The effectuality of animated media for teaching biotechnology materials in Indonesian rural primary schools

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Abstract. Learning technology has been an intriguing medium which may escalate class engagement and students’ interests into learning. However, not every student is entitled to equal opportunity to be able to benefit from this often considered luxury for some, for instance for those living in the rural areas of Indonesia. This study aims to measure the effectiveness of animated media developed for teaching biotechnology materials in rural primary schools in Indonesia. Four teachers from two rural primary schools in the east of Java, Indonesia participated in this study. The teachers and research team collaborated in a lesson study style activities and take turn to use the media to teach materials regarding biotechnology for their students. This mixed method study utilised data gathered from students’ pre-test and post test and the results of interviews with the four teachers, and participatory observation reports of the activities. The results of this study indicated that the media were significantly effective to improve students’ mastery of biotechnology materials, which was facilitated by the affordance of the media to alleviate students’ excitement, autonomy, and focus on learning.

1. Introduction
Learning materials regarding biotechnology can be challenging for the students, especially for primary school students, as it may contain discussions of complicated processes and terminologies. However, these are part of the essential materials for the students to learn as it may be useful both for their current study and for their future especially to help introduce them to the concept of biotechnology and to encourage them to be interested in exploring more about biotechnology. Exploring biotechnology which is the technology that utilises biological systems, living organisms or parts of this to develop or create different products [1] can be useful for their lives as well as the lives of others, as biotechnology often results in the findings of the cure of diseases, environmentally friendly renewable energy, or the improvement of the quality and quantity of agricultural products so as to prevent food shortage. Therefore, we were interested to investigate the effectiveness of animated media that we developed to facilitate primary school students especially those living in the rural area to learn simple biotechnology materials, especially those with Indonesian origin such as the process of making tempeh and tape (fermented cassava).
Much of the literature agrees that the appropriate use of learning technology as medium in teaching may escalate class engagement and students’ interests into learning [2] [3] [4], may have significant impact on learning [5], may facilitate learners’ creativity [6], and may assist learners ‘to take control of their own learning’ [7]. However, not every student is entitled to equal opportunity to be able to benefit from this often considered luxury for some, for instance for those living in some rural areas of Indonesia. Thus, they may have different responses and challenges when introduced to the media. Archipenka et al. [8] propose that ‘for greater equity to be achieved, it is important to ask questions about current practices’. This paper reports on the results of the research looking into the implementation of animated media in two rural schools which may or may not commonly use technology in their teaching. This study was guided by these two research questions:
1. Is the animated media developed effective to facilitate students to grasp complicated biotechnology materials?
2. How do the media developed facilitate (or not) students’ learning?

2. Methods
This study was framed by mixed method design and was conducted in Jember, East Java, Indonesia. Jember is the third largest city in East Java which has considerably developed over the years. Technologies to support education including computers, LCD projectors, smart phones, tablets as well as the Internet are relatively easy to access in this town. However, in the rural areas the situation might be different.

Three data generation methods were utilised in this study. Pre-test and post-test [9] was administered to 78 students who participated in the study. This was aimed to know whether or not the animated media mediated teaching activities were successful to alleviate students’ mastery of the materials. Next, qualitative observations [10] were conducted in the classes during the implementation of the media for teaching, and data were recorded in field notes. Next, we interviewed the teachers participated in the research activity and the head teachers by using semi-structured technique [10]. Data collected by the tests were analysed statistically to find whether or not there was a significant difference between students’ pre-test and post-test scores. Meanwhile, data collected from interviews and observations were analysed by utilising thematic analysis method [11] to map teachers and members or research teams’ opinions of how the animated media may be effective (or not) to assist students to learn biotechnology materials.

This research is part of the larger study on the use of animated media to teach biotechnology for primary students. This paper is written based on the operational field testing step of the study, for which we designed two Macromedia Flash based animated media with traditional biotechnology process of tempeh and tape (fermented cassava) as the theme. Overall, we organised the larger study into these following steps: information collecting, planning, developing preliminary form of the product, preliminary field testing, main product revision, main field testing, operational product revision, operational field testing, final product revision, dissemination and distribution.

The research was conducted in two primary schools on the rural area of Jember, East Java, Indonesia. Although both located in the rural area, the two schools were different in term of technology integration into teaching. The first school, in which we conducted our research on 27 November 2019 was more familiar with technology use into teaching. Almost all of the students had access to mobile phone and would soon purchase laptops to facilitate their learning, with parents support. The teachers had introduced game based exercises such as Kahoot and had set Google classroom for their students. Meanwhile, the other school, where we conducted our research on 4 December 2019 was a typical rural school where technology integration is still a luxury.
different characteristics of the schools were not part of our selection criteria, but were discovered during our research.

3. Ethical Considerations
To ensure ethicality for this study, it was only conducted after we gained ethical approval from the Ethics Committee of Jember University. All the participants had given us their written consent and statement that they voluntarily participated in the study without any coercion. All details about participants and their schools were anonymised to ensure confidentiality.

4. Results and Discussions
To address the first research question ‘whether or not the animated media were effective to facilitate students’ learning of biotechnology materials’, two tests, pre- and post-tests, were conducted to measure whether or not there was an improving score indicating students’ improving knowledge of the biotechnology topic presented. We ran paired sample test on SPSS to know whether or not there was a significant difference between the pre- and post-test scores. Paired samples statistics (Table 1) clearly showed that the post-test scores (M=7.0769, SD=1.12549) were substantially higher than the pretest scores (M=3.5385, SD=2.55176). According to Paired samples test (Table 2), we noticed P < 0.05 (0.000), which indicated that null hypothesis (H0) ‘there is no significant difference between pretest scores and post-test scores’ was rejected. By implication, the post-test results are significantly higher than the pretest results. This result is in line with Falloon’s study [5] that the use of technology may have significant impact on learning.

Table 1. Paired samples statistics.

| Pair 1 | Mean | N  | Std. Deviation | Std. Error | Mean |
|--------|------|----|----------------|------------|------|
| Pretest| 3.5385 | 78  | 2.55176 | .28893 |
| Posttest| 7.0769 | 78  | 1.12549 | .12744 |

Table 2. Paired samples test.

| Paired Differences | Mean | Std. Deviation | Std. Error | 99% Confidence Interval of the Difference | 99% Confidence Interval of the Difference | t     | df  | Sig. (2-tailed) |
|--------------------|------|----------------|------------|----------------------------------------|----------------------------------------|-------|-----|----------------|
| Pair 1 Pretest     | -3.53846 | 2.12403 | .24050 | -4.17367 | -2.90326 | -14.713  | 77  | .000          |
| Posttest           |       |               |           |                                        |                                        |       |     |                |

To address research question #2 ‘How do the media developed facilitate (or not) students’ learning’ we interviewed the teachers participated in the study and administered participatory observation conducted by members of the team and the teachers who were not on duty to deliver the materials for the students on the day. The following are the results of the interviews and observations.
4.1. The animated media make learning more exciting

Teachers and team members agreed that classroom atmosphere was elating when we implemented the media. The students were enthusiastic to learn the materials and were excited to take part in every learning activity that the teacher assigned to them. As mentioned by the following teacher:

I think the media make my tasks easier. Students were more interested into learning, but I am afraid that they want more, so I need to be more prepared to use interesting media like this. The problem is the time and effort that I need to provide to do this activity, it’s so much trouble. However, seeing how my students reacted, super happy, and how the media had helped my students grasp the difficult materials more easily, I do not mind going through all the trouble. (Ms Rani, interview, 27/11)

The particular teacher acknowledged the affordance of the animated media to create exciting learning and thus helped the students to comprehend the complicated materials introduced to them. Therefore, despite her realisation that using technology based media may require them to have more preparation, which is often complicated and not easy, she seemed to eager to keep using the media to support her students’ learning.

All other teachers interviewed echoed the first teacher’s opinion of the media use in their lesson.

I found it hard to operate the media, but I was happy that the team and my colleague helped me. It was really fun, I enjoyed using the media and I think my students were too. So, do I want to use similar media again? Yeah, it’s too complicated to operate, but if I have to use it, I will need help from my colleague, just like today. And I think they will be willing to help me. (Mr Yusuf, interview, 27/11/2019)

My students were happy and I also enjoyed the process, and may I have more media like this for my students please? I think it makes teaching easier and more interesting. (Ms Hana, interview, 4/12/2019)

The observers also confirmed those ideas and agreed that the animated media used had helped create a fun and exciting atmosphere that helped the students to engage in the activities the teacher assigned for them. Thanks to the animation and the music.

The music also seemed to make them happy as I often heard them hum along with the music. (Observer 1, Observation, 27/11/2019)

These findings resonate those of the previous studies that integrating technology into learning may improve class engagement and students’ excitement of learning [2] [3] [4]. However, the excitement which often leads to cheers, laughter, and applause may distract students studying in other classes, either because of the noise or because they may wanted to join the excitement.

Students seemed to be fully engaged with the lesson assisted by the animated media. The media excited them a lot. However, it may distract students from different classes as they were also eager to experience the exciting lesson. I saw a lot of them flocking to this class, curiously. (Observer 2, 27/11/2019)

Therefore, when implementing such media in their learning, teachers shall consider this possible implication and be prepared to anticipate the problem.

4.2. The animated media allow students to learn autonomously

The media used allowed the students to experience autonomous learning, both as it can be played anytime and anywhere and as it allows the students to click answers for some questions. Through this process, learners often feel empowered and this may help learners ‘take control of their own learning’ [7]

I think they were happiest when they were given the opportunity to operate the media themselves. Maybe they feel empowered and more confident that ‘yay, I can do it’. Like when they were given the opportunity to click the answers for the comprehension questions. I think it will be good as well for self study at home. (Ms Rani, interview, 27/11/2019)
4.3. *The animated media help students be more focused into learning*

Another reason that the media afforded to facilitate students’ learning was that it brought the class together and everyone seemed to be interested in the media and stay focused on the lesson. Unlike in other situation when media was not used, teachers would need to hush to gain students’ attention again and again when explaining some materials. However, during the implementation of the animated media, students stayed focused and payed full attention to the materials presented. This finding is in line with Domingo and Gargante [3] proposition that technology integration into learning may increase students’ engagement into learning. With regard to this, Mr. Yusuf commented:

> Usually we would need to tell them ‘pay attention please’ again and again. But we did not need to do that today. (Interview, 27/11/2019)

This notion was confirmed by the observers who discovered that the students seemed to focus on the materials.

> Students focused on the materials. None of them seemed to do other stuff. The animation in the media seemed to have made them even more interested and excited to follow the lesson. (Observer 3, Observation 27/11/2012)

Students were interested in working with the media and with some assistance, they all seemed interested to follow the explanation in the media. They liked the animation I guess, as they would usually show their amazement whenever the animation appears. (Observer 4, 4/12/2019)

These engagements, towards the end, helped improve students mastery of the materials. As confirmed by Observer 3:

> Visibly, the students’ comprehension of the materials increased. It can be seen from the number of students who answered correctly before and after we did the activities. As displayed on the screen. I think it was because of the visualisation of the difficult concepts that make the students not only imagine how it may look, but they can see it demonstrated through the visual. (Observer 3, 27/11/2019).

![Excitement: The animated media escalate learning excitement](image1)

![Autonomy: The animated media allow learning to be more autonomous](image2)

![Focus: The animated media assist students to be more focused into learning](image3)

**Figure 1.** The role of animated media to facilitate students’ learning.

5. **Conclusions**

The animated media was proven to be effective to facilitate students to learn biotechnology materials which were quite complex and rich. The statistics test results showed that students learning outcome significantly improved after they were taught using the animated media as shown by the significant difference of their pre- and post-test scores. The post-test scores ($M=7.0769, SD=1.12549$) were substantially higher than pretest scores ($M=3.5385, SD=2.55176$).
The animated media facilitated the students learning as these helped escalate students’ excitement when learning the materials, helped them be more autonomous and to take initiative and take control of their learning, and be more focused into their learning (Figure 1). Thanks to the animation, pictures, and sounds produced in the media. These facilitated the students to learn better and grasps the complicated process presented easier, which eventually facilitated the betterment of their learning outcome.

6. Suggestion
Based on the results of this study, it is suggested that teachers use more interesting and interactive media for their learning to help students have better learning experiences and learning outcome. Secondly, more research to develop interesting learning media need to be conducted.

7. Disclosure statement
No potential conflict of interest was reported by the authors.

Acknowledgement
The authors would like to extend their gratitude for the University of Jember especially the Islamic Development Bank (IsDB) Project to have provided funding for this study.

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