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To cite this article: Novinta Nurulsari et al 2020 J. Phys.: Conf. Ser. 1467 012023

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## **Exploring the Prospective of Pre-Service Physics Teacher's** Pedagogical Content Knowledge: A Case Study

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Abstract. Indonesia global assessment in 2017 and preliminary survey results illustrated the achievements of teachers' cognitive abilities that were still low in terms of professional knowledge and pedagogic. This study were aimed to describe the existing conditions of the pedagogical content knowledge of physics teachers at the undergraduate level and predict future prospects about what pedagogical content knowledge the pre-service physics teacher (PPTs) will have by considering the futuristic aspects. This study used case-study qualitative research within a group of 52 mostly passive pre-service physics teachers during the fourth semester of their four-year graduate program. It focuses on the central issue of essential topics in school physics learning. The results of the document analysis indicated that they have not been able to design a learning scenario for each Physics essential material with reference to the development of science and technology. Then, they have not showed a good subject matter mastery for each Physics topic. This paper ultimately also explore a hypothetical model of learning strategies that has the potential to develop PPTs' PCK through School Physics learning in college. This strategy is based on the future needs that must be mastered by students from an early age.

#### **1. Introduction**

Results of global assessments related to teacher competence in Indonesia in the past three years since 2015 have not shown encouraging results. The percentage of the value results for high school levels that score above 60 was only 53.55%. This data illustrates that teachers' cognitive abilities are still low in terms of professional and pedagogical knowledge, more commonly known as Pedagogical Content Knowledge (PCK). Preliminary survey results showed that most pre-service physics teachers (PPTs) felt that they have good PCK skills. But after in-depth interviews with a number of randomly selected under-graduate students, it turns out that the level of PCK drawn was still weak. This was indicated by their answers of several questions related to Physics content and about how to explain of physics



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content to students in science learning. The biggest problem found is the fact that the teacher has not mastered a subject matter understanding [1- 3] and conceptual understanding [4- 5]. The centerpiece of many reforms in the field of science teacher education has a Btripartite structure with anchoring points is teacher knowledge about subjects/subject matter knowledge (SMK), pedagogical knowledge (PK) and pedagogical content knowledge (PCK) [6]. SMK is teacher knowledge that leads to the quantity, quality, and organization of information, concepts, and constructions that underlie teachers in certain fields of science (eg, Physics). Meanwhile, PK is related to teacher knowledge about general learning variables, such as classroom management, communication strategies, conducting assessments, and so on [6]. The level of mastery of SMK and PK greatly affects teacher PCK in the end. The relationship between those three variables was explained by [7] and can be seen in Figure 1.



Many studies had been widely investigated as an effort to improve or develop science teacher's PCK [8-13]. However, not many have reviewed the prospects of PPTs' PCK in the future by looking at existing conditions. In fact, efforts to improve teacher PCK can be done early before teachers go to school through in-college learning. Research conducted by [14] has revealed about PCK development of PPTs in science education through workshops, however the research only focused on one specific content and has not covered all broader and relevant topics in learning Physics, while teachers need mastery of PCK for each material that will be applied in school physics learning. Research of [15] also investigated about PPTs' PCK, they explored a modified version of Japanese Lesson Study to determine whether and how it influenced pre-service elementary teachers in their abilities to deliver science lessons that included nature of science (NOS) to their own students. However, this study only involved elementary pre-service teachers, even though the mastery of PCK that teachers must have at primary and secondary education levels was different. In determining alternative solutions so that teachers can later play a professional role in the world of education, this research can contribute in mapping the condition of PPTs' PCK in the present and predicting the prospects of PCK in the future. So, it can give an idea of what kind of framework is needed as a form of problem solving strategy.

#### 2. Method

The reported study is mainly based on qualitative research methods [16]. In this case, this study is focused on develope a prospective hypothetical model of Learning Approach to develop PPTs' PCK.

The methodology used for this study conforms to the exploratory and descriptive 'case study' approach in educational research [17-18]. This research was conducted in two phases of protocol-based interview and document analysis, then preliminary development. The research flow was represented in Figure 2.



We involved 52 PPTs. The special case about our research lies in the characteristics of the sample. We used the purposive sampling technique, where the consideration was that the PPTS were very passive in learning, which the sample characteristics was traced and identified when researcher lectured them in another course besides School Physics based courses. We thought their passivity was only in a few subjects, but apparently not. The PPTs that we sampled show passivity consistency when attending lectures in the courses besides School Physics. They never ask when asked to ask, do not give answers when asked to answer and only silence, they very rarely raise questions or opinions. They seemed not to show enthusiasm in learning. These findings corroborate researchers' assumptions about the characteristics of prospective Physics teacher candidates. In the first phase, we conducted a 'case study' approach [17-18], using protocol-based interview [19] and document-analysis methods [20]. Document analysis is part of a raft of methodological approaches which come under the umbrella term of discourse analysis. The aim of protocol-based interview is to explore PPTs' early mastery in the PCK dimension. Document analysis focused on illuminating the themes and ideologies which give meaning to pieces of documents [20]. Then, it is naturalistic and interpretative and seeks to examine meaning in a given context. Our case is prior knowledge of PPTs' PCK and learning patterns or

sequential learning of science learning lesson plan from the integration of the PCK dimension by considering futuristic aspects. We analyzed documents by recording all findings of the identification. In the second phase, we ultimately also explored and mapped a hypothetical model of learning strategies that has the potential to develop PPTs' PCK through School Physics learning in college based on the results of the analysis during the interview and document analysis.

#### 3. Result and Discussion

3.1. PPTs' early mastery in the PCK dimension

Exploration of PPTs' early mastery of the PCK dimension was analyzed using the protocol [21] that we have developed as an interview guide. The topics of the protocol were illustrated in Table 1.

Phase in conducting learning	PCK case study topics	Interview questions
Preparation	Needs analysis related to things that will be used in the teaching process.	Could you give three examples of things that need to be prepared before the teaching process?
	Preparation of the learning environment	Could you give an example of the latest information that you can convey to students along with the required learning environment?
Action	Development of teaching materials	Could you give an example of one form of teaching material that is relevant to the Physics material and the learning theory?
	Selection of learning models and methods	Could you provide an explanation of the learning model and method that is appropriate for high school kids when learning about optical devices?
	Information search strategy	What search strategies you use to access resources in planning the content to be taught?
	Misconception problem solving	How you solve students' misconceptions regarding Physics content?
Evaluation	Student success evaluation	Could you give an example of how to evaluate student success and indicators of success?

The answers that students give are then categorized based on the tendency of the answers. Our findings based on PCK case study topics in accordance with Table 1 are resumed in Table 2.

<b>Table 2.</b> Findings related to early mastery in the PCK dimension of PPTs		
Code	PCK case study	Categorized findings
	topics	
1	Give three	Relevant answers (more than 60%)
	things that need	Learning material/content, teaching methods, learning techniques,
	to be prepared	tasks for students, learning methods, syllabus of curriculum,
	before the	lesson plan, learning media, learning strategy, modules or books,
	teaching	and evaluation system.
	process.	Irrelevant answers: (less than 50%)
		a) Characteristics of each student
		Reason why this answers was irrelevant: precisely the

Table ? Einding related to corly m actory in the DCV di C DDT-

characteristics of students can be found during the learning process. b) Attitude to master the class Reason why this answers was irrelevant: attitude is not 'things' that must be prepared, but the attitude of the teacher should have been internalized in the teacher himself. c) How to increase student interest in learning & learning objectives Reason why this answers was irrelevant: this section can be contained in apperception activities, which should be in the lesson plan. d) Classroom availability Reason why this answers was irrelevant: what needs to be prepared is the learning environment for students. Teacher readiness e) Reason why this answers was irrelevant: this can be reflected in the preparation done. 2 Give an example Relevant answers: (less than 30%) of the latest For example there is a race about water rockets, so students a) information that must learn in an environment where students can learn they can convey everything about the water rocket. to students along Global warming, the learning environment can be done b) with the required outside the room so that students contextually could seem. learning About the height of shadows formed by objects, the need for c) environment. a supportive environment such as the presence of sunlight. Irrelevant answers: (more than 70%) Students currently have a lack of interest in reading so it a) takes practicum in learning. b) Circumstances must be comfortable, because it is very influential with the concentration of students. Students are invited to create a comfortable learning c) environment by using available facilities such as LCD projectors. d) Comfortable environment with not too crowded atmosphere Types of student learning types, for example auditory, verbal e) linguistics, and kinesthetic. f) Regarding the use of technology, it requires disciplined and conducive learning conditions. Note: these answers were categorized as irrelevant because it seems that PPTs did not understanding what the meaning of *learning environment.* 3 Correct answers: (less than 30%) Give an example of one form of Work and energy, mechanics, dynamic electricity could be a) physics material taught based on constructivism learning theory and the relevant Static fluid, linear motion, electricity, wave, heat, and b) learning theory quantity could be taught based on cognitive learning theory Incorrect answers: (more than 70%) Electromagnetic induction using POE-based interactive a) multimedia

b) Optical using problem based learning

5

- c) Linear motion using cooperative learning
- d) Static fluid using problem based learning
- e) Circular motion physics material, through flash video learning about several examples of circular motion phenomena such as wind worms, wall clocks (if there are no adequate tools)

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- f) Motion using inquiry based learning
- g) Linear motion we can see from the wheels (see the spinning wheel of a car can be conveyed at apperception, so the activity is not a form of learning as a whole but only a part of learning activities)

Note: these answers were categorized as incorrect because it seems that students did not understanding what the differences between learning theory and learning model or strategy.

There is no complete and correct student answer in explaining the learning model and method that is suitable for the optical instrument material. There are **less than 90%** of students' answers that are complete but incorrect, they are correct in distinguishing models and learning methods, but the models and methods they mentioned are actually not suitable for Optical Instrument learning.

More than 5% of PPTs' answers are incomplete but correct in the selection of models or learning methods. The rest briefly stated that they did not know what learning models and methods were suitable.

Mention search<br/>strategies they<br/>use to accessMore than 95% of PPTs stated that they used technology and the<br/>internet in accessing information. They even guided students to do<br/>the same thing to obtain information. The rest access information<br/>resources from books.

More than 60% have no strategy to minimize student's misconception.

**Less than 40%** of prospective teachers give correct answers, some categorized answers to minimize student's misconception include:

- a) Re-explained in detail.
- b) Provide an initial description of the content, then discuss it together and get the right answer regarding the misconception.
- c) Give real examples around students who might be relevant with the concept of physics.
- d) Correcting students' misconceptions through practicum or the responsiveness approach.
- e) Guide students to find together about the correct concept, so do not tell directly that the concept is wrong.
- f) Compare existing theories with the results of experimental experiments.

explanation of the learning model and method that is appropriate for high school students when learning about optical devices.

Provide an

4

5 Mention search strategies they use to access resources in planning the content to be taught.

6 Explain the way they solve students' misconceptions regarding Physics content.

7	Give an example	Only less than 3% answered that the way to measure student
	of how to	success in achieving learning goals was by giving written tests to
	evaluate student	measure cognitive domains, performance tests to measure student
	success and	skills, and non-tests to measure student attitudes. Then indicators
	indicators of	of student success are measured from the minimum standard of
	success.	student's completeness that has been analyzed previously.

The first PCK case study topic in Table 2 showed that actually none of the students' answers are completely perfect in mentioning the 3 main components that must be prepared by the teacher before starting learning. However, we do not immediately divide it into correct and incorrect answers. So, we categorize the answers based on relevance level one by one from the three answers requested. For example, a student only answers 2 components of the correct answer (e.g Lesson Plan and Syllabus), but 1 component is incorrect (e.g. teacher attitude). Then, the 2 components of their answers that we correctly enter in the relevant answers section, while the 1 component of the wrong answers we put into the answers that are irrelevant. The results indicated that PPTs still did not understand the urgency of preparation before teaching and have no idea what to prepare. In fact, the preparation stage (including planning) is an important thing that must be carried out before teaching [22].

Then, the second PCK case study topic indicated that almost all PPTs have not been able to define what a learning environment is. So that their answers are categorized as irrelevant to the purpose of the question. Learning environment refers to the diverse physical locations, contexts, and cultures in which students learn. Learning environments can be in the form of virtual learning environments and online learning environments [23]. Similar results were also found on the third topic, that most PPTs have no a good understanding about the differences in learning theories and learning models. Though it was so clear that a learning theory in which there were procedures for the application of teaching and learning activities between teachers and students, the design of learning methods that will be implemented in the classroom and outside the classroom [24]. Meanwhile, the learning model is the whole series of presentation of teaching material that covers all aspects before being and after learning model and method that was appropriate for high school students when learning about optical devices.

The fifth topic showed almost all PPTs teacher stated that they used technology and the internet in accessing information. For the sixth topic, more than half of the PPTs stated that they did not have and did not even know effective strategies to minimize students' misconceptions regarding Physics content. In fact, misconception is a problem that is often found in learning physics [25]. For the last topic, almost all PPTs answer that how to evaluate student success by providing written tests in the form of test exams for each chapter or basic competency, then indicators of success are measured by comparing student scores with standards they set themselves without any clear source. Though the evaluation of learning must be done by referring to several principles and methods [26-27]. The results lead to the conclusion that in general the level of PCK candidates for Physics teachers is still low, both in the stages of preparation for learning, implementation, and evaluation. They have not been able to choose learning methods and models, and map learning sequences that are appropriate to the content of the learning material. In relation to research that had been conducted previously, PCK was said to contribute to effective teaching. Most studies exploring and identifying PPTs' PCK [28-30], however the studies that had been conducted yet stated that their sample was identified mostly passive in terms of actualizing capabilities as our sample

#### 3.2. Document-analysis regarding PCK indicators and futuristic aspect

Furthermore, our analysis continues to a higher level, 'a document-analysis'. We conduct a study of a series of learning tools including lesson plan drawn up by PPTs when they took the Planning of Physics Learning course. Our document analysis was addressed in such a way to get findings, we used PCK indicators [7] like in Figure 3. First, we analyzed whether the lesson plan developed by the

teacher had fulfilled good PCK mastery indicators. Second, we analyze whether the lesson plan that the teacher has developed is a sample lesson plan for science courses within the future education. Finally, we made a hypothetical model based on the findings we obtained, namely PCK-Based Soft Scaffolding Learning Approach.

#### 3.2.1. The case of PPTs' PCK in lesson plan

Lesson planning represents one of the areas in which PCK was measured. The teacher's student's understanding knowledge illustrated in the lesson plan showed that the teacher lacks knowledge to make appropriate decisions for helping and guiding students in their knowledge construction certainly requires an understanding of student ways of thinking. To investigate initial craft-knowledge that can play a role in future teaching practice, the lesson preparation method that was illustrated in lesson need to be investigated. PPTs are asked to collect their lesson plan that already developed when they took the Physics Learning Planning (PLP) course. We analyze the documents to describe the extent of understanding of PPTs in preparing a lesson on a specific subject topic in a classroom environment. We analyzed the lesson plan by randomly taking 1 sample lesson for each material that had been developed by each PPTs. PPTs were invited individually to prepare 'introductory' lessons about a specified topic when they joined the 'Planning of Physics Learning' course. Physics topics becoming a focus of lesson plan development consist of 13 topics, namely (1) linear motion, (2) work and energy, (3) momentum and impulse, (4) equilibrium and rotational dynamics, (5) static fluid, (6) temperature, heat, and its transfer, (7) wave, (8) optical geometry (optical devices), (9) static electricity, (10) direct current circuits, (11) magnetic fields, (12) electromagnetic induction, (13) alternating current circuits.



Firstly we analyzed the lesson plan document to identify the knowledge PPTs had regarding the curriculum (knowledge of curriculum). This was reflected in the formulation of indicators of competency achievement and learning objectives that originate from the formulation of basic competencies set by the Government. The analysis results related to the knowledge of curriculum owned by PPTs in the formulation of learning goals in detail are shown in Figure 4.



The basic competencies contained in the lesson plan actually illustrate the minimum competencies students must achieve after gaining learning experience in the cognitive and psychomotor domains. However, the formulation of indicators and learning objectives did not show to be in accordance with the existing demands on basic competencies. Moreover, the learning objectives had not shown the elaboration of indicators. Even though the accuracy in setting learning goals was very important [31] to consider because it will greatly determine the learning experience that students will get. Curriculum alignment is crucial in realizing learning objectives. The results illustrated that PPTs lack of knowledge regarding to setting learning goals and they have no good understanding about the content of the curriculum.

Then we continue to identify the PPTs knowledge regarding the orientation to teaching subject matter. The material contained in the lesson plan developed by PPTs has not been able to provide a whole description of the teacher's knowledge of Physics. However, in the material analysis section, it could be identified that PPTs gave no priority in mapping the subject matter based on the basic concepts that required by students. They seems like transferring material content from books or the internet without any selection where the material categorized as a 'core' or a 'branch' one. In the learning sequences, they only described the general topic that students will learning like in the Figure 5. However, the details of the material they put in the material analysis section of the lesson plan do not match the sequence in the learning sequences.



The document did not proved that PPTs were able to design a plan for teaching subject matter [32] systematically based on the core content. Even worse, they were not able to show the uniqueness of the lesson plans that were developed based on their own understanding version. It means, PPTs have absolutely no perspective on their understanding position of subject matter mastery. Additionally, participants may not see the need to expand their subject matter knowledge because they can only envision one way to structure a unit around that topic. Participants seemed to dismiss personal connections to the subject matter and defer to external sources. We do not claim that teachers should discount external authority, as there are many circumstances in which standards, disciplinary experts, and educational research should influence decision making. However, we want PPTs to also value the authority of their own subject matter knowledge, interests, and intuitions.

Furthermore, we analyzed the Physics content in the lesson plan. For example, we focus on material about finding general equations of waves. Physics content in the lesson plan showed that PPTs have not fully understood the concept of how to transform their academic knowledge into teaching activities related to the subject matter. This problem was illustrated in Figure 6.

Misalkan, meninjau sebuah titik P pada suatu gelombang. Jika		
gelombang merambat dengan kecepatan $\boldsymbol{v}$ maka untuk mencapai titik P		
sepanjang x dibutuhkan:		
$t_{on} = \frac{x}{2}$		
Karena terdapat perbedaan selang waktu yaitu, ketika dari titik o		
gelombang telah berjalan t detik waktu titik P adalah:		
$t_p = t - \frac{x}{v}$		
v		
Sehingga persamaan getaran tersebut menjadi:		
someBba Faronanan Boun an caroo ar manjaan.		
$y_p = A \sin \omega t_p$		
$y_p = A \sin \omega (t - t_{op})$		
$y_p = A \sin \omega t \left(t - \frac{x}{v}\right)$		
$y_p = A \sin (\omega t - \frac{\omega x}{v})$		
$y_p = A \sin \left(2\pi ft - \frac{2\pi fx}{\lambda f}\right)$		
$y_p = A \sin \left(2\pi ft - \frac{2\pi fx}{\lambda}\right)$		
$y_p = A \sin(\omega t - kx)$		
$y_p = \pm A \sin(\omega t \pm kx)$		
<b>Figure 6.</b> Physics content in the lesson plan about finding		
general equations of waves		
Seliciti equations of waves		

Based on Figure 6, it appears that PPTs did not describe the wave propagation process to the P point. So, in general we will had difficulty understanding the purpose of PPTs in explaining the general equation of waves, especially the location of o and P points. Supposedly, PPTs should put the figure illustrating the wave propagation in the lesson plan, because actually from the figure we might derive the mathematical equation [33]. Indeed, we should not claim PPTs have not mastered presenting Physics content effectively just by identifying the lesson plan, but through that planning we enable to predict the prospect and progress the PPTs' framework in exploring their PCK. The next analysis was related to PPTs' PCK regarding to the knowledge of instructional strategies. The lesson plan format has provided a column so that PPTs could determine the learning approach, model, and

method that would be implemented. Then, we could identify the learning strategies used in the sequential learning design. However, our findings indicated that PPTs lacked of understanding in choosing instructional designs that were in line to the content to be taught (see Figure 7).

F.	Metode Pembelajaran		
	Pendekatan	: Saintifik	
	Model pembelajaran	: Direct Instruction	
	Metode	: Ceramah, demonstrasi, tanya jawab.	
G. Media Pembelajaran			
<ol> <li>Media/Alat: Pegas, tali, batang statis, penjepit batang statis, kaki batang statis, beban, laptop, dan LCD Proyektor</li> </ol>			
2. Bahan :PPT, buku ajar, dan lembar post test.			
<b>Figure 7.</b> Instructional strategies in the PPTs' lesson plan about wave propagation topic			

Reviewing G point in Figure 7, it appears that PPTs seem to implement the experiment or demonstration procedure in their teaching strategy. However, what was described in F point explains contradictory facts. PPTs decided that they used Direct Instruction, it gave a nonsense learning to put a demonstration procedure in the conventional learning after all it was not enough to understand the concept of wave propagation just by reading and writing [34]. More surprisingly, PPTs did not explain how sequential learning they will apply. They only write the titles of the topics to be taught. This raises a big question in our heads, what is the matter with the development of PPTs' PCK. They seem to have no mastery at all about how to design learning scenarios that they must include in the learning planning document, one of which is a lesson plan. If PPTs are left in this state without being addressed, then the prospect of PCK going forward will be alarming [35]. We will gradually lose a generation of competent teacher candidates. Regarding knowledge of assessment shown by PPTs, it gave no better results. PPTs could not distinguish between forms and assessment techniques. In addition, PPTs have not been able to design an appropriate assessment instrument in accordance with the realm measured, namely cognitive, affective, and psychomotor. Even though, lesson planning and assessment are core tasks of teachers by their very nature [36].

#### 3.2.2. The case of futuristic aspect in lesson plan

PPTs actually did when they planned their lessons and found that that focused mostly on the interests and needs of their students. However, we sees a process that could be becoming a routine, whereby each planning event is influenced by what went on before and what may happen in the future. The starting point to analyze the case of futuristic aspect in lesson plan was identifying the learning goals. An effective lesson plan starts with appropriate and clearly written objectives [37]. An objective is a description of a learning outcome. Objectives describe destination we want our students to reach. Clear, well-written objectives are the first step in daily lesson planning. PPTs set the learning outcome for vibration and wave learning as follows: "after the learning process, students can analyze vibrations and the characteristics of mechanical waves and analyze their physical quantities". The objectives indeed help state precisely what PPTs wanted their students to learn. However, almost from a few lesson plans that we chose randomly showed that the learning sequential in the lesson plan could not help guide the selection of appropriate activities which leads to students' future needs, such as activities that can make students develop higher-order thinking skills [38]. The lesson plan did not provide overall lesson focus of future required skills and direction. A lesson plan was like a road map [39], which describes where PPTs hopes to go in a lesson, presumably taking the students along. While, 'the learning road map' did not illustrate that learning process that will take place could be a bridge for students to be sensitive to future demands and desired behavior skills. Based on these

Young Scholar Symposium on Science Education and Environment 2019	IOP Publishing
IOP Conf. Series: Journal of Physics: Conf. Series 1467 (2020) 012023	doi:10.1088/1742-6596/1467/1/012023

findings, we are not claiming that PPTs are not competent to become teachers, but rather there must be an alternative solution that can help passive PPTs in developing their PCK by starting with designing an appropriate lesson planning and considering futuristic aspects based on their need.

#### 3.3 A hypothetical model to develop PPTs' PCK dimension

Findings of the document analysis and interviews with PPTs, enable us to design a hypothetical model that could be used to help PPTs in developing even improving PCK. We use protocol instruments such as when we identify the PPT's early mastery of PCK dimension. Because later we will apply the model to the School Physics Course that will be taken by PPTs in the fifth semester, so we analyze the need for model development based on their perspectives. The results were then combined with the findings we have obtained previously. Some processes our passive PPTs sample expected to develop their PCK which will then be applied in the School Physics course they take were outlined in Figure 8. Figure 8 indicated that PPTs need more help with soft scaffolding to guide them in developing their PCK. Soft scaffolding was one type of assistance that was direct and dynamic [40]. In fact, soft scaffolding was proven to improve creative thinking skills [41], it means that soft scaffolding potentially can help passive PPTs in improving their higher-order thinking skills, especially in developing the PCK dimension.



The hypothetical model was design from the synthesis of soft scaffolding strategy. Design suggestion from interview results and literature study were embedded in the design and development step. Design step refered to determining learning approach, designing strategy framework, and mapping sequential srategy based on theoretical rationality. Theoretical rationality through literature study was conducted to obtain sequential mapping of learning activities derivatives that still refer to the empirical results of survey data. Finally we proposed an alternative strategy namely **EPISODE** (Encourage students, **Pick** the learning concept, **Simulate** the learning process, **Offering** further consultation, **De**monstrate the learning process) like in Figure 9.



#### 4. Conclusion

We have focused on the topic-to-topic lesson plan that face PPTs. Because we all have different styles of teaching, and therefore planning, the suggestion in this paper are not meant to be perspective. PPTs must allow themselves flexibility to plan in their own way, always keeping in the mind the yearly, term, and unit plans. In realizing lesson plans, part of a skilled PPTs logic in use involved managing such departures [from the original lesson plan] to maximize teaching and learning opportunities. Clearly thought-out lesson plans will more likely maintain the attention of students and increase the likelihood that they will be interested. A clear plan will also maximize time and minimize confusion of what is expected of the students, thus making classroom management easier. However, it seems that the prospects of PPTs' PCK as seen from the way they plan learning have not led to satisfying results. Therefore, the hypothetical model that we have designed hopes to facilitate PPTs in developing their PCK.

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#### Acknowledgement

The authors would like to thank to Research and Community Service Institutions, Lampung University for financial support of this study through the Beginner Research Scheme in accordance with Research Contract Number: 2514/UN26.21/PN/2019. The authors would like to thank to the experts as reviewers for some comment and suggestion to make the paper better.