Collaborative Problem Solving Based Learning A Literature Review In Selected Journals

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Abstract. The curriculum continues to develop along with the times. The rapid development of technology requires curriculum adjustments. The domain of knowledge is no longer the only core domain of the curriculum. The domains of skills, character, and meta learning play a role in successful learning. A learning model is needed that is able to activate the four curriculum components. One of them is a collaborative problem solving based learning model. How is this model implemented in science learning? Through this re search, the researcher tries to explore the related research results that have been reported in 5 selected journals.

Key words: problem-solving based learning; collaborative problem solving; literature review; science learning.

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INTRODUCTION

The world is changing very fast. We face a condition called VUCA (volatility, uncertainty, complexity, and ambiguity) (Cook, 2019). In this condition, any problems that arise often require interdisciplinary solutions. Various information is easy to obtain, but it is difficult to judge which information is useful for solving problems. The problems that must be solved are no longer simple problems (well-defined problems), but are classified as ill-defined problems and even wicked problems. Of course education must be directed to prepare students to face these conditions.

The educational curriculum has been adjusted. The knowledge domain is no longer the only core component of the curriculum. The domain of skills, character and meta learning are 4 important components in the modern curriculum. The inclusion of aspects of skills and character in a balanced proportion in the curriculum must inevitably change learning activities in the classroom. Learning can not only rely on the transfer of knowledge, considering that there is so much new knowledge that must be taught. Selection of essential content is still necessary, but directed at meta learning, namely learning in order to synthesize new knowledge (Learn how to learn).

The involvement of the aspects of skills and character encourages more meaningful learning. Four aspects need to be strengthened in learning activities, namely critical thinking, collaborative, communicative and creative thinking (critical thinking, collaborative, communicative and creative), which are emphasized to improve the quality of learning in the classroom.

One of the learning models that can be chosen to lead to learning activities according to the demands of the model is collaborative problem solving (ColPS). This learning model is a combination of problem-solving learning and collaborative learning. Referring to the OECD document, problem solving is a skill related to individual mentality involving 3 domains of knowledge on essential topics (content knowledge), understanding of how to do (procedural knowledge) and understanding why it should be done (epistemic knowledge). Meanwhile, collaborative skills refer to social competencies related to the ability to explore and understand a problem from various scientific perspectives to become a common understanding, represent and formulate for collaborative work, compile and implement collaborative work plans and carry out monitoring and reflection on the implementation of collaborative work.

Through ColPS, essential knowledge aspects must be emphasized in problem solving. Through interactions with both the physical and social environment, six essential traits are strengthened (attention, curiosity, courage, resilience, ethics and leadership). The problem to be revealed in this research is how is problem solving learning implemented in the classroom? And how are science teachers prepared for collaborative learning?

METHODS

Quantitative Analysis

The research was conducted through a review of research results published in 4 journals, namely the International Journal of Science Education (IJSE), Professional Development in Education (PDE), Technology, Pedagogy and Education (TPE), Teachers and Teaching (TaT), and Applied Measurement in Education. AME). The selection of journals is based on 4 things, namely how to learn collaborative solving in the field of science, how to prepare teachers and prospective teachers for ColPS, how to apply learning technology in collaborative learning and how to assess ColPS?

The sampling of articles is limited to the span of 2014 to 2020. The keyword used is ”collaborative problem solving” OR (”collaborative” AND ”problem solving”) using a search engine from Taylor & Francis Online. The flow of the article sampling is presented in Figure 1.

Based on Figure 1, it can be seen that IJSE contributed the most articles, followed by PDE. This is reasonable considering the number of articles per year IJSE is the largest. However, when viewed based on the ratio to the overall article, TPE is the highest journal (30.35%) followed by PDE (19.53%). However, the resulting level of relevance is not necessarily appropriate.

Content analysis is needed to get a further picture. By using the Latent Dirichlet Allocation (LDA) method, we try to map the grouping of articles obtained. LDA is sufficient to be used in mapping research article topics (Han, 2020). Articles are selected based on the frequency of occurrence of the words ``collaborative”, ”problem” and ”solving” with the threshold for word occurrence being 10. If the three words never appear as a whole phrase, the article is not further analyzed Figure 2.

Qualitative Analysis

For qualitative analysis, two types of coding were used. Descriptive coding is done by selecting sections of the article that contain meaningful phrases for collaborative problem solving to be described. The next step is thematic coding, which is to label the part that has been described into several criteria, namely: Skills, knowledge, meta learning character, collaborative, problem solving and collaborative problem solving.

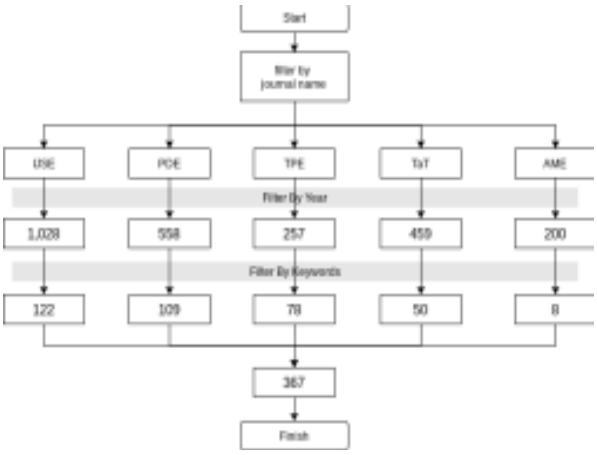

Figure 1. Sampling technique

Figure 2. Reduction technique

RESULTS AND DISCUSSION

Quantitative analysis

By using the generator library, the topic grouping analysis is carried out using the LDA algorithm with a limitation of 5 topics according to the specified journal. The five topics are presented in Figure 3. This analysis is based on

Figure 3. topic grouping

Table 1. Analyze topics based on keywords

Topic Number	Keywords: Most dominant	Contribution(%)	Interpretation
1	teacher, Student, believe, learn, technology, education, teach	8.0	application of educational technology
2	learn, education, technology, student,teacher, school, research	16.1	research in education technology
3	learn, student, design, education, group, study, task	9.9	group assignment design
4	science, student, education, learn, research, study, group	26.6	group learning research in science
5	teacher, learn, professional, school, development, education, teach	39.5	teacher professional development

the key words that appear in the entire article. Through LDA analysis, we can get an overview of topic groupings to make it easier to understand what is the hot issue of the entire article. Thus the analysis can be focused on issues that are relevant to themes related to collaborative solutions.

Based on this analysis, it can be detailed what was discussed on each topic (Table 1). The most dominant topic is topic 5. The most prominent keyword is topic 5 with the keywords: Teacher, learn, professional, school, development, education, teach. Based on these keywords, we can see that teacher professional development is the most prominent topic of the entire article. Thus it can be said that the role of teachers in the 21st century will be increasingly important. The role of the teacher is very important in determining the success of learning in the classroom (Kim, 2018) through the presentation of problems through knowledge deconstruction (Short-Meyerson et al., 2019; Lin, Hou, and Chang, 2020), intervention in learning (Hofmann and Mercer, 2016) and how teachers do evaluation (Care, Scoular, and Griffin, 2016). Harjito Kusmanto et al. *3.1.1 Word Frequency Analysis*

By using the calculation of the occurrence of keywords with a minimum threshold of 10 appearances, of the 367 sample articles, there are 26 articles that meet the criteria. Further analysis is carried out to reduce articles that never mention the keyword collaborative problem solving as one or are discussed in a context of terms explicitly in the body of the article. The result is 9 articles are reduced. Furthermore, 17 articles that met the criteria were coded by marking paragraphs containing keywords reftbl:1. Narrowing down the theme is very important considering the relevance of search results articles on search engines are often only relevant for the top 10 results (Han, 2020).

Qualitative Analysis

1. Knowledge Domain

Even though the portion is reduced, the knowledge aspect is still seen as important (Ercikan and Oliveri, 2016). No matter how great an interdisciplinary ability is, it still requires disciplinary knowledge as initial knowledge. It is impossible to solve science-related problems without being based on certain scientific understanding (Care, Scoular, and Griffin, 2016). This knowledge is needed to isolate a complex problem so that it can be solved with disciplinary knowledge. Without involving disciplinary knowledge, problem solving becomes less meaningful.

2. Skill Domain

Regarding the skills aspect, there are 3

different qibla, namely according to the USA, European Union and OECD governments. However, researchers agree that a conceptualization of 21st Century skills is needed so that it can be used for assignment development and assessment (Care, Scoular, and Griffin, 2016). The OECD approach is widely referred to because it has a standard that is found in everything systematic and includes all 21st century skills including cognitive skills, intrapersonal skills, interpersonal skills, and technical skills (Geisinger, 2016).

3. Character Domain

Of all the articles reviewed, only (Kim, 2018) specifically researched character development. One important part of character education is teaching students to find their identity through negotiation when interactions occur in the classroom. The ability to regulate emotions is part of self-control (Lamminp¨a¨a and Vesterinen, 2018). In this case the teacher must respect students as a researcher. Provide opportunities for students to negotiate and position themselves in a scientific discussion forum. Problem solving efforts through interaction in the classroom must lead to a story of being a scientist in the classroom.

4. Meta Learning

Although meta-learning is an important part of the modern curriculum, apparently not many studies related to ColPS have addressed this issue. Only one researcher (Mathabathe and Potgieter, 2017) tried to reveal through learning using a flow chart flow chart. Whereas metacognition learning is believed to be able to improve the quality of learning because it makes learning more meaningful.

5. Collaborative Learning

Collaborative learning is an implementation of Vygotsky's social constructivism. The success of collaborative learning is strongly influenced by the role of the teacher in the classroom. Placing students in the middle of a problem can be used as a scaffold in collaborative problem-solving based learning (Kim, 2018). Collaboration cannot happen naturally, meaning collaboration must be taught in the classroom (Geisinger, 2016). Collaborative is more than just working together (Kim and Tan, 2013). The feeling of being involved, being given the opportunity to articulate thoughts and concepts to others will have a positive impact on the success of collaborative learning (Mathabathe and Potgieter, 2017). Neutral and positive effects are positively related to constructive group interactions (Gonzales et al., 2019). Integration of knowledge from several students is required to understand the complexity of the problem (Kim and Tan, 2013). The thing to avoid is when one individual dominates a group. Because in fact, in collaboration, there are common goals, not individual goals (Kelly, McLoughlin, and Finlayson, 2016). This is where the role of teacher intervention is indispensable. The thing that needs to be prevented in collaboration is that students choose to take part that is controlled, and do not care about other parts (Kelly, McLoughlin, and Finlayson, 2016). Teacher interventions in the form of diagnostics and according to group needs are more effective than lectures / instructions (Gonzales et al., 2019).

6. Problem-solving based learning

Problem solving contains two aspects, namely procedural and intuitive. Intuitive can emerge if procedural mastered. However, teaching procedural continually will actually make learning mechanical. Therefore, teachers / prospective teachers need to be trained to deconstruct knowledge into structured tasks (well-known problems). Designing problem-based tasks involves the construction of complex elements. Systematic assignments need alignment between task elements and construction (Care, Scoular, and Griffin, 2016). Meanwhile, currently we are faced with VUCA conditions. The problems of the 21st century are real problems (Geisinger, 2016). 21st century problems involve the interdependence between construction components and how to consider them in the design of the assessment and the development of a score scale. Therefore, a continuous problem solving assignment design is needed (Ercikan and Oliveri, 2016). What is no less important to note by teachers is related to grouping. All researchers agree with small heterogeneous groups, including those related to gender (Sullivan et al., 2015). Also differences in disciplinary knowledge also need to be considered. The clustering strategy should be understood by teachers taking into account non-experts but should not have too high a disparity (Geisinger, 2016). Through collaboration, students are trained to explain assumptions as assumptions without justifying them. This was done through a presentation in the discussion (Kim and Tan, 2013).

7. Collaborative Problem Solving

Collaborative problem solving is an effort of two or more people to solve a problem by contributing resources that are controlled together

involving cognitive activities such as gathering and analyzing information, jointly formulating hypotheses and conducting a series of tests. Collaborative problem solving is an amalgamation of elements of critical thinking, problem solving, decision making, collaborative skills and collaborative attributes. There are 11 cognitive elements and 9 social elements involved in collaborative problem solving that form interrelated multicomponent constructs (Ercikan and Oliv eri, 2016). When collaborating and successfully solving problems, students actually have been able to go beyond the representation of individual problems (Kelly, McLoughlin, and Finlayson, 2016). Working in groups to solve discipline-based problems is one learning technique that allows students the opportunity to practice interpersonal skills and while professionals also acquire and apply discipline-specific content knowledge (Balgopal et al., 2017). In contrast to individual problem solving, problems that are solved collaboratively must be real, not the result of knowledge deconstruction. There needs to be negotiation and evaluation in solving collaborative problems. An interdisciplinary approach is needed to see the problem as a whole from various points of view. The success of collaborative problem solving is if the problems presented in the classroom are able to create interdependence between students. Collaborative problem solving involves cognitive processes (exchange of knowledge and tentative solutions to problems) and social processes (communication and collaboration to solve problems) (Kim and Tan, 2013). When a student has been able to engage in collaborative problem solving, he or she has reached the proximal distance, meaning that he has a better ability and has been able to synthesize knowledge through the integration of current information with previous knowledge. Because collaboration facilitates students to share understanding of problems, relevant conceptual knowledge, procedural knowledge, monitor the selection of assumptions and methods through clarification between members (Kelly, McLoughlin, and Finlayson, 2016).Collaborative Problem Solving Based Learning 9

8. Evaluation

Evaluation is a very complicated part, because collaborative problem-solving based learning involves a variety of interrelated and complex constructs. Identification of subskills is required to develop an assessment instrument. The key elements in collaborative problem solving assessment are attitudes, behaviors in thinking or acting and focus on real-life contexts. Researchers agree with 4 assessment blocks, namely construction, item design, results space and measurement model (Care, Scoular, and Griffin, 2016). A systematic approach was tried to be carried out in scoring, namely low-level behavior, high-level behavior (Ercikan and Oliveri, 2016). Balgopal et al. (2017) proposed a combination of stratified and attribute assessments. Sources of assessment can be generated from various authentic data such as videos and text reports. To make an assessment, a coding technique is needed. There are several coding techniques referred to as thematic, open, axial and selective coding (Kim and Tan, 2013; Kelly, McLoughlin, and Finlayson, 2016). Sullivan et al. (2015) proposed coding collaboration based on: problem solving initiation, acceptance of different opinions, asking clarifying questions, elaborating responses, rejecting ideas with reason, rejecting ideas without reason, trying to organize groups. Social dynamics are no less important to note. The social dynamics inherent in the collaborative problem of social regulatory differences require a coding system that captures examples of intra and interpersonal cognitive regulation (Mathabathe and Potgieter, 2017).

CONCLUSION

The challenges of the 21st century are real problems, not least in the field of education. A teacher must have the ability to teach by involving the domains of knowledge, skills, character and meta learning. One model that is considered appropriate is collaborative problem solving learning. Collaborative problem solving is not a natural philosophical skill. These skills must be taught systematically. Therefore prospective teachers must be prepared not only to teach knowledge, but be taught to collaborate and collaborate in solving problems so that later they are able to teach them to students.

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