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Effect of microbiology handout on Amylolytic bacteria and Cellulolytic bacteria from vegetable waste soil on students' cognitive abilities

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Abstract

The scientific literacy framework in PISA 2015 includes context, competence, attitudes and knowledge. Knowledge is closely related to students' cognitive abilities. Analysis of needs in the class of 2020 Biology at the State University of Malang shows that 93.8% of students' knowledge about amylolytic and cellulolytic bacteria in vegetable waste disposal soil is relatively low. One factor is that there are no teaching materials related to this material. The research aims to determine the effectiveness and practicality of handouts in improving students' cognitive abilities. This research method is quasi-experimental with a nonrandomized pretest-posttest control group design—implementation in the control and experimental classes by giving a pretest and posttest. The increase in posttest scores compared to the learning outcome scores for both classes was analyzed using the T-test to compare learning outcomes based on the N-gain score. The results of the unpaired t-test analysis stated that the cognitive abilities of students in the experimental class using handout were higher than those in the control class using PowerPoint—comparison value p-value (0.046) < α (0.05). The conclusion is that the handouts are practical and effective in improving students' cognitive abilities. Students can find out the existence of bacteria that play a role in the degradation process of starch and cellulose so that students can protect the environment and not throw away rubbish, which causes an imbalance in the soil ecosystem.

Abstrak

Kerangka kerja literasi sains dalam PISA 2015 meliputi konteks, kompetensi, sikap, dan pengetahuan. Pengetahuan erat hubungannya dengan kemampuan kogintif mahasiswa. Analisis kebutuhan di biologi angkatan 2020 Universitas Negeri Malang menunjukkan pengetahuan 93,8% mahasiswa tentang bakteri amilolitik dan bakteri selulolitik pada tanah pembuangan sampah sayur tergolong rendah. Salah satu faktornya adalah tidak ada bahan ajar terkait materi tersebut. Tujuan dari penelitian untuk mengetahui keefektifan dan kepraktisan handout dalam meningkatkan kemampuan kognitif mahasiswa. Metode penelitian ini kuasi eksperimen dengan desain *nonrandomized pretest-posttest control group*. Implementasi pada kelas kontrol dan kelas eksperimenn dengan diberikan *pretest* dan *posttest*. Peningkatan nilai *posttest* dibandingkan untuk nilai hasil belajar kedua kelas dan dianalisis dengan uji T untuk membandingkan hasil belajar berdasarkan N-gain skor. Hasil analisis uji-t tak berpasangan menyatakan kemampuan kognitif mahasiswa kelas eksperimen menggunakan *handout* lebih tinggi dibandingkan kelas kontrol menggunakan *Power Point*. Nilai perbandingan p-*value* (0,046) < α (0,05). Kesimpulannya adalah *handout* praktis dan efektif meningkatkan kemampuan kognitif mahasiswa. Mahasiswa dapat mengetahui keberadaan bakteri yang berperan dalam proses degradasi amilum dan selulosa, sehingga mahasiswa dapat menjaga lingkungan, tidak membuang sampah yang menyebabkan ketidakseimbangan ekosistem tanah.

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A. Introduction

Vegetables are classified as agricultural crops. The abundance of vegetables in Indonesia has the potential to become waste because vegetables are materials that are easily damaged because they have a high water content of around 85-95%, thus supporting the growth and acceleration of metabolic reactions of microorganisms (Asgar & Musaddad, 2006). Some types of waste can have a detrimental impact on living organisms and the environment, for example disrupting the balance of the ecosystem and causing disease in animals and humans (Zaved et al., 2008). Bacteria from the isolation of Jambi's Angso Duo market vegetable waste are potential bacteria that can be used as liquid fertilizer. This can be seen from the results of tests on the ability of bacteria to dissolve important elements for plant growth, namely Nitrogen, Phosphorus and Potassium (Harlis et al., 2019). The bacterial isolates found in Pekanbaru city vegetable market waste consisted of 10 genera, namely the Enterobacter, Streptococcus, Streptomyces, Klebseila, Escherichia, Halobacterium, Neisseria, Bacillus, Proteus and Pseudomonas genera (Sayuti et al., 2016).

Cellulolytic bacteria and amylolytic bacteria are involved in the decomposition of vegetable and fruit waste. Amylolytic bacteria can produce amylase enzymes and are able to break down starch (Silaban, 2018). It grows on media containing starch or starch, for example vegetables, fruit, tubers or grains (Wulandari & Purwaningsih, 2019). Cellulolytic bacteria are bacteria that are able to decompose or hydrolyze cellulose through enzymatic action (Deviani et al., 2014). Cellulolytic bacteria can be isolated from substrates containing cellulose, for example, hot springs, river estuaries, compost, garbage, tea gardens, mangroves (Alam et al., 2013).

Based on existing realities, an environmentally caring attitude needs to be instilled in students so they are more sensitive to the environment (Taşar, 2020). Students are required to have meaningful knowledge and be able to think about environmental conditions through education, so that they can foster a caring attitude towards environmental sustainability efforts (Yager, 2010). The character of caring for the environment can be instilled in students by getting them used to throwing away and sorting waste in the places provided (Ismail, 2021). Environmental knowledge obtained during the learning process is important knowledge that can form an attitude of caring for the environment (Rasyid et al., 2023). According to Dewi & Anggraini (2022) having an environmentally caring attitude is very important because the good and bad conditions of an environment are also determined based on the good and bad of human attitudes towards the environment. This statement is reinforced by Tarnoto & Martani (2014) who stated that having an environmentally caring attitude is very important because it is considered an evaluative response, in the form of a cognitive, affective or conative response to efforts to prevent damage to the surrounding natural environment, as well as developing efforts to repair the damage. nature that has already happened.

The results of observations in November 2021 of the 2020 Biology Study Program students showed that students had difficulty learning to achieve basic competency targets in the cognitive aspect. The lack of availability of teaching materials and observation activities that do not provide contextual content about amylolytic bacteria and cellulolytic bacteria from vegetable waste soil can hinder learning. The observation results stated that students were interested in using Handouts in learning to make it easier to understand material about amylolytic bacteria and cellulolytic bacteria from vegetable waste soil.

One way to develop cognitive abilities is by providing varied learning media, for example handouts and through guided learning (Indriwati, et al., 2018). Guided Inquiry is classified as a learning model that directs students to think and improve their cognitive abilities (Refita, 2017). Handouts are innovative teaching materials that can maintain and improve students' cognitive abilities (Purnamasari et al., 2020). Handouts provide material, learning steps, practical procedures, structured assignments, and evaluation questions that direct students to the thinking process (Novitaningrum et al., 2014).

Previous research conducted by Ayu & Rinaningsih (2021) proved that handouts and videos as learning media can improve learning outcomes or student achievement more effectively. Research by Rahmawati et al. (2019) shows that handouts can improve students' cognitive learning outcomes. Research by Amin & Sulistiyono (2021) The handouts that have been developed can improve student activities and learning outcomes in the very good category. Research by Khotimah & Hastuti (2021) show that handouts are proven to be effective in improving cognitive learning outcomes. Research by Nawawi (2018) shows that handouts can improve student learning outcomes in the good category.

Research on handouts regarding amylolytic bacteria and cellulolytic bacteria was carried out

due to the lack of availability of teaching materials and observation activities that did not provide contextual content about amylolytic bacteria and cellulolytic bacteria from vegetable waste soil which could hinder learning. The observation results stated that students were interested in using handouts in learning to make it easier to understand material about amylolytic bacteria and cellulolytic bacteria from vegetable waste soil. The aim of this research is to improve students' cognitive abilities.

B. Material and Method

The type of research used is quasi-experimental with a non-randomized pretest posttest control group design. All students of the Biology Study Program Class of 2021, State University of Malang as a population. The research sample was 30 students offering A and 30 students offering C. The sample determination method used cluster random sampling with 30 students in each experimental class and control class. The experimental class used handouts while the control class used power points. The amylolytic bacteria and cellulolytic bacteria handout was developed following Lee & Owens (2004). Increasing cognitive abilities by comparing the post test results of the experimental class and the control class (see Table 1).

Table 1 Reaserch Design

Group	Pre test	Treatment	Post test
Experiment	✓	Handout	✓
Control	✓	Power Point	✓

Handout of amylolytic bacteria and cellulolytic bacteria developed using the Lee & Owens model which consists of stages: 1) needs analysis and start-end analysis; 2) design; 3) development; 4) implementation; and 5) evaluation (Lee & Owens, 2004). The implementation was carried out on students at the State University of Malang which consisted of two classes, namely the control class and the experimental class. The control class used PPt teaching media according to that used by the lecturer, while the experimental class used amylolytic bacteria and cellulolytic bacteria handout media to improve students' cognitive abilities.

Data analysis technique

This stage is to prove the effectiveness of the amylolytic bacteria and cellulolytic bacteria handouts. The independent sample t-test was used to determine whether there were differences between the experimental class and the control class. Apart from that, it is necessary to know whether there is a difference in the average of the two experimental classes and the control class after the experimental class used handouts and the control class did not use handouts (PPt). The N-gain score test was carried out to determine the effectiveness of using learning media in research. The N-gain score test can be done by calculating the difference between the scores before and after using the handout. The N-gain score formula is as Formula 1.

$$\text{N} - \text{gain} = \frac{\text{Post test score} - \text{Pre test score}}{\text{Maximum score} - \text{Pre test score}} \text{.....Formula 1}$$

The effectiveness criteria for the N-gain score can be seen in Table 2. Then, the division of N-gain score categories in percentage can be seen in Table 3.

Table 2 Classification N-gain score

Score	Criteria
n-gain ≥ 0,7	High effectiveness
0,3 ≤ n-gain < 0,7	Middle effectiveness
n-gain ≤ 0,3	Low effectiveness

(Source: Hake, 1999)

Table 3 Shows the division of N-gain score categories in percentage (%)

N-gain Effectiveness Interpretation Category	
Percentage (%)	**Description**
< 40	Less effective
40 – 70	Enough effective
> 70	Effective

C. Results and Discussion

This research measures learning outcomes in the form of cognitive abilities. Data from the N-gain Score analysis shows that overall learning with Handouts is effective in improving cognitive abilities (see Table 4) with a high category of 70.02 and learning using Powerpoint is 40.78 which is in the medium category.

Table 4 Results of N-Gain Score analysis between Learning with Handouts and Control

Treatment	N-Gain Score	Category
Handout	70,02	High
Control	40,78	Middle

Table 5 N-Gain Score Interpretation Results between Learning with Handouts and Control

Treatment	N-Gain Score	Effectiveness Level
Handout	70,02 %	Effective
Control	40,78 %	Less effective

Table 6 Unpaired t-test results of students' cognitive abilities

	F	Sig.	t	Df
Equal variances assumed	0.038	0.046	-6.406	58
Equal variances not assumed			-6.406	56.714

Next, an interpretation of the level of effectiveness was carried out through the N-gain Score value (see Table 5), which shows that learning using handouts is effective in increasing cognitive abilities compared to using PowerPoint which is categorized as less effective.

The results of the unpaired t-test show that the significance value is p value (0.046) < α (0.05) (see Table 6), meaning that the research hypothesis is accepted, namely that there is a significant difference in cognitive abilities in the experimental class and the control class. Based on the average score of the two groups, it can be concluded that the Handout on "Amylolytic Bacteria and Cellulolytic Bacteria" can be used to develop cognitive abilities more effectively than using Power Point.

This research proves that the amylolytic bacteria and cellulolytic bacteria handouts have a more significant impact on developing students' cognitive abilities than PowerPoint. The difference between PowerPoint and handout lies in the PowerPoint display which prioritizes slides, whereas handout contains brief core material accompanied by explanations so that students can easily understand (Prastowo, 2014). The advantages of handout include; encouraging students to increase their knowledge, containing the essence of the material, compiled from relevant references, supporting tools for explanations from the teacher (Habibati et al., 2019). Handouts can encourage students to form their knowledge independently (Seruni et al., 2020). The weaknesses of Power Point are; not all material can be delivered, special skills are needed to design attractive power point designs, and more time and preparation is needed to display more complicated animations (Wulandari, 2022).

In this research, the handout developed guides students in carrying out practical activities so that they can build a better understanding of amylolytic bacteria and cellulolytic bacteria in vegetable waste soil. The handout also requires students to be able to determine the properties of bacteria found in vegetable waste soil that are amylolytic and cellulolytic through test results. This is a basic competency target in the cognitive ability aspect. The cognitive ability indicators are measured using cognitive levels developed by Benyamin S. Bloom starting from knowledge, understanding, application, analysis, synthesis and evaluation.

The handout contains a description of the material prepared according to research results regarding amylolytic bacteria and cellulolytic bacteria from vegetable waste soil. Contextual content supports students in combining old knowledge with new knowledge (Suryawati & Osman, 2018), making students learn more optimally because it is close to students' daily lives (Haryanto & Arty, 2019). The researchers found various amylolytic bacteria and cellulolytic bacteria in vegetable waste soil, such as: *Cronobacter sakazakii, Klebsiella oxitoka, Klebsiella ozaenae, Providencia stuartii,* and *Yersinia enterocolitica*. Amylolytic bacteria can produce amylase enzymes so they can break down starch into glucose. Amylolytic bacteria can grow in media containing a lot of starch or starch, for example vegetables, tubers, fruit or grains (Wulandari & Purwaningsih, 2019). Cellulolytic bacteria can produce cellulase enzymes so they can break down cellulose into glucose. Cellulolytic bacteria can be isolated from substrates containing cellulose, for example, garbage, tea gardens and mangroves (Alam et al., 2013).

Students are encouraged to be able to solve problems and design proposed solutions to environmental problems written on the handout. Problem solving activities through discussion facilitate students to convey ideas, compete in arguments (Seruni et al., 2020), form reasoning (Nadeak & Naibaho, 2020), and exchange information (Phungsuk et al., 2017). Having students hold discussions and convey criticism or rebuttal can stimulate high-level cognitive ability processes which have a positive influence on learning outcomes (Kollar & Fischer, 2010).

Students' initial knowledge is an important provision to support the learning process (Hailikari et al., 2008). Studying independently also increases students' cognitive abilities significantly and consistently (Rotgans & Schmidt, 2011). The presence of relevant images, photos and reading references in the handout provides an attractive appearance of teaching materials and helps students understand the content presented (Sulistiyanti et al., 2020). All components in the handout developed help students improve their cognitive abilities.

D. Conclusion

Handouts on amylolytic bacteria and cellulolytic bacteria are able to develop students' cognitive abilities. The addition of studies regarding bacteria in vegetable waste soil in general in the Handout is needed to develop students' insight regarding the activities and roles of bacteria found in vegetable waste soil.

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