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# Blended Learning in Animal Biotechnology during Pre-COVID-19, COVID-19 and Post COVID-19 Recovery Phase Periods across the Globe: A Step Forward or Backward

**Lim LWK***

Faculty of Resource Science and Technology, University Malaysia Sarawak, Malaysia

***Corresponding author:** Leonard Whye Kit Lim, Faculty of Resource Science and Technology, University Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia, Email: limwhyekitleonard@gmail.com

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## Abstract

Blended learning is a learning method that combines both Information and Communications Technology (ICT) with traditional teaching. Since the COVID-19 pandemic strikes globally, the application of blended learning has increased exponentially and significantly. E-learning is a critical part of blended learning and the animal biotechnology is one of the subjects that necessitates blended learning. In this review, we described several animal biotechnology blended learning research across the globe over the past five years (pre-COVID-19, COVID-19 and post COVID-19 recovery phase periods), highlighted their methodologies and outcomes before providing future insights to move this learning method forward and to greater heights.

**Keywords:** Blended Learning; COVID-19; E-Learning; Animal Biotechnology

**Abbreviations:** ICT: Information and Communications Technology; MCO: Movement Control Order; LMS: Learning Management System.

## Introduction

Blended learning is defined as a learning mode that integrates the Information and Communications Technology (ICT) with traditional face-to-face teaching. It is deemed as a more engaging and interactive approach as compared to traditional teaching. E-learning is the ICT part of the blended learning approach whereby students can choose to learn from anywhere and anytime [1]. One big benefit of e-learning is that it delivers knowledge with high consistency and most of the time students are allowed to access the lectures multiple times for better understanding [2].

Animal biotechnology is a wide field of study encompassing genomics, gene therapy, gene manipulation, animal handling, population studies, evolution, cell biology, disease management, genetic engineering, growth improvement of animals and many more [3-18]. The fundamental basis in understanding biotechnology is the elucidation of the central dogma of biology or the genetic code [19-34]. It is widely deemed that the genetic code is one of the most difficult subjects to master, there are several research focusing on using animal biotechnology blended learning to ease the learning process. In this review, we consolidated recently conducted animal biotechnology blended learning studies from the past five years (pre-COVID-19, COVID-19 and post COVID-19 recovery phase periods) and further highlighted on their methodology and significant outcomes before providing future directions to steer the blended learning on animal biotechnology to the right path so that passionate educators can benefit from these insights and advance the field to greater heights, in other words, to step forward and not backward.

### Biotechnology Knowledge and Laboratory Experiences of Science Teachers-Turkey (Pre-COVID-19 Period)

In Turkey, it is widely deemed that the lack of biotechnology and laboratory resources available to teachers is one of the major causes of low interests among these teachers. Not to mention that there are other major factors such as limited funding, insufficient academic skills, limited time as well as scarce equipment and facilities impeding the advancement of biotechnology teaching. Orhan, et al. [35] gathered 17 science teachers working in state schools to participate in this e-learning study. The objective of this research is to assess the biotechnology and laboratory knowledge of science teachers after blended learning sessions.

The demographic data of the selected science teachers are as follow: 52.94% female, 47.06% male; 82.35% graduates, 17.65% postgraduates; 5 years and below professional experience to 21 years and above professional experience. Interestingly, 47% of them were capable of performing experimental procedures based on the experimental design given with their peers. 45% of them can execute results interpretation accurately during the evaluation stage [35]. The authors concluded their research with a few solid recommendations, namely to provide in-service training and seminars to science teachers from time to time with contemporary biotechnology knowledge.

### Laboratory Animal Science Training - Portugal (COVID-19 Period)

Specialized training for animal handling is legally obligated in many countries across the globe. Due to predicaments such as shortage of training personnel and space constraints, e-learning may be a great solution for students to learn the required knowledge at their own comfort of time, pace and space.

Costa, et al. [36] conducted two e-learning approaches, namely full online theoretical training and flipped classroom, involving 229 individuals (aged between 21 to 41 years old) attending 15 courses in Portugal. They implemented their e-learning environment based on the open-source Moodle Learning Management System (LMS) version 2.6.11. The objective of this research is to assess the effects and acceptance of students towards laboratory animal science blended learning training. The education levels of participants were as follow: 58.4% master's degree, 24.7% bachelor's degree and 16.9% PhD degree. More than half of them (60.7%) do not have past experience with e-learning resources. Most participants (96.5%) showed positive acceptance towards laboratory animal science training e-learning. Majority of them (94.3%) found the e-learning courses useful in time management [36]. Interestingly, they discovered that the e-learning approach acceptance is highly dependent on students' background and past experience with laboratory animals. Besides, they deduced that e-learning acceptance is independent of age, past e-learning experience, education, gender and professional position [36]. The only limitation of their study is that they did not include participant group that attend classroom sessions only.

### Animal Science Blended Learning - Ghana (COVID-19 Period)

In Ghana, Edem, et al. [37] first conducted an ICT accessibility survey before a blended learning study. The objective of this research is to investigate the acceptance of students and teachers towards blended learning in animal science. As a result, two third of the animal science teachers do not have computers at home and 60% of them do not have internet connectivity at home. Their study involves 19 animal science teachers and 80 students from three selected educational institutions. Interestingly, both animal science teachers and students have similar levels of ICT skills and both groups are not skilled in database software as well as data logging tools [37]. Post survey, all animal science students agreed that blended learning has helped them to be more engaged, gives them more autonomy, instill self-advocacy, allows them to learn at their own pace, allows instant diagnostic feedback, encourages student ownership, keeps them focused longer, as well as prepares them for the future [37]. Interestingly, they deduced that their results are in agreement with the previously determined statistics in 2015, namely 22% improvement in attendance, 22% elevation in grade rates, 28% improvement in test scores, 39% increase in student attrition rates as well as 69% increase in student participation rates.

### Animal Biotechnology Virtual Laboratory Simulations-Malaysia (Pre-COVID-19, COVID-19 and Post COVID-19 Recovery Phase Periods)

In Malaysia, Movement Control Order (MCO) or total lockdown was implemented during the mid-March of 2020, causing all campuses in Malaysia to close operation until August 2020. Animal biotechnology undergraduate students at Taylor's University Malaysia have been exposed to the usage of Labster cell culture virtual simulations that act as a major part of their blended learning modules back in 2019.

Yap, et al. [38] seized the opportunity to conduct a blended learning survey on animal biotechnology subject, focusing on target groups namely the August 2019, March 2020 and August 2020 cohort of students. The objective of this research is to examine the effects of animal biotechnology virtual laboratory simulations on students. Total students involved is 46, with 16 from the first cohort, 18 from the second and 12 from the last cohort. Overall, the students' perception towards the blended learning experience was positive [38]. The enjoyable experience was found to be lower in the March 2020 cohort as compared to their 2019 cohort counterparts and this was postulated to be caused by the anxiety introduced during the sudden lockdown due to the exponential surge in number of COVID-19 infected cases in the country. Interestingly, the August 2020 cohort students enjoyed the animal biotechnology virtual cell culture laboratory blended learning more than the March 2020 cohort students, probably due to the re-opening of campuses and loosen restrictions in August 2020 [38].

### Future Directions: To Be or Not To Be?

The future directions of animal biotechnology blended learning will be steered towards a more immersive experience for both the students and teachers to enjoy and benefit more from it. Some students and teachers may not enjoy the experience at the moment due to several predicaments faced such as limited computer and internet access, limited equipment and facilities as well as scarce funding. However, as the COVID-19 infection wave not showing any diminishing trend, we would have to live with it and adapt accordingly. One interesting and innovative solution to make animal biotechnology blended learning more interactive is the implementation of flipped classroom in tandem with e-learning. In this way, students can be more involve and attentive towards the active teaching process and would have the opportunity to provide inputs that will be beneficial to both teachers and student themselves. With the recent emergence of Chat GPT, educators must now upgrade their teaching approach from time to time to keep on par with the technological advancement happening around us. Both educators and students must now understand that knowledge does not necessarily come from one way in this era, instead it can come from many ways, work in both ways and in various forms.

Another way to make animal biotechnology blended learning more immersive is the introduction to Virtual Reality (VR) technology to provide students with more "real" hands-on experiences in the laboratory. The "to be" factor far superseded the "not to be" factor in the sense that we want to impart as much knowledge (especially laboratory practices) as possible more effectively to the students. The only caution that requires our attention is that a physical pre-lab training is mandatory for students who have not entered a physical lab before (might have been blended learning trained) to ensure the safety of the lab and its users. With adequate monitoring, the animal biotechnology blended learning can go forward with the exponential advancement of the current technology happening vastly around us.

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