

The Effects of Problem-Based Learning with Character Emphasis and Naturalist

Intelligence on Students' Problem-Solving Skills and Care

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Abstract

This research aimed to examine the effect of problem-based learning with character emphasis (PBL-CE), and naturalist intelligence on the students' problem-solving skills and care. The treatment by level 3 x 2 design were given to three groups; PBL-CE (A1), PBL (A2), and regular learning (RL) (A3) on the students with high naturalist intelligence (B1) and the students with low naturalist intelligence (B2). The data on the students' naturalist intelligence and problem-solving skills were collected through tests and the data on the students' care were collected through self-assessment and observation sheets. The data were analysed using manova at 5% significance level. The results of the reserach showed that the PBL-CE affected the students' problem-solving skills and care, naturalist intelligence did not affect the students' problem-solving skills and care, and the interaction between the PBL-CE and naturalist intelligence did not affect the students' problem-solving skills and care.

Keywords: problem-based learning with character emphasis (PBL-CE), problem-based learning (PBL), regular learning (RL), naturalist intelligence, problem-solving skills

Introduction

The future challenges faced by students are increasingly complex both in social and environmental settings. The Ministry of National Education formulates the characteristics of humans in the twenty-first-century which become the orientation to education development in Indonesia. The characteristics refer to the twenty-first-century skillset (Care, Scoular, & Griffin, 2016). One of the skills required regarding this is problem-solving skills (BSNP, 2010). The ability to solve problems is an important qualification for education and life to be able to participate actively in global and digital societies (Eichmann, Goldhammer, Greiff, Pucite, & Naumann, 2019; Osman, 2010; Oktay & Safak, 2012). Simsekli (2015) states that environmental problems have increased significantly at both regional and global levels in the twenty-first century.

Education is an effort to prepare students for future challenges. It is not only aimed to develop academic performance, but also the overall capacity of students (Mak, 2014), including students' character (Kobylski et al., 2018; Isdaryanti, Sukestiyarno, & Florentinus, 2018; Muliastuti, 2017). Cognitive, affective, and psychomotor potential should be developed equally in an attempt to develop individuals who can exist competitively, taking care of the environmental and social problems, being able to solve the problems of life being faced, and maintaining positive values in life. Therefore, the problem-solving skills and care for the environment are two competencies that should be developed simultaneously in the teaching and learning process.

The results of the study indicate that the students' problem-solving skills in Mataram city are not satisfactory. Karmana (2016) reports that the problem-solving skills of high school students in biology subjects in Mataram City still come under poor and fair categories; no one achieved a good or very good level. Some high school teachers have never measured the problem-solving skills of their students (Gayatri, Jekti, & Wahab Jufri, 2019).

The students' character pertaining to care is also far from expectations. The students take less care of the problem on the cleanliness of the surrounding environment when they are at

school or at home. The students frequently leave rubbish around them. Nevertheless, the results of the studies which apply to a particular teaching and learning strategy or media tend to affect the caring characters of the students. The research conducted by Taufiq, Dewi, & Widiyatmoko (2012) reveals that the students' caring characters get into entrenched criteria when applying media with an environmental caring character emphasis in teaching and learning. Therefore, it is necessary to make a serious effort by creating appropriate teaching and learning strategies for the continuous development of the students' problem-solving skills and the students' care.

Teaching and learning is one of the efforts to develop the students' problem-solving skills and the students' care. Ideally, the teaching and learning ought to be designed to improve the students' academic performance as well as increase the students' caring character. The thing we need to do according to Muliastuti (2017) is to ascertain that the process of cultivating character values keeps going. Teaching and learning models should be enriched with character education. Designing characters in teaching and learning helps schools develop the moral of the students (Dinkha, 2008). Such a thing is important to make sure that teaching and learning is focused on character building, not a mere achievement of academic results (Mirania, Parmin, & Sudarmin, 2017).

Designing and intervening in instruction systematically for creating a learning environment needs to be carried out and its effectiveness needs to be investigated in developing the students' thinking skills (Tiruneh, De Cock, & Elen, 2018; Delaney et al., 2017). According to (Tsai & Chiang, 2013) research for problem based learning that is integrated with other innovative teaching methods is very important. Concerning this study, intervention in teaching and learning refers to the addition of character content to the syntax of problem-based learning which is later known as problem-based learning with character emphasis (PBL-CE). PBL-CE is a kind of problem-based learning strategy designed by sharpening stages of the teaching and learning activities to strengthen the students' character and diversifying the syntax of PBL in terms



of meaning to establish the students' character. Thus, the stages of teaching and learning in problem-based learning with character emphasis are enriched with activities that encourage the students to the practice of forming characters consciously or unconsciously, without ignoring the meaning in the syntax of PBL itself.

As a model of learning, problem-based learning is designed through a procedure that begins with a specific problem (Witte & Rogge, 2016; Sadia, 2014). PBL requires the students to construct knowledge independently or collaborate in groups to find a real solution to a problem. Problem-solving experience provided for students causes student problem-solving skills to increase (Karatas & Baki, 2013). Complex, contextual, and structural problems provide the students with an opportunity to develop their ability to think analytically, evaluatively, and reflectively and develop their creativity in exploring various information, develop various possible solutions, and create various sources to solve the problems faced (Tsai & Chiang, 2013; Çal, Sezgin, & Erol, 2010).

PBL increases the students' self-confidence, creates a supportive environment that leads to teamwork, enhances interpersonal communication and problem-solving skills, and builds self-awareness (Aldarmahi, 2016). According to Aldarmahi (2016), PBL is useful for students in constructing knowledge, developing reasoning processes, improving independent learning skills, and increasing intrinsic learning motivation.

Teaching and learning strategies are one of the external factors which affect the students' problem-solving skills and caring characters. Beside that, there are also internal factors, one of which is naturalist intelligence. Essentially, naturalist intelligence is a part of multiple intelligence possessed by humans. It involves sensitivity to problems or natural phenomena and the ability to distinguish between living and non-living things or beings. According to Roos (2017), students with high naturalist intelligence have a strong affinity for nature. Strong affinity is indicated by the great interest in learning the topics related to nature and its phenomena. This study seeks to

find out the effect of problem-based learning with character emphasis and naturalist intelligence on students' problem-solving skills and the students' care in the subject of biology in Madrasah Aliyah.

Methods

This was an experimental study conducted at Madrasah Aliyah (Islamic Senior High School) in Mataram City using treatment by level 3 x 2 design. Three kinds of treatments were given to both the students with high naturalist intelligence (B1) and the students with low naturalist intelligence (B2) during the teaching and learning, namely the problem-based learning with character emphasis/PBL-CE (A1), the problem-based learning/PBL (A2), and the Regular Learning/RL (A3). The research subjects involved three randomly selected groups from two Madrasah Aliyah in Mataram city, namely Madrasah Aliyah Negeri 2 Mataram and Madrasah Aliyah NW Narmada. The grouping of the students into B1 and B2 was based on the rank of their naturalist intelligence test scores. Group B1 covered 30% of the students achieving high naturalist intelligence test score and group B2 included 30% of the students achieving low naturalist intelligence test scores.

The PBL-CE group was given a teaching and learning treatment using the problem-based learning strategy enriched with the activities for developing care. The PBL group was given teaching and learning treatment using the problem-based learning strategy and following the syntax of a model proposed by Howard S. Barrows & Robyn M. Tamblyn (1980). The RL group was given a teaching and learning treatment in accordance with what the teachers have planned on the material of ecosystem and environmental change.

The initial measurement of the students' problem-solving skills were undertaken before the treatment. Teaching and learning was conducted by some biology teachers ten times in each

Madrasah Aliyah. After the treatment, the final measurement of the students' problem-solving skills and the students' care was made.

The data on the students' naturalist intelligence was collected through multiple choice tests and the data on the students' problem-solving skills were collected through an essay tests (Reliability = 0.95). The data on the students' care were collected through self-assessment (Reliability = 0.81) and observation sheets (Reliability = 0.88).

The data on the students' problem-solving skills and the students' care scores were analysed using descriptive and inferential statistics. While descriptive statistics was used to get a descriptive picture of the level of the students' problem-solving skills and the students' care, inferential statistics MANOVA was used to test the research hypothesis at 5% significance level.

Findings

Problem-solving

The measurement of problem-solving skills was carried out before and after the teaching and learning in the three groups. The data on the pretest and posttest scores of the problem-solving skills are presented in Table 1.

Table 1. Comparison of the Pre-test and Post-test Scores of the Problem-solving Skills in the

		Three Groups					
		Groups					
No.	Descriptors	PBL-CE		PBL		RL	
		(A1)	(A2)	(A2)	(A2)	(A3)	(A3)
		Pre	Post	Pre	Post	Pre	Post
1.	Number of subjects	48	48	46	46	42	42

2.	Ideal Score	Maximum	15	15	15	15	15	15
3.	Highest score		9	15	8	15	8	15
4.	Lowest score		0	4	0	2.23	0	2
5.	Average		3.06	10.77	2.91	10.92	3.3	6.62
6.	Category		Low	High	Very Low	High	Low	Moderate
7.	Standard deviation		2.63	2.23	2.11	2.37	1.71	2.95

PBL-CE : Problem-based learning with character emphasis

PBL : Problem-based learning

RL : Regular learning

Pre : Pre-test

Pos : Post-test

Table 1 shows the problem-solving skill score differences on several statistical parameters. There were differences in the average score and categories of the problem-solving skills in the three groups. The PBL group obtained higher average posttest score of the problem-solving skills than the PBL-CE and RL groups. The data implied that the students' problem-solving skills taught with the problem-based learning with character emphasis were not better than those taught with problem-based learning, but they were better than the regular learning.

The results also indicated that the PBL-CE could encourage many students to get into a very high and high category in comparison to the teaching and learning using the RL, but it was still lower than the PBL group. A comparison of the students' frequency based on the posttest score in each category of the problem-solving skills in the three groups is presented in Figure 1.

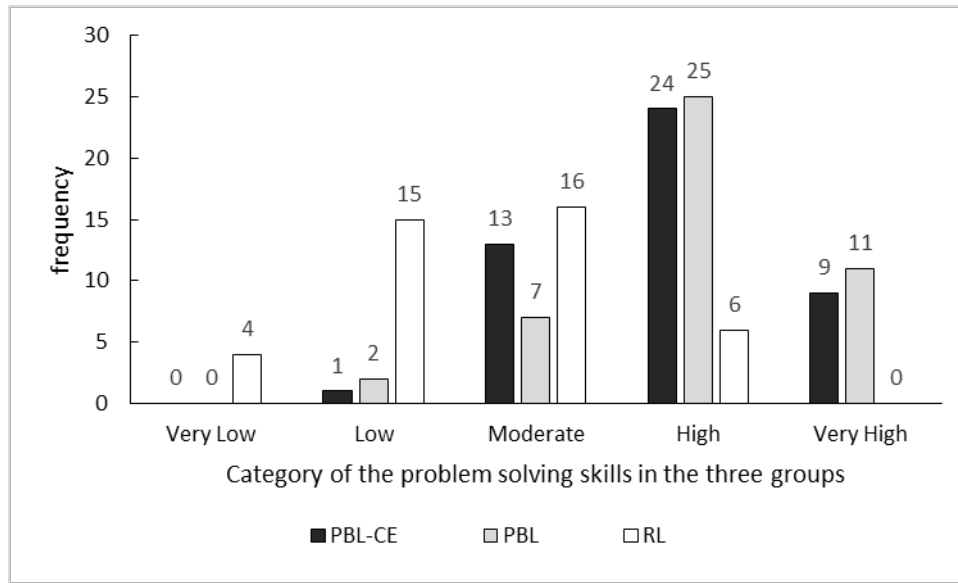


Figure 1. Comparison of the students' frequency based on the posttest score in each category of the problem-solving skills in the three groups

Figure 1 reveals that the students in the PBL group had a greater frequency for a very high and high category than those in the PBL-CE and the PR groups. This means that teaching and learning using PBL-CE has no better effect on the students' problem-solving skills.

The effect of the treatment of problem-based learning with character emphasis and naturalist intelligence on the problem-solving skill variable is seen from normalised gain scores (NGs). The comparison of NGs of the students' problem-solving skills in the three groups is presented in Table 2.

Table 2. Descriptive Statistics of Normalized Gain-scores (NGs) of the Problem-solving Skills of the research Groups

Naturalis				
Group	Intelligence	Mean	Std. Deviation	N
(A1) PBL-CE	(B1) High	.6796	.17787	24
	(B2) Low	.5733	.26578	24
	Total A1	.6265	.23	48
(Category: High)				
(A2) PBM	(B1) High	.7096	.18632	23
	(B2) Low	.6370	.15743	23
	Total A2	.6733	.17446	46
(Category: High)				
(A3) RL	(B1) High	.2695	.18530	21
	(B2) Low	.2548	.30846	21
	Total A3	.2621	.25143	42
(Category: Moderate)				

Table 2 shows the comparison of NGs of problem-solving skills in the three groups. There were average NGs and category differences of the problem-solving skills in the three groups. The average NGs in the PBL-CE group were not higher than the PBL group, but it was higher than the RL group. The PBL-CE and PBL groups have the same category of the problem-solving skills, namely high, but the RL group gets into moderate category. On the basis of the

data above, it was descriptively known that the problem-solving skills of the students taught with PBL-CE were better than the RL group, but they were not better than the PBL group.

Table 2 also reveals the comparison between NGs of the students' problem-solving skills with the students' high (B1) and low (B2) naturalist intelligence in the A1, A2, and A3 groups. The average NGs of the students in A1 group were higher than those in A2 group in the three treatment groups. The results indicated that the students' problem-solving skills with high naturalist intelligence were better than those with low naturalist intelligence. They also indicated that PBL-CE was able to encourage many students to get into a very high and high category in comparison to the teaching and learning using RL. The distribution of the students' abilities in the problem-solving skills aspect based on NGs is presented in Figure 2.

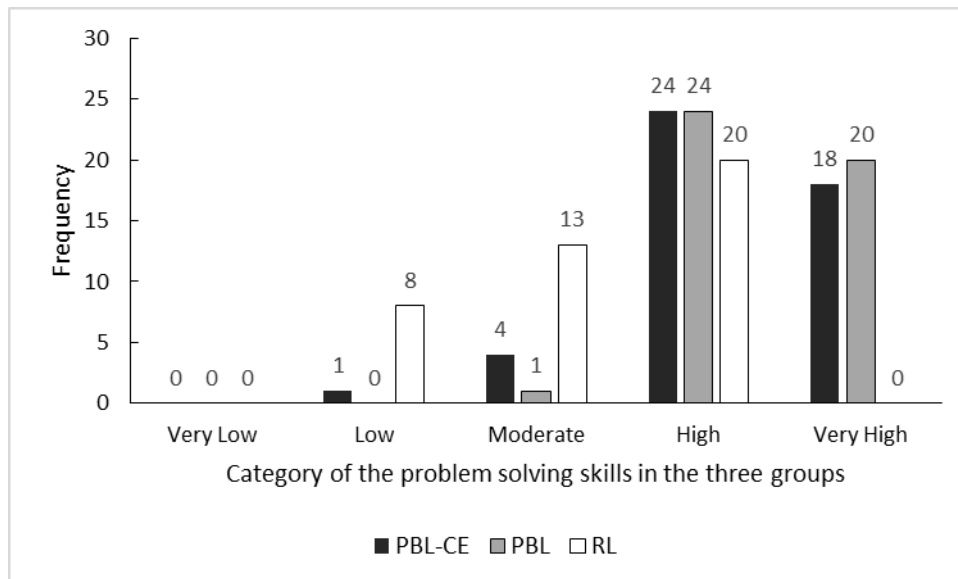


Figure 2. Comparison of the students' frequency based on NGs in each category of the problem-solving skills in the three groups

Figure 2 showed that the students in the PBL group had a greater frequency for the very high and high category than those in the PBL-CE and the PR groups. This implied that the teaching and learning using PBL-CE had no better effect on the students' problem-solving skills.

The Students' Care

Measurement of the students' care was carried out after the treatment had been completed. The results of data analysis on the students' care using descriptive statistics are presented in Table 3.

Table 3. Final Score Data on the Students' Care in the Three Groups

Groups	Naturalist Intelligence	Mean	Std. Deviation	N
(A1) PBL-CE	(B1) High	3.2017	.18518	24
	(B2) Low	3.2029	.27334	24
	Total A1	3.2023	.23241	48
		(Category: Good)		
(A2) PBL	(B1) High	3.1404	.19158	23
	(B2) Low	3.0939	.33660	23
	Total A2	3.1172	.27182	46
		(Category: Good)		
(A3) RL	(B1) High	3.0443	.37062	21
	(B2) Low	3.0024	.25840	21
	Total A3	3.0233	.31626	42
		(Category: Fair)		

Table 3 showed that there were differences in the average scores and categories of the students' care in the three groups. The average score of the students' care in the PBL-CE group was higher than those in the PBL and the RL groups. The PBL-CE and the PBL groups had the same category of care, namely good, but the RL group get into the lower category, namely fair. Based on the data, it can be descriptively stated that the students' care taught with PBL-CE was better than the PBL and RL groups.

Table 3 also shows the comparison of the students' care scores with the students with high (B1) and low (B2) naturalist intelligence in A1, A2, and A3 groups. The average score of the students' care for the A1 group was higher than the A2 group in the three groups. The results indicated that the students' care with high naturalist intelligence were better than those with low naturalist intelligence.

The PBL-CE was able to encourage many students to get into the very good and the good category in comparison to the teaching and learning using the RL. The distribution of the students based on the caring score category is presented in Figure 3.

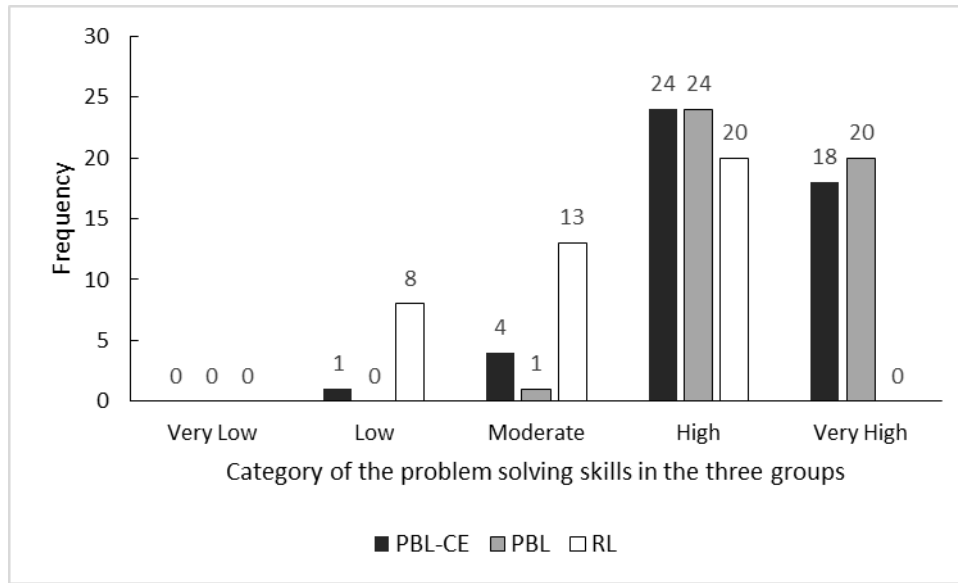


Figure 3. Comparison of the distribution of the students based on the caring score category in the three groups

It was known from Figure 3 that the students in the PBL-CE group had a greater frequency for a good category than those in the PBL and PR groups. This indicated that teaching and learning with PBL-CE had a better effect on the students' care.

Hypothesis testing

Hypothesis testing of the MANOVA using SPSS 16.0 was applied to see the main and simple effect at 5% significance level. The results of the analysis are presented in Table 4.

Table 4. The Results of Multivariate Tests

Effect	F	Sig.
Intercept	8.750	.000
Groups	19.360	.000
Naturalist	1.463	.235
Groups * Naturalist	.514	.726

In Table 4, it can be stated that (1) PBL-CE had a significant effect on the students' problem-solving skills and the students' care, (2) naturalist intelligence had no significant effect on the students' problem-solving skills and the students' care, and (3) the interaction between PBL-CE and naturalist intelligence had no significant effect on the students' problem-solving skills and the students' care.

The next analysis was to determine the effect of the PBL-CE variables and naturalist intelligence on each variable of the problem-solving skills (Y1) and the students' care (Y2). The results of analysis is shown in Table 5.

Table 5. Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum		Mean		
		of Squares	df	Square	F	Sig.
Groups	Problem-solving	4.404	2	2.202	45.795	.000
	Student care	.939	2	.469	6.169	.003
Naturalist	Problem-solving	.141	1	.141	2.936	.089
	Student care	.005	1	.005	.068	.794

Groups *	Problem-solving	.047	2	.024	.494	.611
Naturalist	Student care	.071	2	.036	.467	.628
Error	Problem-solving	6.251	130	.048		
	Student care	9.890	130	.076		
Total	Problem-solving	49.024	136			
	Student care	1340.779	136			
Corrected total	Problem-solving	10.853	135			
	Student care	10.903	135			

Table 5 showed that there were significant differences in the average NGs of problem-solving skills and the students' care scores between the PBL-CE, the PBL, and the RL groups. Thus, teaching and learning using the PBL-CE affected the students' problem-solving skills and the students' care.

The Post Hoc test was conducted to ascertain the group having the best effect toward variables of the students' problem-solving skills and the students' care. The results of the analysis are presented in Table 6.

Table 6. The results of the LSD test

Dependent Variable	(I)	(J)	Mean	Std. Error	Sig.
	Groups	Groups	Difference (I-J)		
Problem-solving skills	1	2	-.0468	.04524	.303
		3	.3643*	.04633	.000
	2	1	.0468	.04524	.303
		3	.4111*	.04680	.000
	3	1	-.3643*	.04633	.000
		2	-.4111*	.04680	.000
Student care	1	2	.1101	.05691	.055
		3	.2040*	.05828	.001
	2	1	-.1101	.05691	.055
		3	.0938	.05887	.113
	3	1	-.2040*	.05828	.001
		2	-.0938	.05887	.113

Groups 1 = PBL-CE, 2 = PBL, 3 = RL

* The mean difference is significant at the .05 level.

Table 6 shows the differences in the average scores of the students' problem-solving skills and the students' care. The students taught with the PBL-CE obtained the problem-solving average score which were not significantly different from the PBL group, but they were significantly different from the RL group. The students taught with the PBL obtained higher problem-solving average scores and it was significantly from the RL group. From Table 6, it can



also be stated that the students taught with the PBL-CE obtained higher care average score and it was not significantly different from the PBL group, but they were significantly different from the RL group. The students taught with the PBL obtained higher care average score and they were not significantly different from the RL group. Thus, the students' problem-solving skills and the students' care taught with problem-based learning with character emphasis were higher and they were significantly different from the regular learning, but they were not significantly different from problem-based learning.

Discussion

This research produced important findings regarding the effect of problem based learning with character characteristics and naturalist intelligence on the students' problem-solving skills and the students' care. The results of the study showed that there was an effect of PBL-CE on the students' problem-solving skills and the students' care. The effect was due to the activities of the problem-based learning with character emphasis in a biology lesson. During the lesson using the problem-based learning with character emphasis, characters were purposely designed through the teacher's action at each stage in the teaching and learning syntax, including caring characteristics. In several stages of the teaching and learning activities, there were always activities for the teacher to generate and strengthen the students' character and remind them to do something related to the certain characteristics such as caring for the environment and society. In the teaching and learning of biology using PBL-CE, the students were faced with authentic problems on the environment surrounding them. The students get used to thinking for problem-solving when they are confronted with the ones which they often witness every day. The environmental problems the students dealt with were in the form of images and news of electronic media. The images and information from media are very appropriate for students to develop their thinking skills (Sutarto, Indrawati, J., & Prihatin, 2018; Castro & Morales, 2017).

When PBL-CE was carried out, the students were encouraged to be sensitive and cared about the problems which existed in their environment by learning the problems given.

The results of the study also showed that there was no effect of naturalist intelligence and the interaction between PBL-CE and naturalist intelligence on the students' problem-solving skills and the students' care. The PBL-CE seemed not to have a significant effect of activating the students' problem-solving skills and the students' care as it was paired with the students' naturalist intelligence. The PBL-CE and PBL did not only support the problem-solving skills and care of the students with high naturalist intelligence, but also those with low naturalist intelligence. This condition was affected by PBL-CE and PBL which required both individuals and groups to participate actively in the activity of problem analysis, convey ideas, find the right information for solving the problem, build hypothesis, think about how the problem-solving works and set up logic about the relationship between one fact with another. The students with high and low naturalist intelligence can respond well to the learning activities carried out using PBL-CE, PBL, and RL. According to Witte & Rogge (2016), the students in the PBL is sometimes not better than those in the traditional class in terms of knowledge acquisition or problem-solving skills.

The teaching and learning process using PBL-CE gives the students a challenge in order for them to interact and solve the environmental problems given. Problems can be used as a starting points for learning (Leite & Dourado, 2013). The completion of a problem requires analytical thinking skills, analysis of possible solutions, evaluation of the problems and available solutions, and the ability to design something as problem-solving alternatives. These abilities need to be continually strengthened in the teaching and learning using PBL-CE, although the students taking part have high or low naturalist intelligence. It is different from the teaching and learning process using regular learning which tends to place the students as the learning object. This has caused a decline in the ability of the students to analyse, evaluate, and create, and weaken the



students' character in teaching and learning. According to Aldarmahi (2016), in the PBL, the students are capable of integrating basic science with life problems in comparison to those in the conventional system.

The post hoc test showed that the problem-solving average score of the students taught with PBL-CE obtained was not significantly different from the PBL group, but it was significantly different from the RL group. The students taught with PBL obtained higher average scores of problem-solving and it was significantly different from the RL group. This condition is much more affected by the same problem-solving activities carried out in the PBL-CE and the PBL groups. Both groups employed a problem-based learning procedure. Viewing from the additional activities carried out by the teacher as the requirement needed for the PBL-CE, there were no specific activities of the teachers and students to strengthen problem-solving skills. All the students in the two PBL-CE groups and the PBL group applied the problem-solving procedures as in the problem-based learning syntax. The problems confronted to the students through worksheets also showed no differences in the two groups. The students in the regular learning decelerate in the problem-solving abilities. According to Dostál (2015), the students need different periods of time to solve the problems. The students' problem-solving skills are indicated by their ability to identify problems, define and represent the problems, formulate the problem being studied, find possible strategies for solving the problem, act on the problem being solved, and review and evaluate the effects of problem-solving activities (Aka, Guven, & Aydogdu, 2010). As a result, the average score of the students' the problem-solving skills obtained by the PBL-CE group is the same as those in the PBL group.

The post hoc test also revealed that the students taught with the PBL-CE obtained higher average scores of care and they were significantly different from the PBL group, and the RL group. The students taught with PBL obtained a higher average score of care and it was not significantly different from the RL group. The teachers' activities in the implementation of the



problem-based learning with character emphasis in the teaching and learning remind the students of the importance of environmental and social care, guiding the students to work in groups and at the same time reminding and training them for religious character, honesty, discipline, democracy, curiosity, caring, and responsibility, guiding the students to express gratitude to God for completing the group work, and reminding and training the students to respect other opinions, listening to others, not dominating the conversation, communicating politely, and respecting differences of opinion, and doing reflection on the process of group work, what is gained, activeness of the members of the group, cooperation, communication politeness, and tolerance. Those sets of the teacher's activities were not the ones which affect directly the skills of the students in solving the problems.

PBL also contains basic activities that encourage the establishment of the students' caring character. The same results in the research conducted by Sadia et al., 2013 indicated that active teaching and learning models, one of which is problem-based learning, provide the students with the opportunities to grow and build positive characters such as honesty, responsibility, discipline, self-confidence, logical, critical, and creative thinking, independence, caring for social and environment, respect for themselves and others, willingness to work hard, cooperation, respecting diversity, openness, empathy, and building a tolerant attitude. The caring characteristics established in regular learning are few and it appeared to be an accidental effect.

Conclusion

Problem-based learning with character emphasis has a significant effect on the students' problem-solving skills and the students' care. Naturalist intelligence does not have a significant effect on problem-solving skills and the students' care. Problem-based learning with character emphasis and naturalist intelligence do not affect the students' problem-solving skills and the students' care. The interaction between problem-based learning with character emphasis and



naturalist intelligence does not affect the students' problem-solving skills and the students' care. The students taught with the problem-based learning with character emphasis obtain the problem-solving average score that is not significantly different from the problem-based learning group, but it is significantly different from the regular learning group. The students taught with problem-based learning obtain higher problem-solving average scores and they were significantly different from the regular learning group. The students with high and low naturalist intelligence give the same response to problem-based learning character-based learning, problem-based learning, and regular learning.

The students taught with the problem-based learning with character emphasis gain a higher average score of care and they are not significantly different from the problem-based learning group, but they were significantly different from the regular learning group. The students taught with problem-based learning gain a higher average score of care and they were not significantly different from the regular learning group. Thus, the students' problem-solving skills and the students' care taught with problem-based learning with character emphasis are higher and they are significantly different than the regular learning, but they are not significantly different from the problem-based learning.

Suggestions

The addition of character content to the problem-based learning syntax does not impede the teaching and learning process, yet it strengthens the teaching and learning for encouraging the better achievement of the students' problem-solving skills. The teacher's understanding of the essence of the problem-solving skills which includes concepts, dimensions, course planning, assessment, and patterns of character integration in the course of planning should be fulfilled. This understanding is considered important for the teachers since it serves as the tool to design course planning that can be used in the teaching and learning process.



When character content is attached to problem-based learning, the students' care is better than those taught using problem-based learning without character content. The findings in this study imply that the strengthening of the students' character should be intentionally performed by the teacher in teaching and learning through course planning. Character content in the course planning should be explicitly stated in the teaching and learning steps to encourage the students in expressing their character during the teaching and learning.

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