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Problem-based learning to develop students' character in biology classroom

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Abstract

Development of students' character in learning processes is important as weel as the effort to improve students' cognitive and skills. In biology learning, development of students' character can be conducted by applying the appropriate teaching strategy. Problem-Based Learning (PBL) is one of the teaching strategies which is potential to develop students' character. This research was a quasi-experimental design to uncover difference of character development by applying PBL compared with direct instruction (traditional learning). The research samples were 72 first year students in Faculty of Mathematics and Natural Sciences, Universitas Negeri Makassar, Indonesia. Students' character development was measured by using questionnaire at the beginning and at the end of study. The students' character was also measured by observation sheet of character during lab session. Research finding indicated that there was no effect of teaching strategy on the students' character development measured by questionnaire. Different finding was indicated by result of observation, the students taught by PBL showed more increase of character compared with traditional strategy. Based on the fact, lecturers should use PBL to develop students' character. Others, the future research can consider usage of more accurate measuring instrument of character like behavioral observation sheet by paying attention on its limitation.

Keywords: Problem-based learning, student's character, questionnaire, character observation sheet, biology classroom

Introduction

Education challenge these days is to yield smart grad having good character. Character is coherent thing to personality including totality idea, aspiration, attitude found on individual that are expressed in mind and action (Lie, 2007). Character refers to group of attitudes, behaviors, motivations, and skills (Musfiroh, 2008) and can determine someone personality. Someone who has a good character, will have thinking the good, feeling the good, as well as having acting the good. Equally, good character represents a harmony among knowing the good, desiring the good, and doing the good (Lickona, 2004). Bahri et al. (2021) stated that the students have to have thinking skills and character as the characterics 21st century learning. Adnan et al. (2021) found that some skills that needed to success in 21st century could trained through science learning.

One of the efforts to realize the mentioned aspects above is by implementing character education. Character education is a system internalizing good character values to student covering knowledge component, willingness or awareness, and action to apply the values. Character education of its nature is non-simply teaching which are good and which are correct, but beyond that, it ought to inculcate habit to the effect that which is good so that learners can understand, can feel kindliness values and become accustomed in doing it (Ma'ruf, 2012)

Character education at level set of education can be done by developing values through learning to be accustomed, extracurricular activity, tuition of counseling and integrated approach by inculcating good behavior and morality in all subject taught in class (Lie, 2007). To educators, character education is the main duty related to development of attitude besides knowledge and skill. Knowledge and skill are important to be owned by learners, however inducing attitude to form mental state of the learners is not less important, so attitude of the learners will be more directed when owning skill and knowledge for their future.

Character education is conducted in order to form and develop the state of thinking, attitude, and behavior of learners to become a good person having positive attitude, good behavior, noble spirit, and great responsibility that can be implemented in daily life. The target of character education is substantively to guide and to facilitate students so that they can own positive character. Fitri (2012) stated that a model be able to be developed to support efficacy of character education was a step by step process including: (1) socialization, (2) internalization, (3) behaving, and (4) cultivation. From this statement, it can be known that the students' character was developed step by step, start from how the students were trained through the implementation of learning strategy/model day by day, until the students behaving and make that characters cultivate.

Effort of character development can be done in campus through habituation during teaching and learning processes. Development of value/character during teaching and learning processes is done by using integrated approach in all subject (embeded approach) (Larson, 2009). During each learning activity cognitive domain as well as afective, and psychomotor domain is developed, so that certain specifie activity is not always needed in order to develop character values. The teacher can be a figurative example to the learners, for the development of certain values like honesty, discipline, and responsibility. While to develop some other values like environmental care, social care and creativity, some conditions and situation are needed so that the learners have opportunity to demonstrate behaviors showing those values.

Several studies have been done by the researcher related to the students' character. Arifin (2017) found that regarding the teaching methodology, teachers had little consensus on how moral values could be integrated into teaching materials and methods, teachers employed different strategies in

teaching values, and they faced challenges in implementing character education (e.g., lack of training). Saputra et al. (2013) found that teachers did not use any scoring rubric for assessing their students' characters, and only assessed the students' characters based on their subjective evaluation during teaching the students because there was no instrument that they can use to assess the students' character.

Development of students' character can be conducted by giving positive experience as much as possible to the students, because, education is an experience, and it is a continuous process which goes on. Experience characters have both active and passive state. Active experience means to try and try, while passive experience mean justly to accept and follow. According to Larson (2009), development of character could be done by integrating character education in daily activity, besides through the approach of teaching strategy.

The character education integration in learning process is carried out from planning phase, application phase, until evaluation phase of the learning process (Khusniati, 2012). In biology learning, students' character can be developed by applying constructivistic learning strategy (Bahri, 2016). Constructivistic teaching strategy is suitable to be used to develop students' character because it can give opportunity to them to train various behaviors like honesty, discipline, responsibility, creativeness, and care. Besides, principle of constructivism can facilitate internalization of values. Furthermore, Khusniati (2012) explained that the arrangement of pre-activity, main activity, and closing activity of learning, were selected and implemented in order the students practice the targeted character values. Besides, behaviour of lecturer during the learning process has to represent the implementation of values to the students.

Problem based learning (PBL) strategy is one of the strategies having constructivistic base. PBL is designed on the basis of the idea that learning is not merely process to memorize fact or concept, but interaction process between individual with its environment.) PBL can develop the skill which needed at knowledge era (Duch et al., 2001; Tan, 2003), because it can develop the high order thinking ability such as critical thinking, problem solving, finding and using learning sources, self-regulated learning, developing ability to work cooperatively, and life-long learning (Steck et al., 2012). PBL can be applied in university course because PBL is based on problem, envolves thinking activity to solve the problem, and correlates to cognitive function of the learners (Izzaty, 2006).

PBL is teaching strategy where the learners are confronted with an ill-structured problem of real world. The learners will take an effort to make the the problem to be clear and structured (well-structured). PBL is proven effective to improve cognitive achievement of biology students (Danial, 2009; Sungur et al. 2006). PBL improves learning motivation (Keziah, 2010), has potential to empower metacognitive skills (Ackay 2009; Bahri & Corebima, 2015; Sungur & Tekkaya 2006; Thomas & Chan, 2002), and improves students' retention (Massa et al., 2013; Prince & Felder, 2006; Strobel & van Barneveld, 2009). PBL provides opportunities to connect theory to practice (Schwartz et al. 2005), also promotes scientific proficiency and literacy, particularly when dealing with scientific concepts, the nature of science and the relationships between science and technology (Duch, 1996). Besides, PBL can stimulate student's affective process in learning process (Lindeman, 1926; Liu, 2009; Prince & Felder, 2006) and students' attitudes towards the learning process (Ferreira & Trudel, 2012; Tandogan & Orhan, 2007). Related to the development of character as one of the afective domains, some research emphasize that afective domain is an integral dimension of PBL (Fineman, 1997).

Method

The design of this research was a quasi-experimental design to compare the influence of PBL teaching strategy and direct instruction (traditional strategy) on the development of student character. In PBL class students were taught followed the PBL syntax: problem orientation, organizing students to learn, lecturer guiding students to do the inquiry, develop and present the work, and analyse and evaluate the problem solving process (Arends, 2008). In traditional learning, students were taught with the lecturer-centred, where lecturer teach with dominated by direct instruction.

The design of the research was pre-test-post-test control group design (Fraenkel & Wallen, 2009) (Table 1). The independent variable was teaching strategies consisting of the PBL and the traditional teaching strategy. The dependent variable was students' characters. This research was conducted for one semester in the first semester of academic year 2019/2020.

Table 1. The quasi-experimental research design

Pre-test	Group	Post-test
O1	X1	O2
O1	X2	O2

X1 = PBL; X2 = Traditional Strategy; O1 = Pre-test scores; O2 = Post-test scores

The population of research consisted of 6 classes of the first year students of Faculty of Mathematics and Natural Science, Indonesia in academic year 2019/2020 as many as 288 students. The sample of research represented all the population. The samples of the study consisted of 72 first year students of Faculty of Mathematics and Natural Sciences, Universitas Negeri Makassar, having equal academic skill based on placement test who were obtained by random sampling. The classes were selected by using simple random sampling technique by the lottery method from the population and entirely by chance because each class has the same probability of being chosen for the sample of research. Two class used in this research employed Basic Biology course. Each teaching strategy was represented by one class. The classes used as the research samples were initially tested for the equality using the data of placement test. The analysis of the equality test used analysis of variance (ANOVA) using SPSS 22.0 for Windows. The result of this analysis showed that two classes were equal ($p > 0.05$).

The placement test is in the form of multiple-choice tests on the biological materials of senior high school level. The number of the test items was 70 items. Development of student character was measured by using a questionnaire to know students' early character by using Likert scale. The number of the character questionnaire was 21 items. Besides, development of student character was measured by using observation sheet of character during lab sessions in every meeting. The sample items of questionnaire and observation sheet were measured character covered honesty, discipline, responsibility, creativeness, and care. The placement test, character questionnaire, and behavioral observation sheet were developed by the researcher and were validated before being used. The instruments used were initially validated by experts and by empirical validation. The expert validation covered the content validity and construct validity. The results of the validation

from the experts showed that the result was 3.80 (strongly valid for the placement test, 3.69 (strongly valid) for character questionnaire and behavioral observation sheet.

The empirical validation covered validity item test and reliability item test. The empirical validation was conducted on 50 students of second year of Faculty of Mathematics and Science. The item validity test means that an item is said to be valid if it has a great contribution toward the total score. A reliability of a test is associated with consistency. A test is said to have a high reliability if the test can provide consistent results. The results of the empirical validation showed that the validity of placement test was in the range 0.385-0.800 (valid), and the reliability of the placement test was 0.978 (high reliability) meaning that the test had good quality. The results of the empirical validation showed that the validity of character questionnaire was in the range 0.466-0.817 (valid), and the reliability of the character questionnaire was 0.933 (high reliability) meaning that the test had good quality. During one semester, both classes were taught using treatment of different teaching strategy, and then a character questionnaire was given to them by the end of research.

The data of this research were the score of character development of the students on the character questionnaire and character observation sheet. The data from the questionnaire were collected from the pre-test and post-test. The data were then analyzed by using Analysis of Covariance (ANCOVA), which were previously performed in the prerequisite tests namely, the normality test using one-sample Kolmogorov-Smirnov test and homogeneity test using Levene's Test of Equality of Error Variances. The data were analyzed using SPSS 22.0 for Windows. The data from the behavioural observation sheet were analyzed by using descriptive statistics analysis.

Results

The students' character development was measured by two instruments, questionnaire and observation sheet. The result of data analysis from these instruments shows the difference. The result of ANCOVA test of students' character based on questionnaire data are shown at Table 2.

Table 2. Summary of ANCOVA test result of students' character development

Source	Type III Sum of Squares	Degrees of Freedom	Mean Square	F	Sig.
Corrected Model	314.747a	2	157.373	8.398	0.001
Intercept	905.956	1	905.956	48.343	<0.001
XCharacter	314.492	1	314.492	16.782	<0.001
Strategy	30.848	1	30.848	1.646	0.204
Error	1293.061	69	18.740		
Total	462916.748	72			
Corrected Total	1607.807	71			

Table 2 shows that there was no difference of the students' character development between students were though with PBL and traditional learning with the $p > 0.05$ (sig. 0.204). It means that there was no influence of teaching strategy on the students' character development.

Table 2 shows the difference with the results of data analysis of questionnaire results. The results of students' character behavior recorded by observation sheet during eight meetings of lab activities in biology course are shown in Table 3. The researcher could observed the character of

students when they do the lab activities for examples, be discipline and responsible to do the practicum, and be honest to report the result of practicum.

Table 3. Development of the students' character behavior during the lab practices

Teaching strategy	Meeting								Total
	1	2	3	4	5	6	7	8	
Traditional	2.28	2.11	2.22	2.21	2.23	2.00	2.06	2.09	2.15
PBL	2.27	2.24	2.14	2.24	2.24	2.28	2.29	2.30	2.25

Character development of students also measured during lab practices can be visualized in Figure 1.
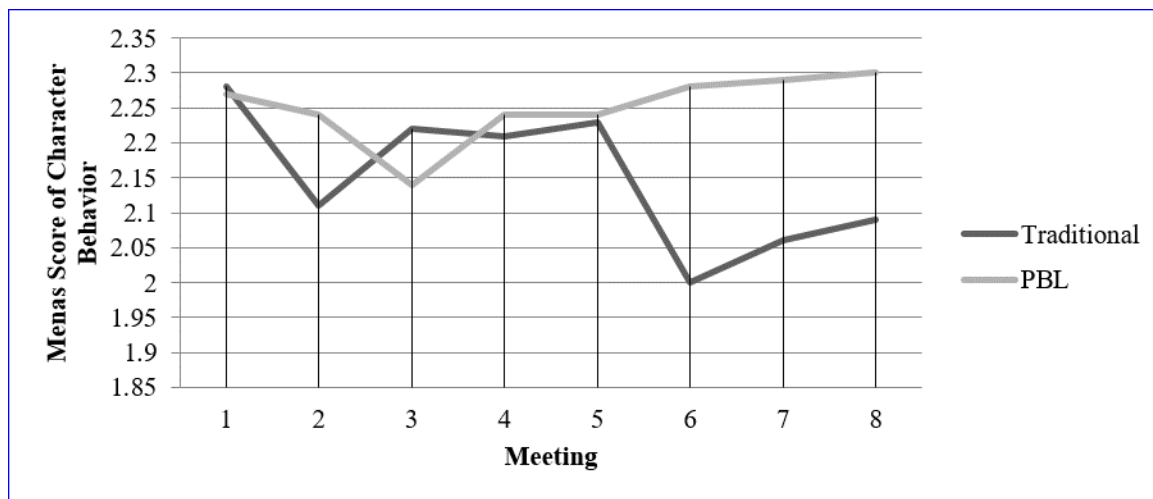
Figure. 1 The development of students' character behavior during lab practices

Figure 1 shows that the character of students were fluctuated during eighth meetings. In the PBL class, the activities of character behavior that showing the increasing started from the fourth meeting until the eighth meeting. On the other hand, in the traditional class it appeared that activities that showed character behavior tend to decline.

Discussion

The results of inferential statistic showed that there was no difference in the character of the students taught by using PBL strategy and those taught by using traditional strategy. It means that the teaching strategy does not affect the character of the students measured by using a questionnaire filled in by the students themselves. However, it cannot be concluded that PBL cannot train the students' character during the syntax application because of different things shown by observation results of the character behavior of the students during the lab sessions. The finding of this study showed that the use of questionnaires was less accurate for measuring the character of the students compared to the use of the observation sheet.

No influence of teaching strategy on student character development as measured by a questionnaire in this study may be due to the use of unsuitable measuring instrument. In this research, the character of the students was measured by a character questionnaire filled out by the student. Drew et al. (2008) explained that in educational research, where, generally the data was obtained by instruments aimed at people (students), so that if something happens which interferes during the process of data collection, the data obtained would be vary from the actual conditions.

This explanation is in line with the findings of previous studies such as the studies conducted by Bahri (2010), Muhiddin (2012), and Bahri and Corebima (2015) showing that the use of a questionnaire to measure parameters such as metacognitive awareness, metacognitive skills and motivation filled directly by the students is less precise. Bahri's research (2010) even uncovered that the use of a questionnaire to measure metacognitive awareness causing data obtained tended to show that metacognitive awareness of students decreased after following the lecture.

The result of study showed that based on observation results during the lab sessions, it could be seen that in the PBL class, mean score of the students' character tended to increase, although there was the decrease at second and third meeting, but the increase tended to be consistent. On the other hand, in the traditional learning class, mean score of the students' character tended to be inconsistent; it sometimes decreased and then increased at the next meeting and then decreased. Based on the findings of this study, it can be assumed that PBL strategy tends to be able to train the students' character compared to traditional strategy.

Character development of students in the PBL class relates to its' syntax. Implementation of PBL syntax develops the students' character during the learning process. The PBL syntax gives opportunities for students to learn independently. It can motivate students to be disciplined in learning and these activities also allow students to discover more facts about the certain topics of different issues. By this teaching strategy, students are trained to be self-regulated learner, to make their own investigations, and to engage in teamwork. Those activities will help the students to be responsible for their own learning (Blumberg & Michael, 1992; Savin-Baden & Major, 2004).

PBL syntax demands responsibilities of individuals as well as of groups. Arends (2008) suggested that each member of the group has responsibility to raise the problems, to find out the solutions and then to discuss it in groups. Similarly, Slavin (2010) said that in the cooperative learning, the responsibility as a key element in the PBL strategy was given to each learner. In addition, individual responsibility formed on the students themselves due to the PBL strategy will develop self-directed learning (self-regulated learning) so that the students can be responsible to manage and control their own learning. Furthermore, Slavin (2010) explained that this type of learning make learners aware of themselves on the responsibility assigned to them and the responsibilities for learning each other.

PBL syntax can also train students to develop their honesty character. In the learning process, students were trained to be honest in evaluating their learning process. Weissinger (2004) stated that related to the PBL syntax, students were the key players in learning, and they would be able to think by their own. In addition, Arends (2008) also showed that PBL syntax helped learners to analyze and to evaluate their own thought processes, skills in conducting investigations as well as their intellectual skills. Finally in the long run, related to the PBL syntax, students will recognize themselves if they have learned to think and to act in a real-world problem situations.

There are some collaborative learning principles, which guide PBL. Those principles can provide a platform for discovery and self-definition (Gabelnick et al. 1990; Qualley & Chiseri-Strater, 1994). Related to collaborative learning existing in PBL, there is an enrichment process of self-discovery to create an environment of mutual influence between the individual and society, between individual and ideas, and between individual and the self-learning process (Lee, 1998). This is in line with Savin-Baden (1998) saying that learning through PBL can challenge the students' self-esteem, and their way of how to view the world and act in it. It encourages students

to reconstruct their own knowledge, and formulate decisions about learning while helping to clarify the values, skills, interests and goals for other students. Thus, students can identify their own strengths and weaknesses as well as the means to overcome or correct any deficiencies (Savin-Baden & Major, 2004). They afford to have the self-awareness and thus become more skilled in the self-evaluation. These activities are proven to train the students' honesty.

PBL provides cognitive effects on students' learning processes including activation and elaboration of prior knowledge, and restructuring of knowledge to fit the problem posed. This activity can train students' creativity. In the learning process, the issue acts as scaffolding that can support the acquisition of relevant knowledge needed to solve the problem (Schmidt, 1993). Dweck (1989) suggested that the students found PBL becoming a powerful source of curiosity driving a person to learn more about a topic. Group discussion dedicated to explain the viewpoints and to face another perspective will stimulate curiosity in the subject matter. PBL dynamics stimulates further thought and therefore has the potential to help the students learn to think about the problem, "play" with ideas and discuss problems (Brake, 1992). Epistemic curiosity is associated with creativity. In most situations of collaborative learning, such as PBL, the students work with each other to seek understanding, solution, or meaning, as well as to create something new (Lee, 2003).

In PBL strategy, the social dimension of learning is an important aspect of the students' learning experience. The implementation of PBL increases social relationship network among students (MacKinnon, 1999). Weisbord and Janoff (1995) stated that this strategy was a platform for students to practice openness towards new ideas and a different perspective and allowed for the ideas exchange. PBL is also an ideal platform to practice listening actively that implies openness to the totality of communication with others. In the discussion, members of the group listen to other points of view before they make judgments or decisions. Students learn to be more caring and sensitive to the opinions of others (Brookfield, 1993). Collaborative learning communities in PBL can create interaction between individuals with ideas, individuals and society, and between individuals with learning process (Lee, 1998).

As one type of collaborative learning, PBL strategy can develop a tolerance, acceptance of diversity, and social skills. Similarly, the results obtained from the discussion activity is very useful to improve students' thinking skills, to help students in order to construct their own understanding of the subject content, to enhance the involvement and engagement, and to assist students for learning on communication skills and thinking processes. Cooperative work that occurs within the group encourages students to develop thinking skills and social skills (Arends, 2008).

Students also get benefit from the interpersonal skills through dialogue and mutual learning in PBL (Barrows, 1988). Through knowledge sharing process and discussing ideas, emotional bonding can be developed (Dweck, 1989). Students also develop teamwork (Steck et al., 2012) because in PBL, students work together to find solutions to complex problems (Ferreira & Trudel, 2012). Students are more likely to express thoughts, feelings, reactions, opinions, information, ideas, and values as the trust has occurred (Rogers, 1994). Confidence in the openness of individuals to share with other people improves interpersonal relationships and the opportunity to learn and strengthen relationships. A more relational dynamics of mutual support will be realized by collaboration, students can develop their awareness to others.

At the Basic Biology course, the implementation of PBL in developing student character can be applied during the theory lectures as well as during practical sessions in the laboratory. Mardapi (2012) suggested that in order to build good character, students needed many opportunities to apply a sense of social responsibility, honesty, and fairness in everyday interactions and discussions. Through PBL, this opportunity can be given to students. In theory lecture sessions, certain characters can be applied through the implementation of PBL. This session could be a process of socialization and character training to students. While the lab sessions can be used by lecturers to observe how far the characters have been taught in the theory lecture session have been internalized and become a habit. Character development should lead the students to be aware and appreciate the importance of the cognitive and affective values, and eventually practice the real values. Practically, there are important spiritual values that should be instilled by students, namely the emergence of a strong desire to practice on these values.

In the traditional learning, discipline character, responsibility, honest, creative, and caring are not empowered optimally. Slavin (2011) stated that the traditional learning was reported as less effective in improving affective learning outcomes. Learning activities in traditional strategy tend to be more verbal (Serbessa, 2006), unilateral instruction (Khalid & Azeem, 2012) and is dominated by a lecture mixed with question and answer methods, so that students become passive. It does not provide the opportunity for students to be self-regulated learner (Kenner & Weinerman, 2011), to make their own investigations, and to engage in teamwork. This can lead students to be less disciplined in learning. In addition, as it makes the students not trained to be honest in evaluating and assessing their learning process. Students are less able to identify their own strengths and weaknesses as well as to seek in order to overcome these deficiencies.

In traditional strategy, individual accountability is often overlooked (Ahmad & Mahmood, 2010), so that tasks were often only undertaken by a member of the group, while the other members are relatively passive. This condition causes the students to be the less responsible persons. In traditional strategy, monitoring by observation and intervention is often done by the lecturer during group studies are ongoing. It does not give students the opportunity to exercise their creativity (Khalid & Azeem, 2012; Tsai, 2013).

In the traditional strategy, social skills are often not taught directly (Akhtar et al., 2012), such as leadership, communication skills, trusting others, and managing conflicts in order to foster the character of students. Traditional strategy emphasizes more on task completion, so often ignore the interpersonal relationships of students. Lecturers often let certain students dominate the group or rely on a group so there is no collaboration and positive interdependence between students in groups and then no proportional interaction. The effect of this condition is care character of students is not developed.

The result of study shows that there was the difference between the results of questionnaire and observation sheet. It means that the students' character measurement by using questionnaire still have some limitations. Correspondingly, Azwar (2009) suggested that there were some limitations in the measurement of character by using an attitude scale. One of which is that the results should be interpreted with caution because the individual frequently response to attitude scale influenced and determined by other factors that do not fully reflect the actual attitude. Seidenberg et al. (1976) stated that one of the factors that could undermine the interpretation was that if due to some reason someone intentionally did not respond really but the responses were directed to the norms of society (social approval) as well as were accepted by the rules of social life (social desirability).

This condition shows that related to the Indonesian population the use of a questionnaire is relatively not suitable to record accurate information.

Based on the fact that the use of questionnaires to measure the character of students is less accurate, it would require an alternative measurement tool that is able to accurately record the character of students. One form of measurement that may be used is by observation as used in this study. In terms of students' character assessment, Arifin (2017) found that teachers mostly employed observation as the assessment tool. Just as the character, so far, students' attitude is more accurately recorded by observation than by a questionnaire. Azwar (2009) stated that it was reasonable to interpret the attitude based on the forms of behavior expressed. In other words, to determine a person's attitude towards something, it can be noticed through his behavior, because behavior is one indicator of individual attitudes. However, it should be noted that certain behaviors are sometimes deliberately revealed to hide the real attitude. Thus, the observed behavior may be able to be the indicator of attitudes in certain situational context, but the interpretation of the attitude should be examined very carefully. Sullivan and Ebrahim (1995) stated that one of the advantages of using observation sheet because the instrument was able to distinguish clearly between the real behavior and a verbal one, that cannot be revealed by a questionnaire. Mambu (2015) developed a teachers' rubric and students' self-assessment rubric to measure the students' characters development.

Apart from anything that has been stated above, Bahri and Corebima (2015) suggested that use of the observation sheets had other limitations in the measuring, such as the number of students in a class, which is too large, impeding the observation of the behavior of each student. Additionally, Lasagabaster and Sierra (2011) stated that the use of observation methods required more time.

Conclusions

Based on the research results, it could be concluded that the teaching strategy did not affect the development of students' character based on the results of questionnaire data analysis. While based on the results of the observation sheet data analysis, students taught using PBL strategy show an increase of scores of characters behavior during the lab sessions compared to those students taught in traditional strategy. It can be assumed that the PBL strategy has the potential to develop the character of students. Based on these facts, there are two recommendations, firstly, lecturers should use the PBL to develop students' character in biology learning, secondly, then further research needs to consider the use of appropriate measuring instruments to measure students' characters such as the use of the observation sheet and/or peer assessment while always paying attention to its weaknesses.

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