RESEARCH ARTICLE

Enhancing bacteriological concept comprehension in multiethnic student through project-based practicum

Didimus Tanah Boleng[a,1,*], **Elsje Theodora Maasawet**[a,2], **Hariska Swandana**[a,3]

[a] Department of Biology Education, Faculty of Teacher Training and Education, Mulawarman University, Jl. Kuaro, Samarinda, East Kalimantan 75119, Indonesia

[1]didimus.tanahboleng@yahoo.com*; [2]elsye_maasawet@rocketmail.com; [3]hariska.swandana_jhssmd@bchati.sch.id

Abstract: The concepts of bacteriology are still poorly understood by students of the Department of Biology Education, Mulawarman University. Certain ethnic characteristics influence student learning processes and outcomes. A quasi-experiment was carried out at the Department of Biology Education, Mulawarman University in the even semester of the 2022/2023 academic year. The aim of the research was to map members of ethnic-based practicum groups in bacteriology practicum in an effort to empower understanding of bacteriology concepts. Ethnic-based practicum means that the practicum is carried out taking into account the ethnic diversity that exists in each group in the class. The research sample was class A and class B students who were taking a bacteriology practicum program. The research instruments were questionnaires and test questions. Data analysis techniques are percentage and covariance analysis. If there is a significant influence, then proceed with Least Significance analysis Difference. The results of data analysis show that there is a significant influence between the application of the product (a Project-Based Learning-based practicum guide) on understanding the concept of bacteriology as a result of development ($p<0.00$). The research sample was class A and class B students who were taking a bacteriology practicum program. For further research, practical material needs to be supplemented with other bacteriological materials, and involve more ethnic types.

Keywords: bacteriology concept; multiethnicity; practicum; project; understanding

For correspondence:
didimus.tanahboleng@yahoo.com

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Introduction

Practical activities are an effort to prove the theories accepted by students in the classroom. Practical activities are an effort to prove the theories accepted by students in the classroom. The majority of Korean nursing universities offer theory courses in their first and second years, with a nursing practicum added in their third year (Kang & Hwang, 2023). Theoretical activities in class for bacteriology material enable students to better understand the material. Students experience themselves in practical activities and are able to collect data to produce product.

Supervised practicum in schools is imperative for the qualification of student teachers entering the teaching profession (Bjørndal et al., 2024). Therefore, complete equipment and practical materials provide greater opportunities for students to carry out actions in the laboratory. A formal evaluation procedure to assess preand post-practicum knowledge would be an asset for judging the effectiveness of the curriculum at increasing content knowledge, scientific understanding, and attitudes about ship-board limnological research (Twiss et al., 2005).

Practicum implementation by students in the laboratory is always equipped with practicum guides. The bacteriology practicum guide contains certain bacteriology practicum objectives. The development of a practicum guide based on the application of the Project-Based Learning (PjBL). In this research, there was no integration between PjBL and practicum. In practicum, it was carried out by implementing work steps based on PjBL model syntax allows students who are guided by the practicum guide to produce products. Yoon and Jeune (2023) define PjBL as a student-centered pedagogy that entails solving authentic problems to help students gain a deeper understanding through active exploration of real-world challenges and problems. While these projects have good intentions, it's unclear whether they are based on educational principles like PjBL (Marnewick, 2023; Zen et al., 2022). PjBL is based on the idea of

multi-stage learning. Thus, it is predicated on Aristotle's idea that knowledge must traverse three domains: (1) Perceptiveness and sensuality; (2) intelligence and reasoning; and (3) ambition and desire (Santos et al., 2023). Academic achievement: the relationship between student engagement and the project-based online learning method revealed six characteristics of PjBL: a central question, learning objectives as a focus, involvement in instructional activities, student collaboration, use of scaffolding technologies, and production of tangible artifa (Guo et al., 2020). To produce products, students need to deepen bacteriological concepts which are then used to design products.

The bacteriology practicum was carried out to clarify bacteriology concepts. Bacteriological concepts are related to sterilization, bacterial growth media, Gram staining, Total Plate Count (TPC), and Most Probable Number (MPN). Sterilization is the beginning of bacteriology practicum. A sterile condition is a condition where there are no vegetative and bacterial spores. Bacteriological concepts are related to sterilization, bacterial growth media, and Gram staining. The growth medium can be solid, liquid, or semi-solid. Gram staining is the application of crystal violet and safrananin dyes to bacterial cells. The results of Gram staining are bacteria that are purple (bacterial cells absorb crystal violet; and bacteria that are red (bacterial cells release crystal violet color and absorb safranin). The total bacterial plate number is an activity to count the total bacterial cells that grow in one petri dish. The most probable number is an effort to detect coliforms in an examination sample.

The concepts of bacteriology material can be understood clearly through project-based bacteriology practicum activities. In all scientific fields, scientific notions are essential for comprehending and explaining natural occurrences (Soeharto & Csapó, 2021). Through projects, students attempt to formulate problems, investigate, discuss the results of investigations using data from the results of investigations assisted by relevant information from scientific journals and the latest bacteriology books. Conventional university lectures might be viewed as primarily passive for the students, in which the lecturer imparts information and understanding of concepts and models to the class (Finbråten et al., 2022). Education in the 21st century requires the use of creativity and innovation in teaching technology (Malganova & Rahkimova, 2015). The process of creating a project is expected to encourage students to actively seek information to understand aspects of the project.

Members of ethnic groups share a common history and origin, as well as a perceived unique “system of shared meanings” composed of norms, language, and customs (Sheppard et al., 2023).Students who take part in bacteriology practicum activities in Samarinda City have diverse ethnic backgrounds. It is thus likely that ethnically diverse workplaces facilitate the formation of interethnic social capital (Manevska et al., 2024; Wang et al., 2023), and ethnic relations course is important in fulfilling the national aspiration of national unity (Idris et al., 2012). Certain ethnicities have unique characters. The unique character of a particular ethnicity can be found in various areas of life. For example, in the field of learning/education, and other areas of life therefore, variables including shared cultural practices and values, as well as intergroup contact and comparison, can reinforce ethnic identification (Suherman & Vidákovich, 2024). Multicultural education is an educational tool for providing equality for all students (Jayadi et al., 2022).

The results of observations in 2023 carried out by a research team at the biology education laboratory, Mulawarman University regarding the bacteriology practicum guide, found that the content pattern of each theme practiced only attempted to prove theories. There is no bacteriology practicum guide yet with a PjBL pattern. Regarding the ethnicity of students who took part in the bacteriology practicum program, information was obtained that there was more than one type of student ethnicity (multiethnic). Students' understanding of bacteriological concepts is still low. The ethnicity of students who take the bacteriology practicum program is quite varied.

Understanding of bacteriology concepts through practical activities is still low. Understanding of bacteriology concepts through practical activities is still low. Practical activities still do not optimally involve ethnic students in practical group work. Students spend a considerable amount of time in schools and universities studying scientific concepts. However, many students still have an insufficient understanding or harbour some misconceptions about scientific concepts, which are persistent and resistant to change (Vančugovienė et al., 2024), and writing-tolearn activities help students gain conceptual understanding of scientific topics (Gunel et al., 2009).

It is necessary to develop a PjBL-based bacteriology practicum guide. Practical product billing, which is preceded by holding a seminar about the product, needs to be done. Monitored the positive impacts of a long-term citizen science project on participants’ scientific attitudes and science literacy (Schneiderhan-Opel & Bogner, 2020).The formation of a bacteriology practicum working group needs to optimize the involvement of all types of student ethnicities. The teacher-centered pedagogy is characterized by the teacher's explanations of content, demonstration of experiments, and limited interactions among students or between students and the teacher (Byusa et al., 2022). Therefore, the aim of the research was to map members of ethnic-based practicum groups in bacteriology practicum by using the implementation of PjBL-based development products in an effort to empower understanding of bacteriology concepts,

Method

Types of research

The research includes quasi-experiment. The research did not randomize sample members, and did not move students from one class to another. The sampling technique in research is purposive sampling. Therefore, the data analysis technique used is covariance analysis. The independent variables are the product (PjBL-based bacteriology practicum guide), development results, and student ethnicity. The dependent variable is understanding of bacteriology concepts.

Sample of research

The research sample was class A and class B students from the Department of Biology Education Mulawarman University, Indonesia, who had a bacteriology practicum program in the even semester of the 2022/2023 academic year. The sampling technique is purposive sampling. Class A students involved in quasi-experiment were 36 people; while the number of class B students is 32 people. The determination of class A and B students to be involved in the research was the ethnicity of the students in those two classes.

Data collection instrument

To obtain data, questionnaires and test questions were used. Questionnaires are used to obtain information about students' ethnic types. Test questions are used to obtain conceptual understanding scores after students carry out bacteriology practicum activities. The sampling technique in research is purposive sampling. Therefore, the data analysis technique used is covariance analysis Material for test questions includes sterilization, bacterial growth media, TPC, and MPN analysis. To obtain student test result scores, student test results are corrected using a scoring rubric for understanding the concept of bacteriology.

Technical Data Analysis

Survey data regarding student ethnicity was analyzed using percentages. Data on the influence of product application, ethnicity, and product interactions with ethnicity; using covariance analysis (ancova). If there is a significant influence, then continue with the Least Significance Difference (LSD) test.

Research process

Development of a PjBL-based bacteriology practicum guide book through a research and development process. The book development process follows the development pattern according to (Thiagarajan, et al., 1974). There are four stages of development, namely: define, design, development, and dissemination. Research and development has been carried out. Research and development has been carried out. The PjBL-based bacteriology practicum guidebook for students of varying ethnicities, as a product of this research, has been published, but has not yet been published. In the development stage, according to this development pattern, a PjBL-based bacteriology practicum guide book (development product) was produced. Testing development products in large classes using a quasi-experimental design.

The implementation of the quasi-experiment began with observing the ethnicity of students in both classes. Next, carry out an equivalency test to obtain two classes that are equivalent based on academic level. Formation of student work groups based on student ethnicity. Application of pre-test for the two classes. Application of treatment (application of PjBL-based bacteriology practicum guide products in the experimental class), and the bacteriology practicum guide currently used (not PjBL-based) in the control class. Furthermore, in both classes a post test was given. The quasi-experimental process is presented more clearly in the Figure 1.

To correct the work results in working on the test questions, a scoring rubric for understanding the concept of bacteriology is used. The development of the scoring rubric was carried out by the research team, which became a new finding for the research team. The points used are point 4 (exemplary response), 3 (good response), 2 (inadequate response), 1 (poor response), 0 (no response). The pattern for developing scoring rubrics for understanding bacteriological concepts refers to Hart (1994).

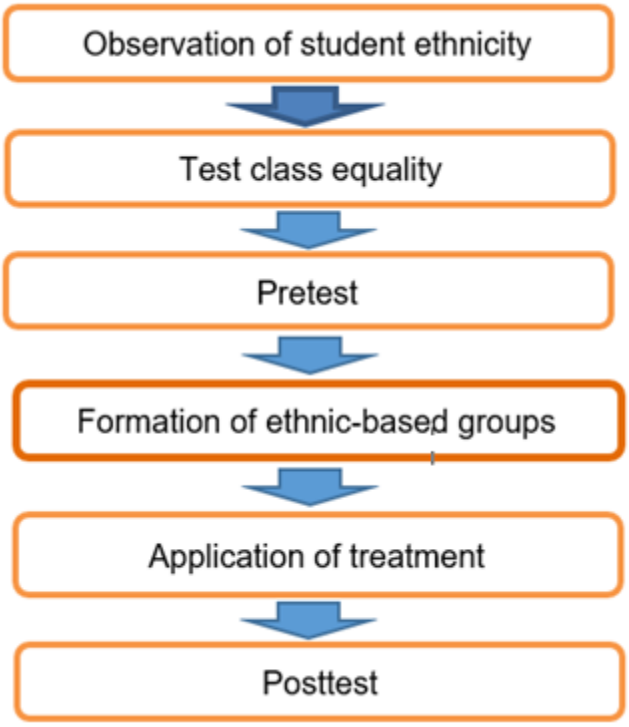

Figure 1. Quasi-experimental flow diagram

Results and Discussion

Student ethnicity

The results of a survey of student ethnicity in class A and class B, found that there was information that there were 12 types of student ethnicity. The majority of students' ethnicity is Javanese. Furthermore, the lowest number of ethnicities are Berau and Palembang. Figure 2 shows the ethnic percentage of students in class A and class B.

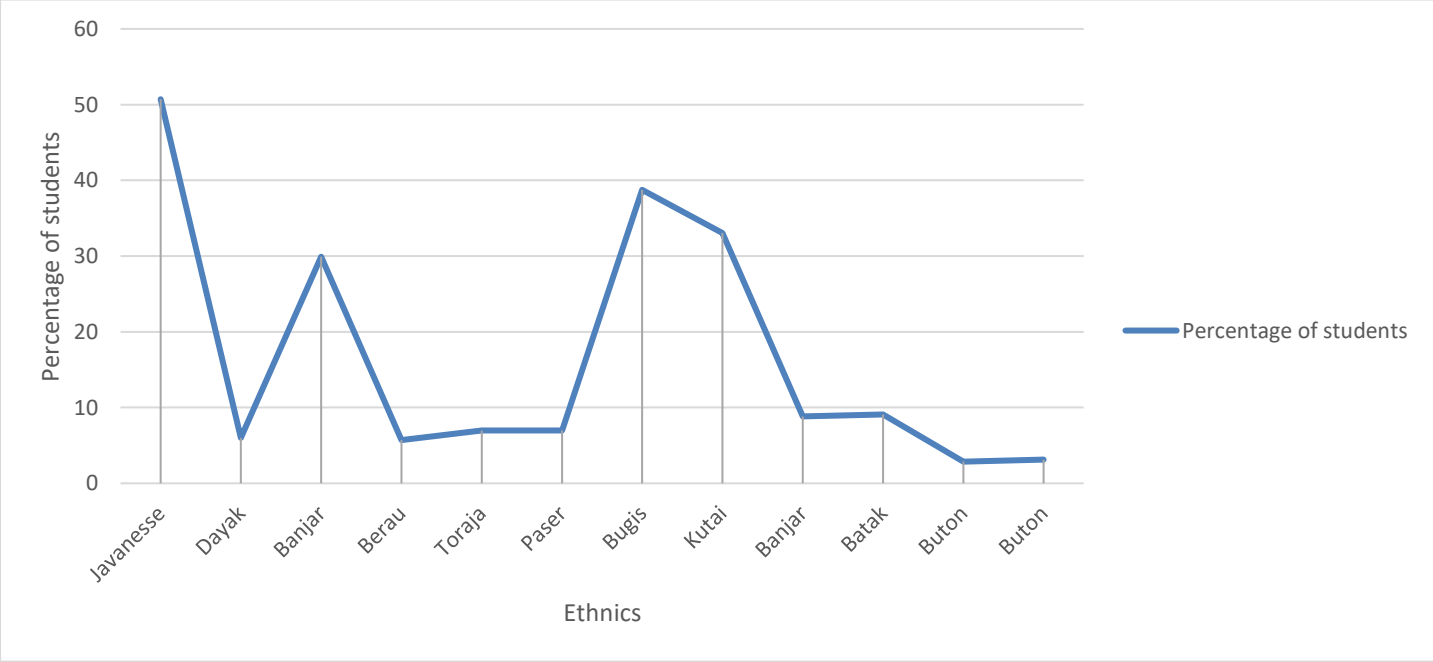

Figure 2. The ethnic percentage of students in class A and class B.

The ethnicities of students in class A and class B were not all involved in the quasi-experiment. The number of students whose ethnicity is in class B can be taken as a research sample. The ethnicities of students in class A and class B who were sample members are presented in the Figure 3.

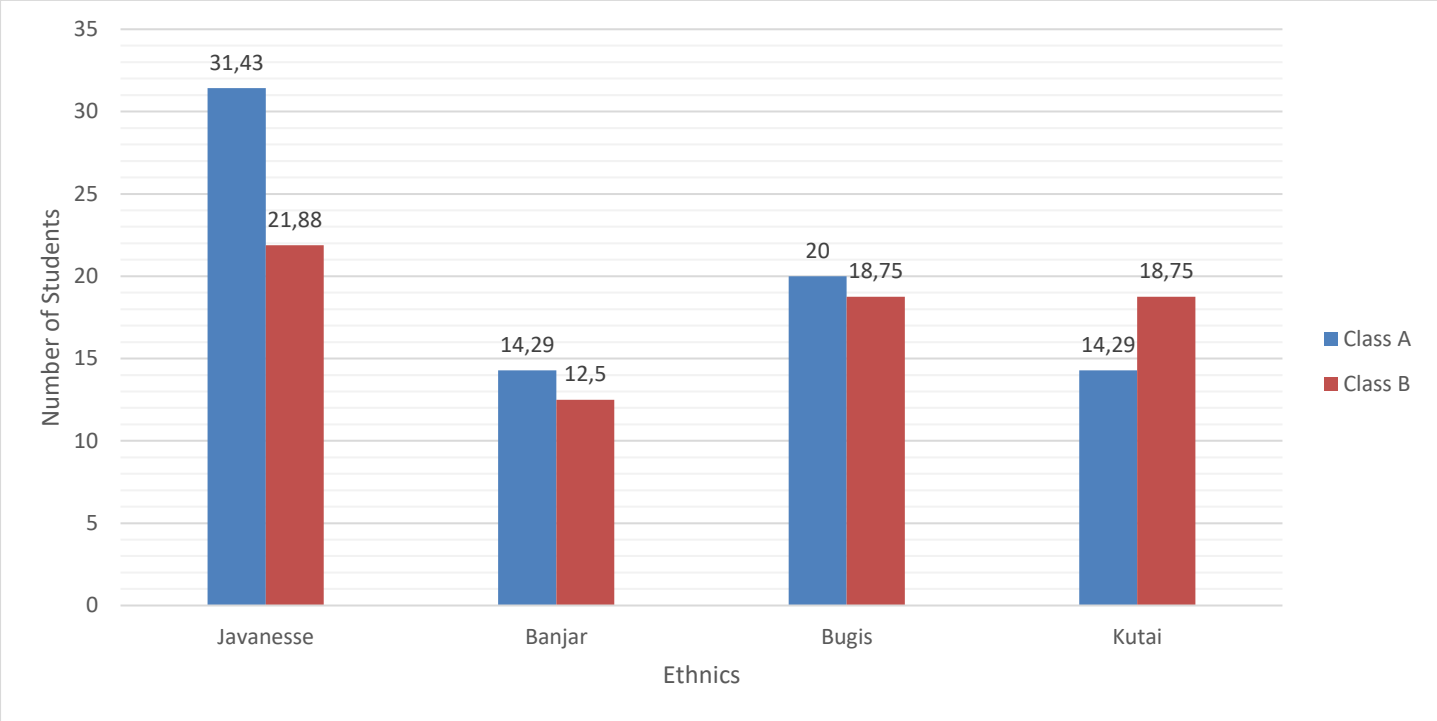

Figure 3. Ethnicity of students involved in the quasi-experiment

ANCOVA results of quasi-experimental data

Before carrying out ANCOVA, assumptions are first tested for the application of parametric analysis. The assumption tests carried out are the normality test and the homogeneity test. Table 1 below contains the results of the normality test and homogeneity test.

Table 1. The results of the normality test and homogeneity test.

Test aspect	The amount of the test value		Decision	Statistical validation
Normality	Pre test	0.03	Normal	One-Sample Kolmogorov-Smirnov Test
	Post test	0.00	Normal	One-Sample Kolmogorov-Smirnov Test
Homogenity	Pre test	0.171	Homogeneous	Levene's Test of Equality of Error Variances[a]
	Post test	0.025	Homogeneous	Levene's Test of Equality of Error Variances[a]

Table 1 shows that the results of the normality test are that the data is normal. Apart from that, the homogeneity test results also show homogeneous data. Thus, the data analysis process can be continued with ANCOVA. Table 2 shows a summary of the ANCOVA results, and Table 3 shows the results of further tests (LSD test) for understanding the concept of bacteriology.

Table 2. Summary of theANCOVA for concept understanding

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	17428.049[a]	8	2178.506	50.949	.000
Intercept	22397.236	1	22397.236	523.809	.000
XConcept	154.630	1	154.630	3.616	.064
Product	8224.999	1	8224.999	192.360	.000
Ethnic	224.615	3	74.872	1.751	.172
Class * Ethnic	61.463	3	20.488	.479	.699
Error	1753.096	41	42.758		
Total	205902.750	50			
Corrected Total	19181.145	49			

Table 3. LSD Advanced test results for concept understanding

No	Class	XConcept	YConcept	Selisih	ConceptCor	Notasi LSD
1	Experiment	20.673	78.769	58.096	77.151	a
2	Control	10.000	41.979	31.979	43.428	b

Table 3 shows that the application of the product in the experimental class is significantly different from the application of the old pattern practical guide in the control class. Empowerment of students' conceptual understanding in the experimental class was significantly higher than in the control class. The learning process in the experimental class was able to increase the difference in understanding of concepts about bacteria compared to that in the control class.

Bacteriology practical guide with PjBL pattern vs understanding bacteriology concepts

The bacteriology practicum guide developed is based on PjBL, its contents follow the PjBL syntax. The work pattern begins with problem formulation, investigation (data collection), discussing the results of data analysis, conclusions, and presentation (discussing the resulting product). PjBL is a useful method for teaching difficult STEM (science, technology, engineering, and mathematics) ideas (Baudin et al., 2022). To be able to produce products, relevant data from up-to-date sources is needed, because students can improve their understanding of concepts by accessing the internet (Fitriyani et al., 2019) and it was concluded that although taking more science courses provides better understanding of basic science concepts, there are still critical misconceptions to overcome and teacher education programs need to adress these issues (Kaya, 2014; Rahhou et al., 2015). The expected lab practicum can improve students' technical and analytic skills using the experimentation given (Liesatyadharma et al., 2022).

Implementation of work patterns according to PjBL syntax begins with an agreement between the lecturer and students regarding the project. PBL is a pedagogical approach in which students create a product (Kong et al., 2024). Projects are carried out by students and produce products. PjBL aims to develop and gain knowledge and skills in a secure project environment (Marnewick, 2023). Students carrying out practicums always strive to produce products through project completion as agreed. They try to understand concepts about various aspects of the product. Regarding the relationship between inhibition and understanding science concept, several past studies documented mixed results. The findings appear to be specific to the different science subjects (Abdullah et al., 2021).

The work contained in the practicum guide is in accordance with the PjBL syntax, allowing students to try to understand the concepts related to the product that will be produced. Developments in the understanding of learning, and science studies strongly evidenced that students can have a deep understanding of science and mathematics and be scientifically literate citizens when they are allowed to learn in conditions where they are active (Michael et al., 2023). Misconceptions are one of the most significant things impeding students' meaningful and long-lasting learning (Sözen & Bolat, 2011). Students are able to understand the concept of the product parts. Understanding the concepts of bacteriology enables students to be better able to explain the facts about bacteriology in practice.

Experimental Class vs Control Class in Empowering Understanding of Bacteriological Concepts

In groups, students discuss the bacteriology concepts they have discovered. The involvement of diverse ethnic groups in groups allows them to strengthen each other. Ethnic groups whose characters are strong in learning help students whose characteristics of other ethnic groups are weak in learning. They complement each other in discussing concepts about an aspect of bacteriology.

In quasi-experimental research, two experimental groups are determined. The first group was given treatment in the form of a PjBL-based bacteriology practicum guide. The second group was not subject to PjBL-based bacteriology practicum guidance (subject to the currently ongoing bacteriology practicum guidance).

In the experimental class, during the practicum, students use a PjBL-based bacteriology practicum guide. Next, they carry out an investigation (collect data). The next stage is data analysis and discussing the results of data analysis. The final stages are making conclusions and product presentation. This work pattern allows students to better understand practical problems and bacteriological concepts discussed in PjBL syntaxes. Conceptual understanding is also indicated by the recognition and creation of relationships between chemistry concepts (Vachliotis et al., 2021).

Ethnic character vs understanding of bacteriological concepts

Ancova results (Table 3) show that ethnicity does not influence empowerment in understanding bacteriological concepts. The ethnicities involved in the quasi-experiment were Javanese, Banjarese.

Bugis, and Kutai. The Kutai, Banjar ethnic groups are local ethnic groups in East Kalimantan Province. Introduced the Cultural Dimensions Theory, individualism and collectivism have been pivotal constructs in examining cultural influences on behavior (Zhao & Hu, 2024).The Bugis and Javanese ethnicities are immigrant ethnicities. These ethnic characters show similarities. The similarity of characters is the result of inter-ethnic interactions that have been going on for years in Samarinda City, East Kalimantan Province. Indonesia is the home of a myriad of traditions and cultures, with at least 300 major ethnic groups and 400 languages (Kawaguchi-Suzuki et al., 2019). As a multiethnic, multicultural and multi religious country, Malaysia can be aplatform to learn various kind of foreign languages in order to promote better understanding towards different people and different cultures in the era of globalization (Aladdin, 2010).

Empowerment of bacteriology concepts in students for all ethnicities is similar. Empowerment of bacteriology concepts in students for all ethnicities is similar. Therefore, more types of ethnicity are needed for future research. It is a record of diverse cultures, creates awareness, and aids the people to develop their behavior (Baan et al., 2022).

Because the ethnic characteristics of the students involved in this research were similar, the interaction between students whose ethnicities varied with the application of the product in the research did not provide a significant difference in effect (see Table 2). In group work in each group where there are students of different ethnicities, mutual reinforcement occurs. Strong ethnic characteristics learn to help weak ethnicities learn. They provide solutions to each other in searching for data. The collected data is used to create products that have been agreed upon at the beginning of the practicum. They practice and try to understand the data collected. In group work for practicum, the differences in ideas given by students from various ethnicities in the group were not very significant. Every ethnic group has their respective education system (Ahmad & Yusof, 2010; Awang-Rozaimie et al., 2012), and each ethnic group was represented by an approximate equal number of members, all interested in the economic, educational, religious and cultural development of their community, preserved the tolerant attitude towards the neighbouring communities (Ruthner, 2012).Therefore, lecturers need to monitor the progress of student group work in each bacteriology practicum. For groups that are less developed in completing practicum assignments, lecturers need to immediately motivate the students in the practicum group.

Conclusion

The application of the product (a PjBL-based bacteriology practicum guide) is able to empower the understanding of bacteriology concepts for students of varying ethnicities. The PjBL-based bacteriology practicum guide contains work orders according to the PjBL syntax. The PjBL-based bacteriology practicum guide contains work orders according to the PjBL syntax. By having a contract to produce a product, students try to understand concepts about various aspects of the product they want to make. The involvement of various ethnic types of students in each work group makes it possible to find the best decisions regarding practicum group assignments.

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Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

Author Contributions

D. T. Boleng: data analysis, methodology, writing original draft preparation, observation and sampling; revision and editing. **E. T. Maasawet:** data analysis, revision and editing. **H. Swandana:** data analysis, revision and editing.

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