17**, 4 p. 352–365.
- [33] Wankel C and Blessinger P, 2013 *Increasing Student Engagement and Retention in e-Learning Environments: Web 2.0 and Blended Learning Technologies*.
- [34] O'Flaherty J and Phillips C, 2015 The use of flipped classrooms in higher education: A scoping review *Internet High. Educ.* **25** p. 85–95.
- [35] García-Marco F-J, 2017 *Pathways Into Information Literacy and Communities of Practice* United States of America: Elsevier.
- [36] Luo N Zhang M and Qi D, 2017 Effects of different interactions on students' sense of community in e-learning environment *Comput. Educ.* **115** p. 153–160.
- [37] Kurucay M and Inan F A, 2017 Examining the effects of learner-learner interactions on satisfaction and learning in an online undergraduate course *Comput. Educ.* **115** p. 20–37.
- [38] Daher W, 2017 Student Voice in the Mobile Phone Environment *Int. J. Mob. Blended Learn.* **9**, 3 p. 12–23.
- [39] Zawacki-Richter O and Naidu S, 2016 Mapping research trends from 35 years of publications in Distance Education *Distance Educ.* **37**, 3 p. 245–269.
- [40] Yilmaz R, 2017 Exploring the role of e-learning readiness on student satisfaction and motivation in flipped classroom *Comput. Human Behav.* **70** p. 251–260.
- [41] Shapiro H B Lee C H Wyman Roth N E Li K Çetinkaya-Rundel M and Canelas D A, 2017 Understanding the massive open online course (MOOC) student experience: An examination of attitudes, motivations, and barriers *Comput. Educ.* **110** p. 35–50.
- [42] Vanslambrouck S Zhu C Lombaerts K Philipsen B and Tondeur J, 2018 Students' motivation and subjective task value of participating in online and blended learning environments *Internet High. Educ.* **36** p. 33–40.
- [43] Erol O and Kurt A A, 2017 The effects of teaching programming with scratch on pre-service information technology teachers' motivation and achievement *Comput. Human Behav.* **77** p. 11–18.
- [44] Kintu M J Zhu C and Kagambe E, 2017 Blended learning effectiveness: the relationship between student characteristics, design features and outcomes *Int. J. Educ. Technol. High. Educ.* **14**, 1 p. 7.
- [45] Pablos P O De Tennyson R D and Lytras M D, 2015 *Assessing the Role of Mobile Technologies and Distance Learning in Higher Education* United States of America: Information Science Reference (an imprint of IGI Global).
- [46] Iglesias Rodríguez A García Ríaza B and Sánchez Gómez M C, 2017 Collaborative learning and mobile devices: An educational experience in Primary Education *Comput. Human Behav.* **72** p. 664–677.
- [47] Sharifi M Soleimani H and Jafarigohar M, 2017 E-portfolio evaluation and vocabulary learning: Moving from pedagogy to andragogy *Br. J. Educ. Technol.* **48**, 6 p. 1441–1450.
- [48] Binti, Liyana, Afip A, 2014 Motivating Adult Learners Using Blended Learning in Higher Education Institution *Int. Ref. Res. J.* **5**, 3 p. 35–42.
- [49] Ramírez-Correa P E Rondan-Cataluña F J Arenas-Gaitán J and Alfaro-Perez J L, 2017 Moderating effect of learning styles on a learning management system's success *Telemat. Informatics* **34**, 1 p. 272–286.
- [50] Wong G K W, 2016, A New Wave of Innovation Using Mobile Learning Analytics for Flipped Classroom, in *Mobile Learning Design : Theories and Application*, D. Churchill, J. Lu, T. K. . Chiu, and B. Fox, Eds. (Singapore: Springer Science+Business Media), p. 189–218.