Problem-based learning model with a scientific approach to improve higher order thinking skills

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Abstract: This research aims to obtain a learning model that can improve higher order thinking skills in financial reporting of accounting. The model was developed using four stages of research and development (R&D): 1) preliminary research; 2) development; 3) testing for limited scale; 4) testing for wide-scale. The population of this research is the Accounting Vocational School in Madiun. For limited scale test, it was concluded that there were significant differences in HOTS and learning achievement scores before and after implementation of the model (sig. < 0.05), but Ngain for HOTS and learning achievement 0.110 (low) and 0.08 (stable). For test wide-scale class, it was concluded that there were significant differences in HOTS and learning achievement in experiment class (sig. < 0.05), with Ngain for HOTS and learning achievement 0.183 (low) and 0.30 (medium) for SMKN 2 Jiwan and 0.11 (low) and 0.105 (low) for SMK 5 Madiun.

Keywords: problem-based learning; PBL; scientific approach; higher order thinking skills; HOTS.

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1 Introduction

Vocational high school (VHS)/SMK is also an investment to improve the quality of human resources, which is the main requirement to increase the rate of economic growth, equal opportunity, and for social change. However, vocational school is considered not able to carry out its role optimally. This is reflected in the lack of trust level of the owners of the business world and the industrial world to the competencies of VHS students.

Based on BPS data in February 2017 the level of employment is still dominated by graduates with lower education or lower junior high schools, namely 75.21 million people or 60.39%, while high school graduates equivalent to VHS are 34.06 million people or less than half of them have low education. Data from the same source shows that the highest open unemployment rate is vocational school graduates, namely 9.27%, 7.03% senior high school and 6.35% diploma. It is very ironic that vocational schools which are expected to produce graduates who are ready to work are actually contributors high unemployment. To overcome this problem, the government has adopted a policy through Presidential Instruction No. 9 of 2016 concerning revitalisation of vocational schools in order to improve the quality and competitiveness of Indonesian human resources involving 11 ministries/institutions. Especially for the Ministry of Education and Culture there are six tasks, namely:

1 creating a roadmap for developing the vocational school
2 perfecting and harmonising the VHS curriculum with competencies according to the needs of graduate users (link and match)
3 increasing the number and competence of educators and vocational education staff
4 enhance cooperation with ministries/institutions, regional governments, and the business/industrial world
5 improve access to vocational school certification and vocational accreditation
6 establish a vocational development working group.

In the 4th Generation of Industry, the need for human resources who have analytical and evaluation capabilities to produce creative products is needed. For this reason, VHS must prepare their graduates to meet current and future needs. One of the skills needed is higher order thinking skills (HOTS). HOTS are students' skills in evaluating ideas and

choices for decision making (Apino and Retnawati, 2017). Aspects of HOTS related to the process of analysing, evaluating, and making arguments (Prayitno et al., 2018). HOTS are abilities related to the activities of analysing, evaluating, and creating (Pratama and Retnawati, 2018; Saido et al., 2015; Soeharto and Rosmaiyadi, 2018; Yen and Halili, 2015). It can be concluded HOTS are skills to do higher-order thinking in order to have cognitive knowledge in the dimensions of analysis, evaluation, and creation.

Based on the results of the tests conducted by the teacher, the learning achievement was still not maximal. Repeat values from 32 students showed that for the knowledge aspect the highest score was 95, the lowest score was 45 with an average of 73.34 and those who had not achieved completeness as many as 8 students. Repeat values for aspects of skills also show that they are not maximal, which is indicated by the highest score of 100, the lowest value of 25, the average value of 71.5, and those that have not reached the completeness of nine students. Learning in VHSs is still oriented towards lower order thinking (LOT) and not oriented to market needs. Learning tends to be monotonous and does not stimulate students to create products. A learning model is needed that can stimulate students to improve HOTS. Creativity competence (21 first century skill) can emerge if students already have analytical, evaluation, and creative abilities. Competence has a broader scope, by considering aspects of cognitive, functional and interpersonal skills, and ethics. This is then called the 21st century skills needed to deal with complex environmental changes, and the skills used in everyday life (Acedo and Hughes, 2014).

On learning process, improving HOTS of the students is done through the application of appropriate learning models. Some researchers have applied models, methods, and strategies to improve HOTS: Vijayaratnam (2012, p.16) show that problem-based learning (PBL) through learning activities by giving real problems and problem solving steps can build students' ability to conduct research, share insights with group members, conduct real trials, and apply them directly in HOTS that has been unconsciously built by students. The results of the supporting study Ganiron (2014, p.223) also show that:

1 learning that promotes HOTS can improve student learning achievement in project management courses
2 PBL results in an increase in the ability of students to understand concepts, ability to solve problems and the ability to manage cases
3 learning achievement achieved by the trial class are much higher than the control class because students learn based on the problem scenario presented, connect them with real problems, investigate and achieve learning goals through HOTS
4 the existence of learning that builds HOTS of the students can better understand the learning objectives so that they can improve learning achievement.

PBL so far has not been widely used for learning in high school/vocational school and is more widely used for learning in higher education. This is indicated by studies conducted previously by Aktamis and Ergin (2008), Aka et al. (2010), Buang et al. (2010), Celik et al. (2011), Bayat and Tarmizi (2012), Erdogan and Senemoglu (2013), Ganiron (2014). Based on several explanations of learning theory, relevant research results, and taking into account the condition of the research object (vocational school in the City of

Madiun/SMK Madiun), it is necessary to develop a PBL model with a scientific approach to improve HOTS. PBL model with a scientific approach the combination of PBL models with scientific approaches strengthens the 'investigation' syntax in efforts to improve HOTS. Previous research separates the use of the scientific approach with PBL (Hidayati and Retnawati, 2018) which concludes that both can increase HOTS, while (Tambunan, 2019) provides different conclusions, where PBL is more effective than a scientific approach. Vocational students must observation literature and report from any source. Vocational students must observe literature and reports from any source. In the analysis and evaluation step, they analyse all sources from books, journals, reports and any source before communicating their own reports. Investigation, analysis and syntax evaluation are rarely carried out in vocational classes.

2 Method

The research used research and development method which refers to the stages or steps of developing by Borg and Gall (1983, p.775). The stages of development are simplified into four:

1 preliminary research

2 development research

3 testing for limited scale class

4 testing for wide-scale class.

Not all steps in developing Borg and Gall (1983, p.775) are described in this article. The population of this research is the Accounting Vocational School (SMK) in Madiun. The sample of this research are 26 students of SMKN 1 Geger class XI Ak1 for limited scale class which used single pre-post-test Knapp (2016, p.468) and for wide-scale consist of 65 students of SMKN 2 Jiwan and 48 students of SMK 5 Madiun which used single and control group pre-post-test [Sukmadinata, (2013), p.209]. Models and instruments were validated by experts using content validation index (CVI) analysis [Lawshe, (1975), pp.567–568].

3 Results and discussion

The results of this research are presented in four stages results and discussion of:

1 preliminary research

2 development research

3 testing for limited scale class

4 testing for limited scale class.

The results and discussion of each stage are described in the following sections.

3.1 Preliminary research

The findings obtained from the results of class observations are:

1 the students' active involvement in learning has not been optimal

2 the teacher still dominates the learning process strongly

3 there is no discussion among students

4 learners are more dominant and listening to the teacher's explanation and working on the problem training given by the teacher.

The teacher is still dominant using the lecture method, which is 12 people or 60%, three people or 15% use the lecture method varies, and five people or 25% who have used PBL. This indicates that teachers still tend to use conventional learning models. Teachers still do not practice high-level thinking skills (HOTs), which is as much as 60% or 12 people and 40% or eight people who have trained high-level thinking skills. This shows that so far the teacher still tends to teach students to low-level thinking skills. However, as many as 100% or 20 teachers stated that they experienced problems in training high-level thinking skills. These constraints that stated influence on student learning achievement as much as 85% or 17 people and which states no effect as much as 15% or three people. Teachers who apply the scientific approach are 75% or 15 people and only 25% or five people have not applied the scientific approach. But of the 20 respondents as many as 60% of teachers still experienced problems in applying the scientific approach while 40% or eight teachers stated there were no obstacles. Although the presentation uses a high scientific approach, it is only concentrated on solving problems.

Based on the results of observations it can be concluded that:

1 the students' active involvement in learning has not been optimal

2 the teacher still dominates the learning process

3 there is no discussion among students

4 more dominant students record and listen to explanations teacher and do the problem training given by the teacher.

The questionnaire observation results are synergistic with the results of questionnaires that provide information:

1 the dominant teacher uses the lecture model

2 the teacher has not trained HOTS in learning

3 the scientific approach that has been applied by the teacher is only oriented towards problem solving.

3.2 Development research

After expert validation and improvement [with CVI = 1 (very relevant)], FGD was returned to the model and recommendations were obtained to simplify the syntax model. Changes in the design and syntax of the model after improving the results of expert validation and FGD are as follows: syntax of the PBL model with the scientific approach

(PBLS) with the steps of orientation, organisation, investigation, resolving problems, analysis and evaluation, communicating. The PBLS syntax from the literature review analysis is described in Table 1.

Table 1 Syntax of PBLS

Model of learning syntax		
PBLS	*PBL*	*Scientific approach*
Orient the students to problems (orientation)	Orient the students to problems	Asking question
Organising students to learn (organisation)	Organising students to learn	Test the question
Investigating through observing and asking questions (investigation)	Assist independent and group investigations	Make a hypothesis
Solve the problem	Helps compile and present artefacts and exhibitions	Carry out research or experiments
Analysis and evaluation	Analyse and evaluate the problem solving process	Analyse data and make conclusions
Report or communicate		Create and communicate reports

The detailed description of the PBLS syntax is presented in Table 2.

Table 2 Design of PBLS syntax

Syntax	*Activities*
Orientation (orienting students to problems)	The students pay attention to the explanation of learning objectives, material, prepares the equipment needed, describe the final results to be achieved in learning.
Organisation (organising learners for learning)	The students form groups and pay attention to the explanation of the learning steps that must be done by students.
Investigation (investigating through observation and questioning)	The students develop work steps or procedures that will be carried out, make observations and examine the material given by the teacher and ask questions about things that have not been understood.
Solve the problem	The students perform problem solving, namely preparing financial statements that are correct in accordance with the principles of preparing financial statements of service companies. The teacher's activities at this stage are observing and evaluating the process and providing guidance to students who are experiencing difficulties. At this stage students can hold small discussions with other students.
Analysis and evaluation	The students conduct analysis and evaluation of the impacts that occur on each account in the financial statements. The activity of analysing and evaluating is done so that students are more careful in drawing conclusions and making interpretations of the financial statements prepared.
Report (communicate the results of analysis and evaluation)	Students report the results of work by presenting to other students. Students who present the results are chosen randomly while others respond or give suggestions.

3.3 Testing for limited scale class

The testing for limited scale class was carried out in one school involving teachers and students. At this trial stage teachers and students jointly conduct a test of the draft of the product produced, which is then observed through discussion activities to get input. The limited scale class is carried out at the SMKN 1 Geger for two weeks. The PBLS models were implemented in 26 students of class XI Ak1 in experiment class. Which the statistical Hypothesis Ho_1: there is no difference in the application of PBLS and classical models to learning achievement, and Ho_2: there is no difference in the application of PBLS and classical models to HOTS. The results of the t test can be seen in Table 3.

Based on the results of the t test in Table 3, it can be seen that the value of sig. < 0.05, so Ho_1 and Ho_2 rejected. It can be concluded that the use of the PBLS model before and after treatment gives a significant difference for student learning achievement and HOTS. Based on the N-gain score, it was concluded that HOTS average score had an increase in the low category and learning achievement tended to be stable. This result is due to the implementation of the orientation process model dominated by lecture activities so that interactions between students, student interactions with teaching resources, student interaction with teachers have not been implemented.

3.4 Testing for wide-scale class

Testing for limited scale class was done at SMKN 2 Jiwan (consists of control classes 32 students, an experimental class of 33) and SMKN 5 Madiun (consist of 24 control class students 24 experimental class students). The research was conducted for two weeks. Which the statistical Hypothesis Ho_1: there is no difference in application of classical models to learning achievement in the control class, Ho_2: there is no difference in application of classical models to HOTS in control class, Ho_3: there is no difference in application of classical models to learning achievement in the experiment class, Ho_4: there is no difference in application of classical models to HOTS in experiment class. The result of the t test with SPSS can be seen in Tables 4 and 5.

Based on the results of the t test (Table 4) it can be seen that sig. < 0.05 for HOTS and learning achievement in the experimental class. It can be concluded that Ho_3, and Ho_4, are rejected so that it can be concluded that:

1 There are differences in learning achievement in the experimental class pre and post-test. The average value of post-test learning achievement is greater than the pre-test.

2 There are differences in HOTS values in the experimental class pre and post-test. The value of HOTS post-test is greater than the pre-test.

Based on observers' observations, students are motivated to learn and discuss when PBLS models are applied. The implementation of learning still has passive students so that the teacher motivates students by giving explanations.

Table 3 Testing for limited scale class results

		Paired differences					*t*	*df*	*Sig. (two-tailed)*
		Mean	*Std. deviation*	*Std. error mean*	*95% confidence interval of the difference*				
					Lower	*Upper*			
Pair 1	LA_pre-post	–4.038	7.074	1.387	–6.896	–1.181	–2.911	25	.007
Pair 2	HOTS_pre-HOTS_post	–2.577	4.272	.838	–4.303	–.851	–3.075	25	.005

Note: LA = learning achievement.

Table 4 Test results t test with SPSS SMKN 2 Jiwan Madiun

		Paired differences							
					95% confidence interval of the difference				
		Mean	*Std. deviation*	*Std. error mean*	*Lower*	*Upper*	*t*	*df*	*Sig. (two-tailed)*
Pair 1	LA_pre-post Control class	–.938	2.675	.473	–1.902	.027	–1.982	31	.056
Pair 2	HOTS_pre-post Control class	–.219	3.290	.582	–1.405	.967	–.376	31	.709
Pair 3	LA_pre-post Experiment class	–10.303	5.987	1.042	–12.426	–8.180	–9.886	32	.000
Pair 4	HOTS_pre-post Experiment class	–5.091	5.276	.918	–6.962	–3.220	–5.543	32	.000

Note: LA = learning achievement.

Table 5 Test results t test with SPSS at SMKN 5 Madiun

		Paired differences					*T*	*df*	*Sig. (two-tailed)*
		Mean	*Std. deviation*	*Std. error mean*	*95% confidence interval of the difference*				
					Lower	*Upper*			
Pair 1	LA_pre-post Control class	–1.250	3.378	.690	–2.677	.177	–1.813	23	.083
Pair 2	HOTS_ pre-post Control class	–1.000	3.388	.692	–2.431	.431	–1.446	23	.162
Pair 3	LA_pre-post Experiment class	–4.375	4.959	1.012	–6.469	–2.281	–4.322	23	.000
Pair 4	HOTS_ pre-post Experiment class	–2.667	4.923	1.005	–4.745	–.588	–2.654	23	.014

Note: LA = learning achievement.

Based on the results of the t test (Table 5) it can be seen that sig. < from 0.05 for learning achievement and HOTS in the experimental class. It can be concluded that Ho_3, and Ho_4, are rejected so that it can be concluded that:

1 There are differences in learning achievement in the experimental class pre and post-test. The average value of post-test learning achievement is greater than the pre-test.

2 There are differences in HOTS values in the experimental class pre and post-test. The value of HOTS post-test is greater than the pre-test.

The results of the observer's assessment of the application of the PBLS model gave an average score of 3.55 and the responses of the students gave an average score of 3.39. Students are motivated to learn and discuss when applied to the PBLS model. At the implementation stage the model of students emerges serious discussions in groups to solve problems in preparing financial statements. Based on the results of trials in two schools (SMK 2 Jiwan Madiun and SMK 5 Madiun) it can be concluded that the PBLS model has a significant effect on increasing HOTS and learning achievement in Jiwan 2 Jiwan and SMK 5 Madiun.

For limited scale test, It was concluded that there were significant differences in HOTS and learning achievement scores before and after implementation of the model (sig. < 0.05), but Ngain for HOTS and learning achievement 0.110 (low) and 0.08 (stable). For test wide-scale class, It was concluded that there were significant differences in HOTS and learning achievement in experiment class (sig. < 0.05), with Ngain for HOTS and learning achievement 0.183 (low) and 0.30 (medium) for SMKN 2 Jiwan and 0.11 (low) and 0.105 (low) for SMK 5 Madiun. HOTS and learning achievement score increase at wide-scale class. The results of the response of users and students showed an assessment in the good category.

Based on these results it can be concluded that the PBLS model has a significant effect on improving learning achievement and HOTS. The results of the observer's assessment of the application of the PBLS model gave an average score of 3.5 with categories (accordingly) and the response of students to the application of the PBLS model gave an average score of 3.43 with the appropriate category. The results of the literature review (Kingston, 2018) revealed that from the 20 studies of research literature reviewed, it shows that PBL may be more effective than traditional teaching in social studies, science, mathematics, and literacy. The results of the literature review (Kingston, 2018) revealed that from the 20 studies of research literature reviewed, it shows that PBL may be more effective than traditional teaching in social studies, science, mathematics, and literacy. The results of this literature study are also supported by research (Narmaditya et al., 2017; Suryanti, 2017). PBLS is the result of the development of the PBL model, so it also supports the improvement of learning outcomes such as the description of research results that have been described.

Other research also revealed that PBL also increased HOTS (Jailani et al., 2017; Noma and Prayitno, 2016; Riadi, 2016; Untari et al., 2018). All of this research was developed by science and mathematics education researchers. PBL research in the department of accounting education has not yet led to HOTS (Narmaditya et al., 2017; Suryanti, 2017). A scientific approach needs to be combined to improve HOTS.

Previous research separates the use of the scientific approach with PBL (Hidayati and Retnawati, 2018) which concludes that both can increase HOTS, while (Tambunan,

2019) provides different conclusions, where PBL is more effective than a scientific approach. These two results seem contradictory, but in mathematics learning (Tambunan, 2019) the use of PBL is more effective because the treatment in mathematics learning is more focused on problem solving exercises rather than verifying phenomena such as science learning. PBLS in this research is a combination of PBL and scientific approach and it was found that the PBLS model is able to increase HOTS. The scientific approach is needed in learning in the vocational classroom because so far education in the field is directed at procedural completion without the opportunity to open students' creative ideas and innovations in solving problems demanded for competence in the 4th Generation of Industry Revolution. The combination of PBL models and new scientific approaches in this research has an impact on improving learning outcomes and HOTS. The research from (Widiawati and Joyoatmojo, 2018) has combined PBL and scientific approach, but it does not produce new syntax and does not explain the scientific subject. Kim (2011) also modify PBL by integrating the web-based practice system to systematise the implementation of PBL syntax, but it has not yet reached the syntax of measuring its impact on learning outcomes and HOTS.

4 Conclusions

Based on these results it can be concluded that the PBLS model has a significant effect on improving learning achievement and HOTS. For limited scale test, It was concluded that there were significant differences in HOTS and learning achievement scores before and after implementation of the model (sig. < 0.05), but Ngain for HOTS and learning achievement 0.110 (low) and 0.08 (stable). For test wide-scale class, It was concluded that there were significant differences in HOTS and learning achievement in experiment class (sig. < 0.05), with Ngain for HOTS and learning achievement 0.183 (low) and 0.30 (medium) for SMKN 2 Jiwan and 0.11 (low) and 0.105 (low) for SMK 5 Madiun. HOTS and learning achievement score increase at wide-scale class. The results of the response of users and students showed an assessment in the good category.

This development research has produced a prototype model which is a combination of PBL models and scientific approaches. The weaknesses that arise in applying the PBL model can be reduced by applying the PBLS model. The orientation is carried out by:

1 instructing students to search literature for financial report forms and definitions

2 paying attention to explanations about learning objectives, materials, preparing needed equipment, describing the final results to be achieved in learning.

This step is able to streamline the learning process. The investigative syntax that is the result of collaboration from the scientific approach requires students to develop scientific work procedures or steps that will be carried out through observation and review of material and literature. Investigative activities are very helpful for students in training high-level thinking skills. In addition to orientation and investigation syntax, the syntax of communicating can also help students to increase self-confidence and express the results of studies in writing and verbally. Between students the process of analysis and evaluation occurs so that new information/knowledge is more meaningful. The results of the application of the PBLS model in the limited class provide information that the model can significantly improve learning achievement and HOTS. In the wide-scale class also

results that the PBLS model has a significant effect on improving learning achievement and HOTS.

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