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Development of Group Science Learning (GSL) Model to Improve the Skills of Collaborative Problem Solving, Science Process, and Self-Confidence of Primary Schools Teacher Candidates

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This Research & Development (R & D) aims to develop and produce a qualified Group Science Learning (GSL) model. The main product is the GSL model that has the following syntax: (1) Motivation and problem orientation based on Internet of things, (2) Collaborative problem-solving activities, (3) Presenting, (4) Non-routine problem-solving, and (5) Evaluation. The GSL model quality data was obtained through the Focus Group Discussion by using the GSL model quality assessment instrument. The GSL model quality analysis used average validity score, single measures ICC, and Cronbach's coefficient alpha. The results show that the developed GSL model is qualified. The research implies that the qualified GSL model by the expert judgment can improve the skills of collaborative problem-solving, science process and self-confidence of primary school teacher candidates.

Keywords: collaborative problem solving skills, group science learning, primary schools teacher candidates, science process skills, self-confidence

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INTRODUCTION

The primary school teacher education has an important role in preparing primary school teacher candidates to success in the global era of Fourth Industrial Revolution (4IR). To succeed in the global era of Fourth Industrial Revolution (4IR), students and teacher candidates need skills that support them such as scientific creativity, innovation, collaborative problem-solving, critical thinking skills, scientific literacy, scientific communication, and collaboration (Astutik & Prahani, 2018; Griffin & Care, 2015; Jatmiko et al., 2018; Jatmiko et al., 2016; Pandiangan et al., 2017; Prahani, 2017; Sunarti et al., 2018; Suyidno et al., 2018). The results of previous studies by Harding and Griffin (2016) and Hesse et al. (2015) showed that learning and assessment of collaborative problem-solving skills are needed and driven by the needs of students at the school and workplace levels. A collaborative problem-solving skill is the capacity of a person to effectively engage in cognitive and social processes with others in solving problems that students encounter (Care & Griffin, 2014; Harding & Griffin, 2016; Hesse et al., 2015; OECD, 2015). Recent research results showed that the process of problem-solving requires the skill of the scientific process as the basis of scientific activity (Prahani, 2017; Suyidno et al., 2018).

Along with its development, the process contained in scientific investigation is packed more systematically in the form of skills that must be owned by a primary school teacher candidate to conduct a scientific investigation. One of the most important aspects of the primary school teacher candidate is the science process skills (Crawford, 2000; Zakar & Baykara, 2014). Science process skills are used by scientists to build knowledge, find problems, and make conclusions (Abdullah et al., 2015; Karsli & Şahin, 2009). Science process skills are procedural, experimental, and systematic skills as the basis of science (Abdullah et al., 2015; Dogan & Kunt, 2016; Karsli & Şahin, 2009; Suyidno et al., 2018; Zeidan & Jayosi, 2015), so it is important for primary schools teacher candidates to develop a good understanding of them science process skills.

The importance of collaborative problem-solving skills and scientific process skills in education has been reported in many studies (Abdullah et al., 2015; Care & Griffin, 2014; Dogan & Kunt, 2016; Griffin & Care, 2015; Hesse et al., 2015; Karsli & Şahin, 2009; OECD, 2015; Zakar & Baykara, 2014; Zeidan & Jayosi, 2015). Some previous research results have shown limited pedagogical knowledge and skills, especially in designing effective learning activities for the training of students (Jatmiko et al., 2018; Jatmiko et al., 2016; Pandiangan et al., 2017; Purwaningsih et al., 2018; Suprapto et al., 2018). Some research results also indicate the lack of collaborative problem-solving skills, science process skills, and self-confidence of teacher candidates (Crawford, 2000; Purwaningsih et al., 2018; Suprapto et al., 2018; Suyidno et al., 2018; Zakar & Baykara, 2014).

The results of TIMSS and PISA studies showed that Indonesian students' problem-solving skills are in the lower levels (Martin et al., 2008; Martin et al., 2012; OECD, 2016). This is reinforced by preliminary study results at primary, junior and senior high schools, and in colleges for primary that are in primary teacher candidates education in Indonesia which show that generally collaborative problem-solving skills, science process skills, and confidence are in a low category (Astutik et al., 2016; Prahani, 2017; Prahani & Budi, 2014; Prahani et al., 2015; Prahani, 2015). The problems of weak collaborative problem solving skills and science process skills can be solved by using Problem Based Learning (PBL) model and Collaborative Problem-Solving (CPS) model (Arends, 2012; Batdi, 2014; Celik et al., 2011; Mercier & Higgins, 2014; Pollastri et al., 2013; Sockalingam & Schmidt, 2011).

The results of the study found that the use of PBL toward teacher candidates could improve their outcomes, altough the ability to investigate (science process skills) and collaborate to solve problems remained low (Celik et al., 2011). The results of the meta-analysis study of the 2006 to 2013 results showed that PBL model has not been able to train the collaborative problem-solving skills maximally (Batdi, 2014).

The CPS model has been developed by Mercier and Higgins (2014) and Pollastri et al. (2013) with the general collaborative learning for improving collaborative problem-solving skills. The study results by Pollastri et al. (2013) that teacher must improve students' self-confidence and understanding of collaborative problem-solving approaches. Self-confidence is the hopes and beliefs for success in one's life (Ackerman & Zalmanov, 2012; Hesse et al., 2015; Keller, 2010). Self-confidence affects the success of student learning processes and outcomes (Kapur, 2008; Kapur, 2010; Kornell et al., 2009; Richland et al., 2009; Roediger & Karpicke, 2006). Findings based on previous research and TIMSS results that self-confidence of Indonesia student at the bottom (Martin et al., 2012; Prahani, 2017). The results of the study show that collaborative problem-solving activities would be successful if group members were able to share multiple representations with other members, although such activities have not yet been fully developed and emphasized as regards in-class learning (Mercier & Higgins, 2014). Multiple representations were supported by Internet of Things. One of the most important aspects of the teaching and learning process is Internet of Things, especially in Fourth Industrial Revolution (4IR). (Wang et al., 2013; Wieman et al., 2010).

The results of previous studies have shown that the multi-representation, the internet of things, science process skills and self-confidence are essential components of the collaborative problem-solving process. The results above show that PBL model and CPS model still require further development to improve the skills of collaborative problem-solving, science process and self-confidence of primary school teacher candidates. This innovation is expected to be a solution to improve the skills of collaborative problem-solving, science process and self-confidence of primary school teacher candidates.

Therefore the development of Group Science Learning (GSL) model has an important role as an innovative learning model that can improve the skills of collaborative problem-solving, science process and self-confidence of primary school teacher candidates. The main objective of this research is to produce a qualified GSL model to improve the skills of collaborative problem-solving, science process and self-confidence of primary school teacher candidates.

METHOD

General Background

The subject of the GSL model in this study is the primary school teacher candidates. This research is categorized in Research and Development (R & D). The purpose of this research is to produce a qualified GSL model (which been valid in content and construct, and reliable) to improve the skills of collaborative problem-solving, science process and self-confidence of primary school teacher candidates. The main product is GSL model in the form of a GSL model book. The GSL model Book covers (a) the scope of GSL model development, (b) theoretical and empirical support of the GSL model, (c) the planning and implementation of the GSL model, (d) the management of the learning environment, (e) Implementation of the evaluation, (f) GSL model: A final thought, and (g) bibliography. Therefore, it is necessary to assess the quality of the GSL model by using the GSL Model Quality Assessment Instrument that has also been developed. The instruments has been declared valid and reliable (Prahani, 2017). Focus of this research on validity of the qualified GSL model by the expert judgment can improve the skills of collaborative problem-solving, science process and self-confidence of primary school teacher candidates.

Instrument and Procedures of Research

The development of GSL model is based on the adaptation of Wademan model research development design (Erika et al., 2018; Nieveen et al., 2007; Pandiangan, 2017; Prahani, 2017) as follows in Figure 1.

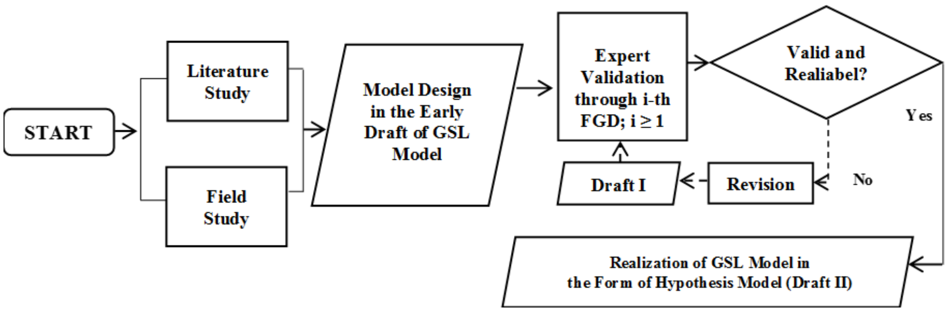

Figure 1
The research development stages of GSL model

The preliminary research was conducted to collect data related to: (1) the skills of collaborative problem-solving, science process and self-confidence of primary school teacher candidates, (2) the PBL and CPS model, (3) the supportive factors of learning and the lectures or students views about the learning. The result of this preliminary study is the model design in the form of GSL model draft. The results obtained in the literature study and preliminary studies are used as materials to develop the learning device products as the operational form of GSL model. They are: (a) development of GSL model, (b) realization of GSL model, (c) preparation of GSL model, and (d) validation of GSL model devices through Focus Group Discussions (FGD). The GSL Model Quality Assessment Instrument was filled by education experts who reviewed and assessed the learning model developed by researchers during the FGD. It's used to obtain GSL model validity and reliability data. The qualities of the GSL model were judged by the content validity and construct validity (Erika et al., 2018; Nieveen et al., 2007; Prahani, 2017). Content validity is there is a need for the intervention and its design is based on state-of-the-art knowledge (Erika et al., 2018; Nieveen et al., 2007; Prahani, 2017).. Construct validity is the intervention fulfil logically designed (Erika et al., 2018; Nieveen et al., 2007; Prahani, 2017). The developed GSL model was validated by 2 experts in Focus Group Discussion (FGD). The FGD was held for ± 2 hours. FGD results are served as a reference to revise the GSL model.

Data Analysis

The quality of GSL model is determined by referring to the results of the assessment with the criteria of the average validity score, that is: 3.30 < Very Valid ≤ 4.00; 2.30 < Valid ≤ 3.30; 1.80 < Less valid ≤ 2.30; 1.00 ≤ Invalid ≤ 1.80 (Erika et al., 2018; Prahani et al., 2015; Prahani et al., 2016). Further analysis to determine the quality of GSL model that had been developed in terms of the validity and reliability analysis of GSL model is done by using single measures Interrater Coefficient Correlation (ICC) and Cronbach's coefficient alpha (Malhotra, 2011; Pandiangan, 2017). The validity and reliability of GSL model is determined by the validity formula r_α = [(Mean Square people - Mean Square residual)/ (Mean Square people + (k-1) $*$ Mean Square residual)] and Cronbach's alpha $\alpha = k\, r_\alpha / [1+ (k-1)\, r_\alpha]$ (Malhotra, 2011; Pandiangan, 2017). GSL model is said to be valid if $r_\alpha > r_{table}$ and invalid if $r_\alpha \leq r_{table}$.

FINDINGS AND DISCUSSION

Rationality of the Developed of Group Science Learning Model

The GSL model developed to improve the skills of collaborative problem solving, science process, and self-confidence of primary school teacher candidates refers to the flow of the problem-solving process from John Dewey. The flow of the problem-solving process from John Dewey is supported by learning theories, namely the theory of positive dependence, cognitive constructivist theory and social constructivist, cognitive learning theory, behavioural learning theory, and motivational learning theory. Figure 2 shows the rationality of the developed of GSL model that was described as follows.

The first phase is motivation and problem orientation based on Internet of things (IoTs). The lectures' learning should motivate to awaken the sense of self-confidence of the primary school teacher candidates, convey the purpose of the learning, and provide direction on the learning process and the assessment of collaborative problem-solving skills and self-confidence. The ARCS theory (Attention, Relevance, Confidence, and Satisfaction) and motivational theory are reinforced by the results of research that motivation gives effect to success in individual and collaborative problem solving (Keller, 2010; OECD, 2013). Lectures provide authentic collaborative issues. Based on perspective of John Dewey, schools should be the laboratories for real-life problem solving (Arends, 2012). Reinforced with a top-down process by Slavin (2011) that primary school teacher candidates start with complex problems to solve and then solve or find (with the help of lectures) the basic skills required based on IoTs. This condition makes it easier for primary school teacher candidates in processing the concepts to be learned in learning because the beginning of learning concept will be more remembered by primary school teacher candidates. Reinforcement with the primacy effect theory that the tendency for items appearing at the beginning of a list is easier to remember than other items (Slavin, 2011). This phase of the lecture should emphasize the introduction of confidence-building strategies. The research results of Keller are strategies to improve the self-confidence of primary school teacher candidates, i.e. (1) learning requirements, (2) success opportunities and (3) personal controls (Keller, 2010).

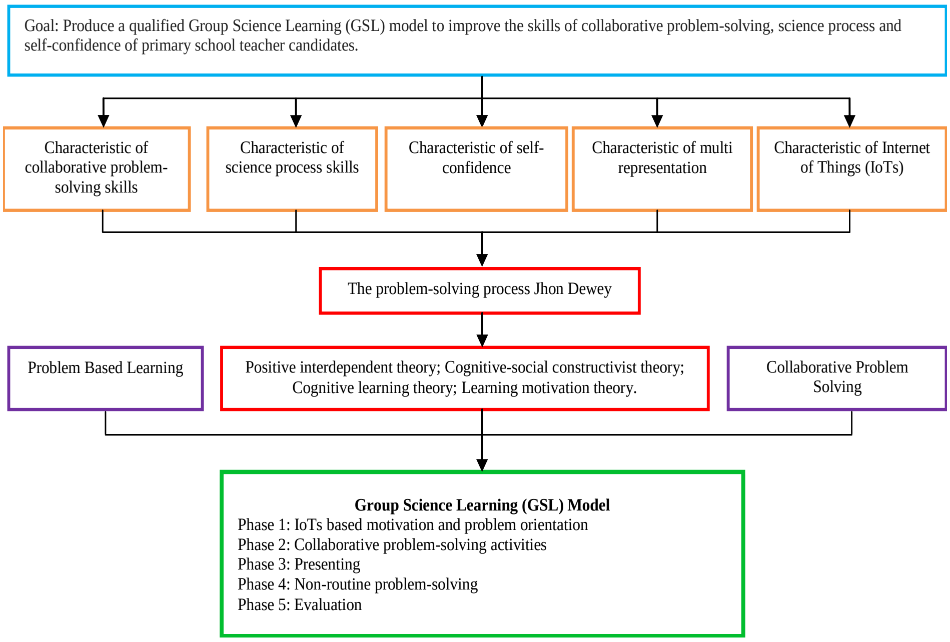

Figure 2
Rationality of the development of group science learning model

The second phase is the Collaborative Problem Solving Activities. Primary school teacher candidates gather in heterogeneous (expert and novice) groups (2-4 primary education teachers) and understand shared problem space in the worksheet through the sharing of multiple representations and peer instruction (i.e. at Table 1). The formation of heterogeneous groups is based on Vygotsky' social constructivist, that learners share individual perspectives with others to build the mutual understanding that is not possible to build individually (Moreno, 2010). A face-to-face social interaction among primary school teacher candidates provides an opportunity to share the alternative views or ideas, helping them see ideas in different ways. The collaborative problem-solving cases, plans for problem-solving should be based on a common problem representation and provide the basis for a well-regulated and coordinated problem solution (Hesse et al., 2015). The collaborative problem-solving activity of primary school teacher candidates is expected to be able have self-confidence and have a positive interdependence between experts and novices primary school teacher candidates. The previous Research (Laal, 2013) found that positive interdependence (collaborative) will result in promoting interaction (improved) as each individual mutually supports and facilitates each other's efforts. The self-confidence of low learners has an effect on the problem-solving process (Ackerman & Zalmanov, 2012; Koriat & Ackerman, 2010). Lectures guide primary school teacher candidates in routine (academic) problem-solving activities as an effort to tackle collaborative problem-solving skills, science process skills, and self-confidence in the learning process. The scientific collaboration is a scientific activity carried out by more than one individual by interdependent means, including scientific activities carried out by small teams and larger groups (NRC, 2015). Each primary school teacher candidates has a responsibility in obtaining information. Information is obtained through the skills of the science process. It is based on the cognitive constructivist theory by Piaget (1954, 1963), every aspiring learners of any age actively involved in the process of acquiring information and constructing their own knowledge (Arends, 2012). The primary school teacher candidates should be actively involved in solving individual problems before contributing to collaborative problem-solving. It is expected that in heterogeneous groups consisting of primary school teacher candidates of expert and novice, there will be collaborative understanding in problem-solving. Students are not yet expert still need guidance when problem-solving uses multi-representation in constructing verbal, visual, and mathematical descriptions of problem-solving activities (Kohl & Finkelstein, 2008; 2007). Findings of earlier research results show that collaborative problem-solving skills can be trained to learners where learners build knowledge through working together in a social environment to learn and solve a problem or produce a product (Burns et al., 2014; DeWitt et al., 2014; Laal & Ghodsi; 2012).

The third phase is Presenting. Lectures guide primary school teacher candidates to present the results of collaborative problem-solving activities for the internalization of concepts, collaborative problem-solving skills, science process skills, and self-confidence of primary school teacher candidates. Supported by the theory of retention, the learner needs to remember the observed behaviour in order to be able to imitate it in the future (Bandura, 1977). The results show that self-confidence is one of the most important aspects of learning and motivation of students (Dowd et al., 2015; Keller, 2010). Communication skills are important to facilitate collaborative skills and social performance achieves the expected goals in a team (OECD, 2013). The primary school teacher candidates should present the results of collaborative problem-solving activities. Internalization is the process of deepening the skills of collaborative problem solving, science process, and building self-confidence of primary school teacher candidates, in accordance with the cognitive constructivist theory, namely the theory of the level of information processing. Based on the study of argument, theory, and empirical, then the third phase of the learning model developed is Presenting.

The fourth phase is Non-Routine Problem Solving. Lectures provide follow-up tasks in the form of non-routine problem solving that must be solved collaboratively as a stage of enhancing collaborative problem-solving skills and self-confidence of primary school teacher candidates. These activities of primary school teacher candidates to increasingly be able to increase their self-confidence and must have self-regulation in collaborative problem solving for new problems. Supported by theory, that is (1) self-regulated learning, the ability to control all aspects of one's learning, from advance planning to how one evaluates performance afterward (Moreno, 2010), (2) production, the learner needs to convert the mental representations created during encoding to motor activity (Bandura, 1977). The primary school teacher candidates are expected to be able to transfer the knowledge they have acquired to new problems (contextual and complex problems), in accordance with the positive transfer theory and scaffolding. The results of research by Gok (2014), Brooks and Koretsky (2011), and Vickrey et al. (2015) found that individual problem-solving performance has a positive relationship with students' self-confidence and peer instruction can increase the confidence of primary school teacher candidates in problem-solving, but there has been no self-confidence in collaborative problem solving. Other research results by Kirschner et al. (2011) suggest that problem-solving group has the highest learning outcomes compared to individual and competitive learning.

The fifth phase is Evaluation. Lectures guide primary school teacher candidates evaluate processes and outcomes in collaborative problem solving, science process skills, and self-confidence of primary school teacher candidates. In this process, primary school teacher candidates should also be able to regulate and assess themselves and others. This view is in accordance with self-evaluation, judging if the outcome of one's actions or strategies is acceptable or unacceptable (Moreno, 2010). The results of previous research showed that the need for evaluation of lectures from the process of investigation and problem solving that has been done by the primary school teacher candidates is an important component, without any feedback obtained by a little knowledge (Arends, 2012). Lectures give praise or appreciation for collaborative group achievements. Lectures provide advanced task or projects to deepen concepts, collaborative problem skills, science process skills, and self-confidence. In accordance with motivation theory, learners need to be motivated to learn from the model and to reproduce what they learned (Bandura, 1977) and the last effects; the tendency for grains that appear at the end is easier to remember than other items (Slavin, 2011). The results show that the advantages of collaborative activities show better problem-solving skills compared to individuals (OECD, 2013).

The researchers' argument supported by empirical theory and empirical studies as described above, the five-phase GSL syntax is established, namely (1) IoTs based motivation and problem orientation, (2) Collaborative problem-solving activities, (3) Presenting, (4) Non-routine problem-solving, and (5) Evaluation. Primary school teacher candidates are required to be pro-active and have the high positive dependence on collaborative problem-solving team activities to increase self-confidence so that the developed learning model is named Group Science Learning (GSL) model. The implementation of GSL model to improve the skills of collaborative problem-solving, science process, and self-confidence of primary school teacher candidates by design are presented in Table 1.

Table 1
Syntax of GSL model

Lecture's Activity	Primary School Teacher Candidates' Activity
Phase 1: Motivation and Problem Orientation Based on Internet of things	
❖ Lecture motivates (video / image / demonstration) primary school teacher candidates, conveys learning objectives, and provides guidance on learning and assessment of skills of collaborative problem-solving, science process, and self-confidence. ❖ Lecture provides collaborative issues.	❖ Primary school teacher candidates are motivated by trying to understand the learning objectives, taking into account the direction of the learning process and the skills of collaborative problem-solving, science process, and self-confidence assessment presented by the lecture. ❖ Primary school teacher candidates pay attention and try to understand the problems that are given by the lecture.
Phase 2: Collaborative Problem-Solving Activity	
❖ Lecture divides primary school teacher candidates into heterogeneous groups (expert and novice) (3-4 primary school teacher candidates) and divides the worksheet. ❖ Lecture guides primary school teacher candidates in routine (academic) problem solving activities at the worksheet 1 as an effort to train skills of collaborative problem-solving, science process and instill self-confidence in the learning process.	❖ Primary school teacher candidates gather in heterogeneous groups (3-4 primary school teacher candidates), understand the shared problem space in worksheet through multiple representation, and peer instruction sharing. ❖ The activities of primary school teacher candidates in routine (academic) problem solving activities in worksheet 1 as an effort to train skills of collaborative problem-solving, science process and instill self-confidence (motivation, persistence, and ability) in the learning process: ✓ primary school teacher candidates formulate a problem to train the task regulation, ✓ primary school teacher candidates share the view in making the hypothesis, ✓ primary school teacher candidates learn and build knowledge during the activities of identifying variables and make operational definitions of experimental variables, ✓ primary school teacher candidates are actively involved in participation to gather information (experiment), graph, analyze, and make conclusions, and ✓ primary school teacher candidates perform self-reflection as a form of social regulation.
Phase 3: Presenting	
❖ Lecture guides primary school teacher candidates to present / communicate the results of collaborative problem-solving activities to classical / to other groups. ❖ Lecture guides primary school teacher candidates to internalize the concepts, skills of collaborative problem-solving, science process and fosters primary school teacher candidates' self-confidence through presentation activities.	❖ Primary school teacher candidates present / communicate the results of collaborative problem-solving activities to classical / to other groups. ❖ Primary school teacher candidates internalize the concepts, skills of collaborative problem-solving, science process and fosters their self-confidence through presentation activities.
Phase 4: Non Routine Problem Solving	
Lecture provides follow-up tasks in the form of	Primary school teacher candidates do follow-up work

Lecture's Activity	Primary School Teacher Candidates' Activity
worksheet 2 non-routine problem solving (authentic) that must be solved collaboratively as a stage of improving the skills of collaborative problem-solving and science process that they have already had and increase the self-confidence of primary school teacher candidates.	in the form of worksheet 2 non-routine (authentic) problem solving that must be solved collaboratively as a stage of enhancing skills of collaborative problem-solving, science process, and increasing their self-confidence (motivation, persistence, and confidence in ability).
Phase 5: Evaluation	
❖ Lecture guides primary school teacher candidates to evaluate processes and outcomes in skills of collaborative problem-solving, science process and confidence. ❖ Lecture provides follow-up tasks for collaborative groups.	❖ Primary school teacher candidates evaluate the process and outcomes in their skills of collaborative problem-solving, science process and self-confidence. ❖ Primary school teacher candidates in collaborative groups obtain and undertake follow-up work outside of school hours.

GSL Model Quality Assessment

The results of the GSL model quality assessment are presented in Table 2.

Table 2 shows that the validity of the content and reliability of the GSL model includes: (1) GSL Model Development Needs, (2) State of the art of GSL Model, (3) GSL Model Theory Support, (4) Planning and Implementation of GSL Model, (5) Learning Environment Management, and (6) Use of Advanced Evaluation Techniques have an average validation score of 4.00, 4.00, 4.00, 3.85, 4.00, 4.00 with very valid criteria of which r_α is 1.00 and is greater than r table, so that each component is declared valid. As for the reliability of each component in terms of value α was 1.00, so that each component is declared reliable.

Table 2
Analysis result of GSL model quality scoring

Component		Validity and Reliability of GSL Model				
Content Validity		Validity Score	r_α	Validity	α	Reliability
1.	GSL Model Development Needs	4.00	1.00	Valid	1.00	Reliable
2.	State of the Art of GSL Model	4.00	1.00	Valid	1.00	Reliable
3.	GSL Model Theory Support	4.00	1.00	Valid	1.00	Reliable
4.	Planning and Implementation of GSL model	3.85	1.00	Valid	1.00	Reliable
5.	Learning Environment Management	4.00	1.00	Valid	1.00	Reliable
6.	The Use of Advanced Evaluation Techniques	4.00	1.00	Valid	1.00	Reliable
Construct Validity						
1.	GSL Model Overview	4.00	1.00	Valid	1.00	Reliable
2.	Theoretical and Empirical Support of the GSL Model	4.00	1.00	Valid	1.00	Reliable
3.	Planning and Implementation of GSL Model	3.85	1.00	Valid	1.00	Reliable
4.	Learning Environment Management	4.00	1.00	Valid	1.00	Reliable
5.	The Use of Evaluation Techniques	4.00	1.00	Valid	1.00	Reliable
6.	GSL Model: A Final Thought	4.00	1.00	Valid	1.00	Reliable

Table 2 shows that the validity of the construct and reliability of the GSL model includes: (1) GSL model Overview, (2) Theoretical and Empirical Support of the GSL Model, (3) Planning and Implementation of GSL Model, (4) Learning Environment

Management, (5) Evaluation Techniques, and (6) GSL Model: A Final Thought have an average validation score of 4.00, 4.00, 4.00, 3.85, 4.00, 4.00 with very valid criteria and r_α is 1.00 that greater than r table, so that each component is declared valid. As for the reliability of each component in terms of value α, everything is in the value of 1.00, so that each component is declared reliable.

Tables 2 and Figure 2 illustrate that in general the content validity of the GSL model has met the novelty and need for the development of the GSL model to improve the skills of collaborative problem-solving, science process, and self-confidence of primary school teacher candidates. The novelty of this research is in the form of intervention. Interventions take precedence over the learning model to improve the skills of collaborative problem-solving, science process, and self-confidence of primary school teacher candidates. The results of this intervention are based on literary studies and studies on PBL and CPS model. The results of the study found some weaknesses that need to be improved to improve the skills of collaborative problem-solving, science process, and self-confidence of primary school teacher candidates.

The novelty of the GSL model if it is compared to the PBL model in improving collaborative problem-solving skills lies in phase 4: Non-Routine Problem-Solving. This phase is specifically designed for primary school teacher candidates to undertake non-routine problem-solving that must be resolved collaboratively as a stage of enhancing their collaborative problem-solving skills as well as improving the confidence of primary school teacher candidates. The recommendations by Celik et al. (2011) that the primary school teacher candidates will reinforce their own concepts by transferring to new issues, so the scope of information that they get will be more

The novelties of the GSL model when compared to the CPS model are as follows. (1) In Phase 2: Collaborative Problem-solving Activities, learners are provided an based IoTs shared problem space that learners can optimize the use of multiple representations in collaborative problem-solving processes and the implementation of scientific process skills, as well as collaborative scientific (Hesse et al., 2015; NRC, 2015; Mercier & Higgins, 2014). (2) In Phase 3: Presenting, learners are required to present the results of collaborative problem-solving activities as a mean of exploring communication skills, increasing responsibility, cooperation and confidence. (3) The presence of phase 4: Non-routine problem-solving specifically designed as a non-routine problem-solving exercise as a productive way to support cognitive joint (Rosen, 2014) that does not exist in the CPS model, improving the owned collaborative problem-solving and the self-confidence of learners (Mercier & Higgins, 2014). (4) Phase 5: Evaluation, learners are given follow-up tasks in the form of project tasks that are expected to explore differences in achievement of basic education teachers in new problems, metacognitive implementation in collaborative problem-solving process, training the social skills and creativity in collaborative activities (Prahani et al., 2015; Rosen, 2014).

The construct validity of the GSL model has shown consistency between phases in the model syntax, consistency between model components, and consistency between model and underlying theories. The GSL model consists of five phases that include: (1) motivation and problem orientation based on IoTs, (2) Collaborative problem-solving activities, (3) Presenting, (4) Non-routine problem-solving, and (5) Evaluation. These five phases have been designed to be interconnected with each other. The results of the FGD findings analysis show that the GSL model is qualified (has been valid in content and constructs, and reliable). The results of previous research show that product development (model, device, media, and learning) quality (valid, practicality, and effective) can be used in learning to improve the learning outcomes (Husamah et al., 2018; Jatmiko et al., 2018; Limatahu et al., 2018; Madeali & Prahani, 2018; Pandiangan et al., 2017; Prahani et al., 2018; Purnamawati et al., 2017; Suyidno et al., 2018; Tan et al., 2016). Therefore, based on the above description, the review of all aspects of the GSL model quality assessment, it shows that the GSL model is qualified (already valid in content and constructs, and reliable) so that it can be used as a solution to improve the skills of collaborative problem-solving, science process, and self-confidence of primary school teacher candidates.

CONCLUSION

GSL model is collaborative problem solving based learning by design to improve collaborative problem-solving skills, science process skills, and self -confidence of primary school teacher candidates. The five-phase GSL model includes: (1) motivation and problem orientation based on IoTs, (2) Collaborative problem-solving activities, (3) Presenting, (4) Non-routine problem-solving, and (5) Evaluation. The result of research shows GSL model with average content validity (3.98), construct validity (3.98), with validity of each aspect statistically in ($r_\alpha = 1.00$) and reliability in ($\alpha = 1.00$). It can be concluded that the GSL model is qualified (valid in content and constructs, and reliable) by experts. The implication of this research is that a qualified GSL model can be used to improve the skills of collaborative problem-solving, science process, and self-confidence of primary school teacher candidates. Further research focus is needed to test the practicality and effectiveness of the GSL model to improve the skills of collaborative problem-solving, science process, and self-confidence of primary school teacher candidates.

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