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*Research Article*

# Learning Obstacles in the Making of Lesson Plans by Prospective Mathematics Teacher Students

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Prospective mathematics teachers' students must be able to build didactic situations that encourage students to actively learn. They must also be able to develop lesson plans independently. The facts found include lesson plans in the form of drill activities and the activity of downloading lesson plans from the Internet rather than compiling the lesson plans themselves, which are problems that need to be resolved. This study aims to analyse the learning obstacles experienced by prospective mathematics teacher students in preparing lesson plans. This research was a qualitative didactic design research with a focus on the analysis of didactic and metadidactic situations. The research subjects were three easily accessible prospective teachers, lecture administrators, lecturers from certain courses, and program administrators. Lecturers were chosen through the snowball method. The analysis of prospective teachers learning obstacles was conducted by analysing their actions, formulations, and validations during courses on curriculum analysis, media, and microteaching. The results showed that there were (1) ontogenic obstacles, namely, the readiness of students to attend lectures; (2) didactic obstacles, namely, imperfect learning materials and SLPs (semester lecture plans) that did not include elaborating and studying basic competence as indicators; and (3) epistemological obstacles, namely, the lack of opportunities for students to practise in the field, confirm, and validate the work they had produced with practitioners (i.e., school mathematics teachers). The results showed that there were ontogenic obstacles to student readiness, a didactic obstacle to learning materials used in lectures, and epistemological obstacles to the absence of interaction with schoolteachers. After knowing the learning obstacle of mathematics learning planning lectures, this research has implications for the development of lecture designs that encourage students to produce lesson plans. The lesson plans produced by students make school students learn actively.

## 1. Introduction

Mathematical knowledge is built from solving problems [1–3]. Based on the problem, a student will act mentally and then apply the way of thinking to solve the problem. The process of thinking occurs iteratively until knowledge is formed [2]. A person's expression of their thinking can be in the form of scribbles on paper, sketches of situations, or even thinking in silence. Meanwhile, the sign that knowledge has been mastered is indicated by the student's ability to prove a theorem through their process.

In principle, knowledge will be obtained epistemic. Epistemic knowledge will be obtained through the stages of perception, memorial, and introspective and finally formed a priori which is knowledge itself [4, 5]. The perceptual stage is done by responding to provided didactic situation. The memorial stage is marked by students taking mental actions to connect the results of the perceptual process with their experience, knowledge, and potential so that formulations (concepts, rules, evidence, problems, or problem solutions) are produced [6]. The introspective stage is an activity to rethink the resulting formulation and validate it through interactions between students and teachers. The final stage of building knowledge is the formation of a priori, namely, the activity of concluding knowledge in general.

Epistemic learning theories include the theory of didactical situation (TDS). There are 4 situations in TDS, namely, action, formulation, and validation to build institutionalization [7–10]. The action situation is the process of someone accepting the problem and carrying out activities to solve the problem. Problems are didactic situations built by the teacher as part of the student learning process. Action situations are in the form of hands-on activities or cognitive activities. The series of activities carried out in the action situation will form the formulation of knowledge. The formulation is the initial stage of knowledge received by a person in the form of understanding based on his experience. Initial knowledge that is understood by someone needs to be validated so that his knowledge becomes general. At this time, the knowledge experienced by someone has arrived at a validation situation. A series of action situations, formulations, and validations then form the knowledge institutionalization that can be used to solve problems in didactic situations in the initial stages of learning.

The didactical situation theory does not specifically apply to mathematics learning. In general, students often face problems in learning mathematics. These problems will encourage mental action and hands-on activities to form formulations [2]. The process continues with validation and knowledge institutionalization. The description means that a teacher must be able to build a didactic situation in the classroom. In other words, while studying to become a teacher, prospective teacher students are also required to understand how to build didactic situations in the classroom. The embodiment of this ability can be seen in the lesson plans produced by prospective teacher students. Besides lesson plans produced can build mathematical didactic situations, prospective teacher students are also able to develop lesson plans independently.

Building lesson plans independently means that prospective teacher students master the scientific knowledge that will be taught previously, embodied in a resume or concept map of a material. Furthermore, they reduce scientific knowledge into knowledge that will be taught to students. The reduction process involves the applicable school curriculum. After reducing knowledge, prospective teacher students then develop a device that can check the achievement of the knowledge being taught. This process is consistent with Chevallard's didactic transposition process [11]. The whole process must be passed by prospective teacher students to produce a lesson plan that can encourage students to actively learn.

Because mathematical knowledge starts from a problem, the teacher's ability to build problems is very important [12]. Problems that are used for classroom learning must encourage students' mental activity. Such problems must also inhabit the cognitive space the student has mastered with a small, additional level of challenge [13, 14]. In principle, this situation illustrates that the problems a teacher develop must originate from elements that the students have mastered [15]. The three statements above demonstrate the importance of prospective teachers' possession of these abilities when they graduate. Implicitly, the graduate profile has been contained in the graduate profile in the study program curriculum [16], UNNES Curriculum for S1 [17]. The graduate profile of the mathematics education study program can be a mathematics educator, researcher, and even an entrepreneur. As mathematics educators, graduates of the mathematics education study program can become educators in the field of mathematics who understand students, organize educational mathematics learning, master the scientific fields of mathematics and mathematics education, and have noble personalities. The focus of this research was the graduate profile who become mathematics educators.

Teacher candidates' education in Indonesia proceeds in two stages. The first, undergraduate education, is completed within 4 years. In this first stage, prospective teachers will focus on their academic skills and deepen their scientific knowledge. The second stage is professional education, which occurs over 1 year. In professional education, prospective teachers will focus on developing their pedagogical abilities. They practice composing lesson plans and media is then used to practice in peer teaching activities. However, in stage 1, undergraduate education, student-teacher candidates can do the same, although not as deeply as student-teacher candidates in the professional education stage.

During their undergraduate education, student-teacher candidates in Indonesia will generally study courses as shown in the following fishbone diagram (Figure 1).

The diagram above illustrates the flow of lectures that prospective teachers must pass to become good lesson planners. With an ideal learning paradigm, they will understand how to plan their students' future learning well when they learn to make lesson plans. A good lesson plan is indicated by, among other things, learning activities that encourage students to learn independently.

In the description of the curriculum of mathematics education, some subjects support prospective mathematics teachers in learning to construct instructive problems. These are analysis of school curricula and learning media, which are supported by many pure mathematics subjects. To gain further knowledge, prospective teachers must learn teaching practices in micro- and peer teaching. With the completion of these courses, the study program can be said to have prepared prospective teachers ideally. Students are required to become teaching professionals who can develop problems to help learners construct knowledge independently.

Given this ideal framework, how did prospective teacher students perform in the classroom? Some students (S1, S3, and S4) were able to build learning media with technology. S1 used augmented reality, while S3 and S4 used PowerPoint slides. However, the three research subjects were unable to inspire their students to learn independently [18]. The learning situation that was created has not been optimal in building knowledge. From the analysis of the learning tools they made, only S1 was able to build a plan starting from analysing the abilities students had mastered. S3 and S4 performed repetitive activities at

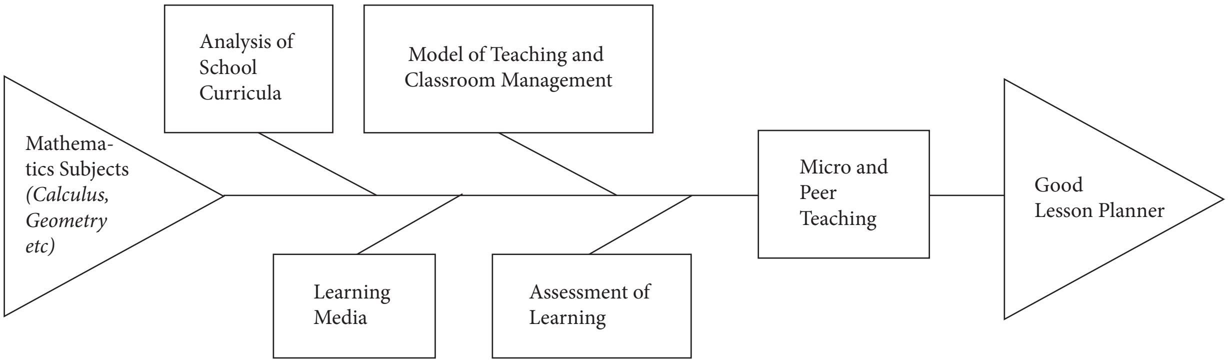


Figure 1: Fishbone diagram of subjects that prospective teachers must pass to become good lesson planners.

each planned learning stage. The three students were also able to create a problem for their students, but the problems were constructed such that not all of them encouraged students to respond mentally. The teachers (S1, S3, and S4) still explained a significant amount of material [18]. However, the media they used did not help students build conceptual understanding. The media the research subjects created tended to function as a tool to help teach the teacher (S1, S3, and S4), not as a tool to help the students develop a concept of the intended subject.

Student-teachers were believed to have attended lectures on school curriculum analysis, learning media, and micro- or peer teaching practices. S1, S3, and S4 have followed the Practice Teaching in Schools (PTS) curriculum, which means that based on the structure of the curriculum, they have passed these subjects (a participant labelled S2 removed from the study). However, the lesson plans the student-teachers designed did not reflect the hypothetical learning trajectory (HLT). The activity was intended to elaborate school students' basic competence (BC) into ICA (an indicator of competency achievement through the HLT) [19]. Designing activities for learning by repetition, as S3 and S4 did, was not incorrect [20], but by junior high school, the appropriate learning technique was to encourage students to think in tiers of knowledge [14].

Another fact is that S1, S3, and S4 did not prepare lesson plans independently from the first. The three subjects admitted that they modified the lesson plans they received. Two subjects modified lesson plans from seniors, while 1 subject modified from downloads on the Internet. The three subjects felt that there was nothing wrong with what they were doing because the material presented was the same as the lesson plan downloaded. Under the pretext of having modified lesson plans, they assumed that what they were doing was right.

The curriculum of the study program, which was designed according to best practices, and the student-teachers approaches indicate that there were learning obstacles in the lectures they attended. A learning obstacle describes a person's limitations in mastering a topic [7]. In this case, the limitations found pertaining to the preparation of a lesson that would encourage students to learn independently. These obstacles can be ontogenic, namely, the readiness of students to attend lectures related to the analysis of school curriculum and media; didactic, namely, the incompatibility between models, modules, and the resulting product; or epistemological, namely, the gap between theory and practice due to lack of practice [21].

By understanding the various obstacles that occur in training prospective teachers, the creators of the study program should be able to identify the necessary improvements to be made, whether rearranging the structure of the study program curriculum or simply improving the content of the courses. Lecturers will also be given sufficient information to make process improvements while the researcher will identify the source of the observed phenomena. This research is relevant because of the benefits and importance of learning obstacle analysis.

*1.1. Problem Statement.* The prospective mathematics teachers must be able to prepare lesson plans independently. The resulting lesson plans can also encourage students to learn. The fact that occurs shown that the resulting lesson plans did not help students to learn. In lesson plans, teachers still needed to explain the material rather than facilitating students to learn. They were also still downloading lesson plans from the Internet and getting them from seniors, rather than preparing lesson plans independently. This fact was reinforced by the results of a questionnaire in several teacher institutions that 58.3% (from 228 respondent of prospective mathematics teacher students in Indonesia) stated that they downloaded the lesson plans and modified them as needed. This fact shows that there are learning obstacles in planning mathematics learning. A study that wants to know the learning obstacles in mathematics learning planning and the implications for the realization of a lecture design needs to be carried out.

*1.2. Research Question.* To examine student learning obstacles, the following research questions are needed. What are the obstacles for prospective mathematics teacher students in planning learning? To answer this question, auxiliary questions are needed, such as what was the process of the previous mathematics learning planning lecture? How are the learning materials used in the lecture? What are the results of the previous learning planning lecture? The answer to this question will produce a finding about student learning obstacles in learning planning lectures.

## 2. Methods

This study adopted a qualitative didactic design angle with a focus on the analysis of didactic and metadidactic situations. This research was intended to describe the ontogenic, didactic, and epistemological obstacles leading to observed phenomena in S1, S3, and S4's teaching. The three research subjects are prospective mathematics teachers in the mathematics education program who have passed the PTS. This research involves students, lecturers, and policymakers and is equipped with complementary lecture materials. For supporting data, questionnaires were distributed to 6 teacher institutions in Indonesia, and 228 respondents were obtained. The main subjects were 8th-semester students who had practised teaching in schools. The lecturers who became the research subjects were the lecturers who taught Course A (related to school curriculum analysis), Course B (related to learning media development), and Course C (related to micro or peer teaching practice), which had been attended by 3 subject students. The main instrument in qualitative research was the researcher himself.

Data were collected through a series of document analyses, interviews, FGD, and field observations in the lecture classroom. Document analysis was conducted before interviewing the subject. The documents analysed include lesson plans produced by the subject and student worksheets produced during teaching practice in class. Because the subject is a practical student, before the interview, the researcher has made observations when the subject is practising teaching in the classroom. Interviews with student subjects were conducted 2-3 times with 1 interview duration of 30 minutes. Interviews with lecturer subjects were conducted 1 time with a duration of 45 minutes in one interview. FGD was conducted 2 times, 1 time with student subjects and 1 time with lecturers, to confirm the data collected through interviews. Field observations were carried out when the lecturer lectured on Course A, Course B, and Course C. This process is an iterative to find the cause of phenomenon [22].

To identify learning obstacles, the research analysed didactic situations in the course, including the stage of action, formulation, validation, and institutionalization. The analysis of action, formulation, validation, and institutionalization are stages of the Theory of Didactical Situation (TDS) framework. The meta-didactic analysis was performed through small-group discussion with lecturers who taught S1, S3, and S4 in their courses, to understand the lecture situation the student-teachers experienced.

The action stage is the process of prospective teachers designing lesson plans. The context of this research was the lecture process that occurred in Course A, Course, and Course C. The formulation stage is the student-teachers understanding of the concept of designing a lesson plan. In this study, student-teacher formulations are seen in the products of their courses. The validation stage involves interaction with other people who can objectively assess the created formulation. The validation in this study was a review of the lesson plan focused on elaborating BC to indicators, the student worksheets, and the activity planned for in school. Institutionalization is the new knowledge achieved by prospective teachers. The context of this study was the formation of knowledge and understanding of the process of preparing lesson plans that encourage students to learn independently. The phenomena described in Section 1 represent the institutionalization of prospective teachers' knowledge.

The analysis above was intended to identify learning obstacles consisting of ontogenic, didactic, and epistemological obstacles. Ontogenic obstacles were primarily whether students were mentally ready to receive lectures in Courses A, B, and C [21, 23, 24]. Ontogenic obstacles can be seen from the subject statement and analysis of the curriculum structure that applies when S1, S3, and S4 did the courses. Describing ontogenic obstacles by describing the structure of the curriculum, reinforced by descriptive narratives from the research subjects, has been conducted in previous studies [25–28].

Didactic obstacles can be identified by analysing the lecture process in the semester lecture plans (SLPs) and lecture materials. The SLP reveals whether the lecture process encourages student-teachers to produce lesson plans, worksheets, and media that will encourage school students to learn independently. Confirmation from research subjects S1, S3, and S4 as well as course lecturers will be specially meaningful in this process. The use of learning materials in lectures will also help to identify the didactic obstacles that may have occurred. Describing didactic obstacles by analysing learning tools, reinforced by descriptive narratives from lecturers or teachers, has been performed in previous studies [29].

Epistemological obstacles are whether S1, S3, and S4 have had enough practice, validation, and confirmation in the field (meeting with the teacher as a practitioner) regarding the lesson plans they have produced [21, 30]. Epistemological obstacles could be identified based on statements from S1, S3, and S4, and affirmed by SLP analysis. Confirmation from the lecturer offered crucial evidence to determine the epistemological obstacles in this study. This activity was similar to previous didactic studies [24, 30, 31].

The research subjects were chosen based on the snowball sampling technique, in which one research subject was identified through the opinion or analysis of the results from previous research subjects [32, 33]. The subject search scheme is shown in Figure 2.

This study was ethical and like previous studies [34, 35]. After all activities, at the end of prospective mathematics teachers' course of study, they practise micro- or peer teaching. In the curriculum structure, microteaching occurs at the end of the theoretical lecture period and is referred to as Course C.

Small group discussion was held for S1, S3, and S4 to confirm the phenomena that occurred to them. The discussion also identified lecture problems students experienced in Courses A, B, and C. Another focus group discussion (FGD) among the researchers, program

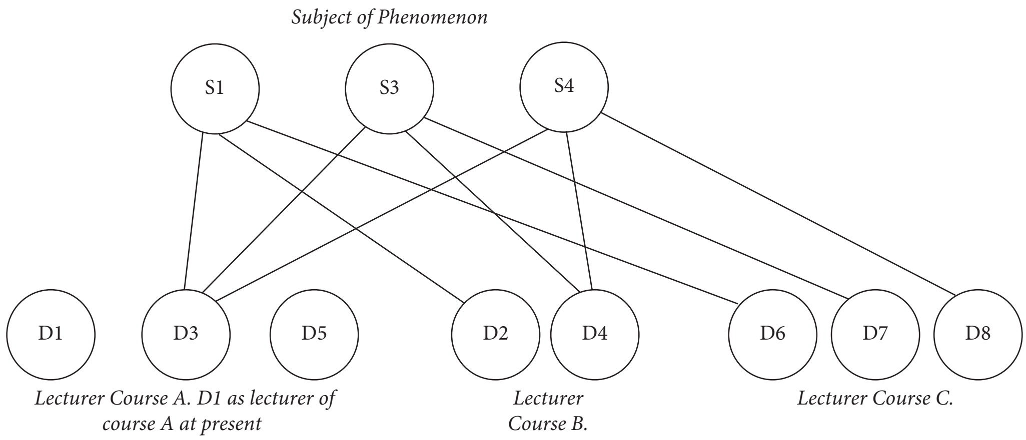


Figure 2: Subject search scheme for this study.

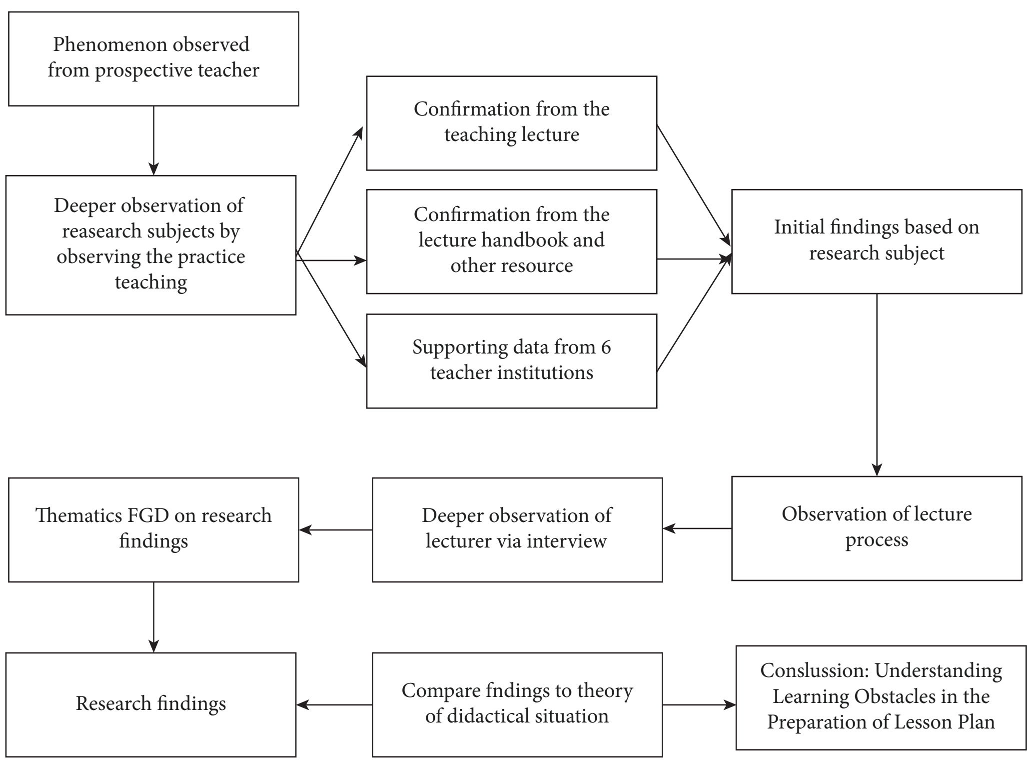


Figure 3: The research steps.

administrators, and lecturers were held to explore the lecture process in the three courses. This discussion ensured that the problems S1, S3, and S4 identified exist and need to be analysed to identify their causes. The data in this research were obtained through individual interviews and small group discussion. Small group discussion is important because the results obtained from these activities tend to be reliable.

*2.1. Data Analysis.* In this study, the data were analysed in two stages, a prospective analysis and a metadidactic analysis. The prospective analysis was conducted through observation, while the three subjects performed guided teaching practice in schools within 3 months. The results of this analysis were deepened by interviewing the three subjects to discover the causes of the observed phenomena from the three subjects. These subject interviews led to the first hypothesis of the problem phenomenon.

Metadidactic analysis was performed by making observations in lectures. Three lecture topics were observed, namely, analysis of curriculum (course A), learning media (course B), and microteaching (Course C). The results of the observations in the lecture were then confirmed by the lecturers in the three courses. The results of the prospective and metadidactic analyses were then examined for patterns of suitability. If the subject and other research sources provided inconsistent data, then the data were omitted. The results of the prospective and metadidactic analyses were then confirmed with TDS to identify the types of learning barriers prospective mathematics teachers encountered. The analysis is carried out to connect between theory and phenomena. The phenomenon that occurs is explained based on the theory of didactical situation [36].

This research was conducted after the phenomenon was discovered. The researcher then explored the phenomenon and hypothesized that it occurred by looking at various sources, research subjects, textbooks used, and lecturers in subjects related to the phenomenon. The research was then continued with observations in lectures on these subjects, followed by an in-depth investigation of the lecturers and ended with FGDs with policymakers. The research findings were then confirmed with the didactical situation theory to develop the conclusion of the research. The stages of this study are presented in Figure 3.

*2.2. Validity of Research.* The facts found in this study were traced and then concluded through the induction process [36]. The weakness of the induction process is the generalization of the research findings [37]. Therefore, this study requires 4 things that can be used to validate the findings, namely, credibility, transferability, confirmability, and dependability [38, 39]. Credibility is how confident the qualitative researcher is in the truth of the research study's findings. The data collected in this study will be triangulated. Triangulation involves the phenomenon subject, teaching lecturers, and learning materials used. Information from the phenomenon subject will be confirmed to the lecturer in charge through a one-to-one interview. From the collection of information from one-to-one interviews, the accuracy of the data was confirmed again in FGD involving managers [40].

From the triangulation activity, accurate information is generated on the research phenomenon. In this study, the desired information is the answer to the following questions: how do perspective teacher students prepare lesson plans? Will the lesson plans produced by them encourage students to learn independently? This information will help researchers to find their learning obstacles. In the end, research can provide input to managers on a lecture design that can minimize learning obstacles that occur.

Transferability is how the qualitative researcher demonstrates that the research study findings apply to other contexts [39]. In the education of prospective teachers in Indonesia, every prospective mathematics teacher will go through this process. Students will learn to prepare lesson plans that will be practised in practical schools. The learning obstacles found in this study can also occur in the education of other teacher candidates in Indonesia. The implication of this research is the realization of a learning planning lecture design (in the research location this course is called microteaching), which encourages students to prepare lesson plans that encourage students to study actively, which can be applied in various other prospective mathematics teacher educations. In this context, the transferability process runs.

Confirmability is the degree of neutrality in the research study findings [39]. In other words, this means that the findings are based on participant responses and not any potential bias or personal motivations of the researcher. This involves making sure that researcher bias does not skew the interpretation of what the research participants said to fit a certain narrative. To establish confirmability, qualitative researchers can provide an audit trail, which highlights every step of data analysis that was made to provide a rationale for the decisions made. This helps establish that the research study findings accurately portray participant responses.

This research starts from a phenomenon. The search for phenomena that occur is carried out by interviews and FGD on the phenomenon subject. The information obtained in the interview was strengthened by FGD on the subject. The information obtained by the subject students is then confirmed to the lecturer in charge of the courses and learning materials used. Some information is then narrowed down so that it becomes standard information that has gone through various stages of data collection. With the various stages of the research, the data in this study have been confirmed by various parties. In this context, the principle of confirmability has been implemented in this study.

Finally, dependability is the extent that the study could be repeated by other researchers and that the findings would be consistent. This study will explain the various learning obstacles that occur in perspective mathematics teacher students. The implication of these findings is the realization of a learning planning lecture design that will help prospective teacher students produce lesson plans. The results of this study will help lecturers in other universities replicate the research results and apply them in their respective local lectures. Of course, other lecturers need to adapt to the local context, but in principle, this lesson plan learning plan document can be applied elsewhere. The results of this study (in the form of a semester lesson plan) were also consulted with experts outside the researcher. In this case, the principle of dependability has been met in this study.

## 3. Results and Discussion

*3.1. Results.* Three elements became the focus of this study, namely, analysing the school curriculum, developing media, and prospective mathematics teachers' preparation of lesson plans. The focus of the discussion with the three instructors, D1, D3, and D5 is on student activities in Course A lectures, starting from curriculum analysis activities to producing student worksheets. This aligns with the achievement of course competencies: "Students can study, explain, teach, and develop learning tools (lesson plans, learning materials, and assessments) for school mathematics in junior high school (JHS) and senior high school (SHS) following the current curriculum. . . . " (UNNES Curriculum for S1 [17].

D1 experienced a unique trajectory. D1 taught Course A according to the 2016 study program curriculum and after the change instated by the 2020 curriculum. Course A, before the change, contained activities to work on and discuss math problems at the junior and high school levels. After the changes were imposed, the activities of discussing

Table 1: Course A lecture SLP snippet.

| Lecture topic | Forms of learning; learning methods; student assignments<br>Face to face (FF), practicum (pr), seminar (S), practice (P), individual task (IT), structured assignments (SA) | Time | Assessment techniques and indicators |
|---|---|---|---|
| a) Reviewing the core competencies (CC) and basic competencies (BC) of JHS level VII<br>b) Developing learning indicators and scenarios following CC and BC | Form: FF<br>Activities in class: discussion/brainstorming, presentations, lectures, and question and answer with PjBL learning models; enrichment of posing problems.<br>Online: flipped classroom learning, Elena, and WhatsApp group<br>Task: SA<br>(1) Prepare presentations with groups, and make projects on developing indicators and learning scenarios at BC JHS level VII<br>(2) Presentation and discussion to analyse indicators and learning scenarios at BC JHS level VII | FF:<br>$2 \times 3 \times 50$'<br>It:<br>$2 \times 3 \times 60$'<br>SA:<br>$2 \times 3 \times 60$' | Indicator<br>Students can (1) develop indicators according to CC and BC at JHS level VII and (2) design learning scenarios according to CC and BC at JHS level VII |

questions and analysing basic competence were separated into two different courses. D1 conducted the lecture before the pandemic and during the pandemic. Changes in Course A's content made the online lecture process a challenge.

As Table 1 shows, Course A lectures were conducted online. Activities describing BC and indicators were performed as project tasks. The results of the project were then presented to ascertain whether students understood how to describe BC to achieve indicators. D1 confirmed that, before the activity of translating BC into these indicators, the students received materials about the definition of curriculum and curriculum development. During this activity, D1 presented material on how to describe BC as an indicator. D1 also provided several reading sources and concepts that students could read [41]. What D1 did was not problematic. At these students' age, information can be understood by reading [42]. However, the students' reading culture should always be developed, not only through textual reading but through critical reading. Students must continue to discuss to build their curriculum literacy [43]. The following is an excerpt from the researcher's conversation with D1 which states this:

> *Researcher (R).* So that students can carry out indicator development projects, how is the lecture process that you do?
>
> *Subject D1*: I give an example in the form of learning materials. In the learning materials, there are examples of how to describe basic competency (BC) into indicators. Then I direct students, especially in the scenario section, so that students adjust to the model that will be used.
>
> *R.* Just by reading the examples, is there any problem with the lecture process?
>
> *D1*. Actually if you are forced, the student can do it, sir. By being forced, students will still be able to. It's just that with many tasks, of course, the knowledge is not perfect.
>
> *R.* How sure are you those students can describe BC as an indicator?
>
> *D1*. I believe student success is 50%, sir. To make indicators, students need an assessment concept, such as bloom, and this first-semester student has not yet received it.

This activity only occurred during the pandemic. D3 confirmed that the Course A lectures when the three research subjects took the course were conducted in the old pattern. Students analysed the depth of material in a BC by working on school math problems and discussing them [44]. The activities D3 conducted at that time aligned with the SLP compiled with the Course A teaching team. The assumption was that, by discussing school math problems, students would be able to understand how to teach the material [41]. This assumption was not wrong. By solving problems, students become more critical and creative [45, 46]. The following is an excerpt from an interview with D3:

> *R.* So there are facts, perspective teacher students are less successful in describing BC as an indicator. In preliminary research, the first step resulted in the student learning steps not being successful. In the end, they re-explain the material, instead of encouraging students to think. What do you think?
>
> *D3*. When students attend lecture A, they always discuss about BBC Indicators, and Bloom's Taxonomy, but not in detail. Whereas if students make BC 3 indicator, it's still not optimal if BC is about upward analysis. Those with BC skills, they must focus on solving related problems. I directed students to read the skill taxonomy of Marzano et al, but it has not worked yet.
>
> *R.* What is the process in lecture A so that you can encourage students to produce indicators of BC?

*D3*. I usually invite them to watch explanations about Bloom's taxonomy on YouTube. Then look at the verbs that can be used to make indicators. Followed by compiling indicators, it seems that there is a need for an explanation of the dimensions of knowledge according to Bloom's revision, sir because I did not discuss it in lecture A at all. Sometimes I get confused about which one is discussed in A and which is in other courses.

Furthermore, the researcher confirmed these data with D5. D5 explained the changes in the content of Course A and the desired student products in detail. D5 thoroughly discussed the student worksheet, which visualized the translation of BC into indicators. BC could be achieved with more than one indicator. A student worksheet, as a teaching aid, can achieve one or more indicators. From this student worksheet, we can see the real activities the teacher conducted (S1, S3, and S4) in the classroom. If the student worksheet did not align with the lesson plan, it indicated an error in the transfer of knowledge in Course A [47]. This showed the common mistakes of prospective teachers who were not optimally prepared for teaching practice [48]. The following is an excerpt from an interview with D5.

*R*. How is the process of changing the content of the curriculum review 1 course, which was originally a practice question, into an activity to analyse the curriculum?

*D5*. Well, the process started with the fact that indicators are teacher authority. So of course, lecturers must have a place to train prospective teacher students to have that ability. It was this philosophy that made me propose to change the content of the curriculum review course. In principle, one BC can be broken down into several indicators. These indicators are then realized in student activities contained in the worksheets.

*R*. What do you think about the phenomenon that I found, that the student worksheets produced by students do not reflect the activities that have reached BC?

*D5*. I have said before that BC, indicators, and student worksheets must be in harmony. If it is found that there are things that are not in harmony with students, it is necessary to check what courses are training them.

From this discussion with D1, D3, and D5, there is a pattern of incompatibility that the three of them agree on. Students learn to develop lesson plans in Course A by reading and indicative of examples. This does not give students experience in preparing lesson plans from scratch. The discrepancy between the lesson plan and the student worksheet is due to the lack of experience of prospective teacher students in preparing lesson plans. Experience is one of the important things in the process of becoming a teacher. Graham [49] said that the skill of preparing a good lesson plan will emerge with a lot of experience.

S1, S3, and S4 made lesson plans well. The learning process was designed in stages, with a thinking stage starting from what students understood to developmental activities [50]. However, after further investigation, the resulting student worksheet did not encourage students to develop their knowledge. Students better understood the material from the teacher's explanation. The interview with D5 also revealed that the indicators compiled by S3 and S4 were not indicators.

Table 2 shows the phrase "Using Cartesian coordinate planes," which is not a true indicator. The phrase prevents the teacher from achieving the indicators. The keyword in the indicator above was the phrase "to determine the position of the point to the origin (0, 0) and showing the origin" ([47]). D5 also stated that, to describe BC as an indicator, student teachers must have mastered pure mathematics. This discussion suggested that prospective teachers should take Course A in semester 3, contradicting the current pattern of students taking Course A during semester 1. This was an important finding of this study.

The results of the confirmation of findings were then related to Course B. Researchers focused on the media used by S1, S3, and S4 when they did PTS. From the confirmation of the three subjects, the search for research findings continued to D2 and D4. The confirmation activity with D2 revealed that, in the process of media preparation, prospective mathematics teachers were directed to use the ADDIE stages (analysis, design, development, implementation, and evaluation) for the development process. The analysis stage was intended to consider the basics and review the latest technology that could be used in learning the material [51]. At the design stage, prospective teachers also analysed the right learning model. D2 stated that several student-teachers were imprecise in choosing the type of technology and learning model used.

Unlike D2, D4 prioritizes discussing the nature of learning media. The media used for teaching must encourage students to do mathematics. D4 explains that mathematical activities can involve touching, moving, sharing, and other activities [52]. S3 and S4's selection was not a learning medium because it only displayed the teacher's instructions rather than inviting students to do the math. This finding is another important note of the research.

D4 is also considered the use of technology in learning. Not all mathematics topics were suitable for teaching with technology. D4 gave an example of studying the surface area of a block. He argued that physical media, which gives students the experience of feeling and manipulating the block's surface, is better than any broadcast media. Even when the researcher proposed augmented reality, D4 argued that the use of physical media to learn about the surface area was better. D4's statement aligns with several studies that suggest that manipulative media is very meaningful in learning mathematics [53]. D4 does not deny that the use of technology will increase students' learning motivation. However, as a principle of learning mathematics, strong motivation was not the only path to the discovery of knowledge. In the principles of learning mathematics, motivation will encourage children to guess, ask questions, cut, write, draw, and perform various other mental activities. Mathematical activities can arise with didactic problems posed by the teacher, regardless of the medium [2, 54].

Table 2: The snippet of ICA made by S3.

| Indicators of competence achievement |
| --- |
| 3.2.1. Using the Cartesian coordinate plane to determine the position of the point to the origin (0, 0) and show the origin |

Interviews with S1, S3, and S4 were then strengthened by FGDs between the three subjects which led to new discussion related to Course C. In Course C lectures, the three research subjects stated that there was no learning activity to make lesson plans. The following is an excerpt from the FGD that stated the following fact:

> *R.* So, actually, when did you guys learn to make a Lesson Plans?
>
> *S1.* E. . . I'm not sure, sir? Actually, since 1st semester we have been introduced to the form of Lesson Plans, but I just realized now, it turns out that I have never been taught when did we learn to make lesson plans.
>
> *R.* What about you S3, S4? When did you learn to make a Lesson Plan?
>
> *S3.* In Course A, we made lesson plans, sir. But, we were only given an example and then followed the example. In other subject it's the same. We were given an example, then we just adjust the example.
>
> *S4.* Actually, in many courses, we were given the task of making lesson plans. But similar with S3, the process was given an example and then we adjusted it according to our thoughts.

Students learned independently through examples of lesson plans given by lecturers and finding other examples online. In Course C lectures, the three research subjects also stated that validation activities with their peers and teachers were lacking. As a result, they conducted their plans without knowing whether the plans they had drawn up were good or not [55].

The Course C learning process turned out to have variations because there was no standard procedure for Course C lectures. In the SLP, information about lectures was very general. There were no standard steps the lecturer for Course C had to follow. For example, D6 validated students' mathematical abilities by assigning them to compile a concept map of mathematical material. So, every time they prepared a lesson plan, the students first had to prepare a concept map, describe the translation of BC into indicators, and then compile the lesson plan [56]. The lecture path using a concept map was not present in Course C lectures taught by others.

*3.2. Discussion.* Based on the description of the implementation, the results of the analysis based on the TDS can be described as follows.

*3.2.1. Action.* Students have learned to translate BC into indicators in Course A. Student-teacher candidates have also started to think about what media could be used in teaching certain materials in Course A. However, the discussion conducted by students was not optimal because Course A participants were still in their first semester. Their knowledge of mathematics was incomplete. Furthermore, students learned to make learning media in Course B. Although the media produced was not related to the analysis students conducted in Course A, the process of making learning media in Course B was quite good. Discussion between lecturers and students was productive and iterative. In Course C, students prepared lesson plans based on the examples provided and those they found online. Students also practised lesson plans that were arranged online or offline. In the process of making lesson plans, students conducted mentoring activities and practised iteratively.

The failure of the resulting lesson plans in encouraging students to learn independently shows that there were problems in the implementation of lectures. Because Course C synthesizes the knowledge of prospective mathematics teachers, the Course C lecture process is naturally very important. Prospective teachers in lectures should not only listen to explanations, read literature and learning materials, and study examples of lesson plans but also be given examples of how learning encourages students to learn independently through experiential learning and discovering concepts themselves. Ideally, the process students will experience will also be experienced by prospective mathematics teachers during their education, so that, in the action stage, teaching students will not only plan to learn for their students but also experience learning modelling.

The education of prospective teachers from an early age seems to be important for their success. The importance of the integration of activities for prospective teachers has been understood for a long time. Other studies suggest that the action activities above should also be conducted by other teaching institutions. It was said that a prospective teacher must understand the vision and mission of being a teacher [57]. They should also meet with their schoolteachers often, as a habit. Early adaptation to the school environment will help student-teacher candidates to make the transition from learning to teaching especially during a pandemic [58].

This action stage requires scientific knowledge of mathematics. The knowledge of prospective mathematics teacher students who attend mathematics lectures is used by them to prepare lesson plans. In transposition, this action stage is realized by scholarly knowledge of prospective teacher students. The form of scholarly knowledge can be in the form of a description of mathematical knowledge or a concept map. Concept maps are one way to see a person's breadth in understanding a context. And, this is the ability that needs to be possessed by prospective mathematics teachers [59, 60].

*3.2.2. Formulation.* In the context of making lesson plans, formulation occurred independently for each prospective mathematics teacher. They tended to download the lecture material, particularly the example lesson plan, from the Internet. Lecturers provided examples of completed lesson plans and learning materials but did not give information on how to plan a lesson. The learning materials compiled were in the form of information about how to become a professional teacher and how to conduct lectures for Course C. The prospective teachers had to use their memories and perspective to understand how to build a good lesson plan.

The failure of the lesson plans produced by prospective mathematics teachers to encourage students to learn independently showed that student-teacher formulations in planning learning were incomplete. Student formulations of planning learning occurred at the stage of duplicating or modifying other people's lesson plans. The activity of analysing BC and translating BC into indicators occurred in several courses, including Course A. By Course C, prospective mathematics teachers were assumed to have undergone this process. However, because the curriculum analysis process and the teaching practice are temporally too distant (4 semesters difference), students tended to omit the process.

*3.2.3. Validation.* The validation stage is generally performed by the lecturer. In lectures, students did not have many discussion with their cohorts to find errors in their work. Validation was conducted by lecturers in the form of presentations in class. In Course B lectures, the validation process ran iteratively in 3–5 guidance sessions, while, in Course A and C lectures, validation occurred only once. A single validation in lectures was not a problem. However, considering the quality and creativity of prospective teachers' work, the quantity of guidance required becomes apparent. The ideal amount of guidance for students' work remains to be achieved.

In the three courses, based on the SLP analysis, there were no student activities that were directly relayed to the teacher. Students and lecturers conducted all of the activities on campus. The involvement of teachers, as practitioners, could feasibly be tested in the design of future lectures. If the validation process runs smoothly with friends, lecturers, and schoolteachers, the process of validating the work of prospective teachers would be achievable.

This validation stage is easy if students have a sense of belonging. Having a sense of belonging means that they feel that what is done on campus will be done by them at school. It was suggested that, by involving the community, student teachers will have a sense of belonging; thus, in the education of prospective teachers, the involvement of practitioners is important [61]. Another research finding also fully supports increasing contact with practitioners and adds that the more often student-teacher candidates meet and connect with schoolteachers, the more insight and knowledge they gain [57].

*3.2.4. Institutionalization.* The whole process of action, formulation, and validation show that the lectures were not optimal. This lack of optimization also manifested in the results of the institutionalization of prospective teacher students S1, S3, and S4. Prospective mathematics teachers were manifestly unable to prepare lesson plans independently and even less capable of developing lesson plans that encouraged students to learn independently. This shows that there were learning obstacles in the lectures. The researcher divided the obstacles identified into three types: ontogenic, didactic, and epistemological obstacles [21].

Finding 1: S1, S3, and S4 were mentally ready to take Courses A, B, and C. In the 2016 curriculum (the curriculum at the time they studied), Course A and Course B were implemented starting in semester 4. S1, S3, and S4 also stated that they were ready to attend lectures. This was reinforced by D1 and D3's statements that the curriculum review lectures in the advanced semesters were more successful. Curriculum expert D5 stated that Course A lectures should occur as soon as possible in semester 3 so that students would be mentally prepared. This mental readiness aligns with the cognitive development and habituation of students [14].

This indicates that S1, S3, and S4 did not experience an ontogenic obstacle. The research subjects were mentally ready to attend lectures. Another problem appears in the content of Course A. In the Course A lectures, the philosophy of analysing the curriculum was translated into practising school math problems. S1, S3, and S4 did not experience this change in Course A content. Ultimately, new findings emerged, namely, the existence of didactic obstacles in the lectures. The content of the material presented in the lecture did not help S1, S3, and S4 to be able to describe BC as indicators. Naturally, this affected their ability to create constructive didactic situations. If the information received did not adhere to the objectives, it would have a natural impact on the prospective teachers' abilities to plan learning [48, 62].

However, there were changes in Course A lectures in 2020. The 2020 government-mandated curriculum requires the study program to prepare students to be ready to work in semester 5 (UNNES Curriculum for S1 [17]. This means that, in five semesters, all compulsory lectures must have been completed. This curriculum format dramatically altered the curriculum structure of the mathematics education study program. Course A, which was typically in a middle semester (3, 4, or 5), became a mandatory semester 1 course.

This change drew the researchers to assume that students were not ready to receive the material. D1, D3, and D5 agreed that changes in the curriculum format by placing Course A in semester 1 would not allow prospective teachers to master the curriculum review activities. D1 stated that, in the 13 sessions that had occurred by December 2020, the achievement of competencies was not more than 55% of the target. In other words, in terms of competence, students have not been able to achieve the goals of the course. D3 reinforces this fact with his teaching experience. When Course A became a mandatory course in semester 1, the achievement of new student competencies was very unsatisfactory. D5 stated that Course A should be taken after students had gained experience in content courses. When students took Course A with weak competence in mathematics content, they were unable to imagine how to understand students' needs when teaching the material. This means that the students participating in Course A in semester 1 were mentally unready [14] and demonstrates problems with the lecture design creating ontogenic and didactic obstacles for prospective teachers [9, 21, 63].

Finding 2: the Course A lectures were found to be suboptimal. Some elements that were considered suboptimal were caused by the absence of an empirical practice process. Students conducted curriculum analysis activities based on theories that they read and discussed together with lecturers and colleagues. Empirical activities such as meeting with teachers and discussing the results of curriculum analysis with practitioners were important for students. By meeting practitioners, student-teacher candidates will gain experience in the field and get input on the analysis conducted in the course. This empirical activity will encourage student-teacher candidates to be creative based on real activities in the field [48].

The absence of activities that intersect with practitioners and the field was one of the obstacles to learning for prospective teachers. If they are familiar with theoretical activities, student-teachers need more time to adapt when conducting practical activities [64]. Practical activities will bring student-teacher candidates closer to the world of education for when they enter the field after college.

This shows that prospective teachers in Course A experienced a gap between theory and practice. This shows that the epistemological obstacle of Course A occurred in the lack of practice activities to discuss the results of curriculum analysis with practitioners or teachers in schools [21]. These obstacles were discussed with D1, who approved the finding and stated that training activities and discussions with teachers and practitioners will be implemented in Course A in the future.

Finding 3: discussion and confirmation from D2 and D4 resulted in a new finding that lectures need to include activities that encourage students to analyse which topics can be addressed with technology-based learning media. This discussion arose because S1, S3, and S4 all used learning media in their teaching practice. However, S3 and S4 only used technology (PowerPoint) as teachers to deliver instructions rather than to help students engage with concepts. S1 used better media, namely, applications utilizing augmented reality. Virtual media produced by students is expected to increase students' creativity while studying [65].

Weaknesses were found in the lecture activities, namely, the absence of an analysis of the suitability of the course material for the technology used. Course B lectures have never included such an activity. D4 affirmed the researcher's conclusion and confirmed that an analysis of the suitability of the course material for technology has never been conducted. Student-teacher candidates tend to make media based on their desires and innovations rather than considering the nature of teaching or whether the media would encourage students to learn [66]. On the subject, the use of PPT and AR as learning media did not add value to the technology itself. The fact showed that the didactic design of using AR did not encourage students to learn independently, meaning that the quality of learning by utilizing AR was not optimal [67]. In an ideal context, learning media and technology used should support learning. Teachers must understand the concept of technological pedagogical content knowledge (TPACK) in compiling media [68].

Student-teachers must analyse the suitability of course material for technology in Course B. This activity will guide prospective teachers in choosing the technology to use to create media. D4 argues that not all technologies suit the material to be taught. In the matter of surface area of blocks, for example, D4 believes that giving students toothpaste boxes is more meaningful to teaching the material than using a computer slideshow, even though it looks better than cardboard boxes. Experiential activity is one of the components of active learning [69].

Finding 4: the Course C lecture at the end of the process of preparing prospective mathematics teachers at the undergraduate level should have a guiding concept. The roadmap for this course has not been developed. In the future concept, the action, formulation, and validation process lead to the institutionalization of students' understanding of the role of a professional teacher in Course C lectures. In the activation process, prospective mathematics teachers must learn how to transpose their knowledge or translate the mathematical knowledge they possessed to convey it to school students. A prospective teacher must select the material that needs to be conveyed to students according to the level of the students' thinking abilities. For example, a teacher must decide whether junior high school students need to prove or simply understand the concept of the similarity of sets. In the formulation process, the preparation of the lesson plans from the beginning–guided by teaching modelled by the lecturers–will help student-teachers understand the process of forming student knowledge. The process of analysing BC and making media was summarized in several sessions of Course C to reveal past knowledge. The idea validation process naturally involves an active schoolteacher. In the future Course C lecture model, teachers should be included in lectures. Teaching institutions cannot stand alone as the sole agents of training teachers. Collaboration with stakeholders is necessary. All of the ideal concepts of action, formulation, and validation will lead to the institutionalization of prospective teachers' knowledge. The most obvious result of thorough institutionalization is a good teaching practice, which encourages students to learn independently. The impact that can be seen is that the lesson plans prepared by student-teachers will show student learning activities focused on experiencing, interacting with, and communicating their learning.

Finding 5: in the education of prospective mathematics teachers, some elements have not been implemented in an integrated manner. Courses A, B, and C were administered with partially distinct competence achievements for each course. The integration of the courses is very important because every process that was followed by prospective teachers in educational lectures models the process they will conduct in schools. The process of analysing the curriculum in Course A, making media in Course B, and practising all preparations for teaching practice in Course C were mini-processes of being a teacher. Inconsistent competencies will interfere with prospective mathematics teachers' understanding.

All of these findings indicate that being a teacher at the beginning of their tenure is quite a challenge. Four elements become the foundation of being a mathematics teacher, namely, mastering mathematical content, mastering pedagogy, mastering classroom management, and understanding students' social conditions. The five findings above are a guide to understanding the pedagogical context and the mathematics content necessary for successful instruction. This aligns with Ergunay and Adiguzel's [70] findings that these four elements are crucial for first-year teachers.

*3.3. Implication.* By knowing the learning obstacles that occur in perspective teacher student, the mathematics education curriculum can be seen again in the content of the lectures. In a time of urgency, improvements that need to be made immediately are designing lectures that help students to plan to learn. The subjects that need to be redesigned include curriculum analysis, mathematics learning media, model and basics of learning mathematics, evaluation of mathematics learning, and microteaching. Student learning obstacles that are found require practical and short actions. A summary of all the competencies needed by prospective mathematics teacher students can be seen in the microteaching course, and the redesign of the microteaching lecture design must be carried out immediately.

Lecture design that is produced based on analysing obstacles includes analysing scholarly knowledge, identifying student needs on the material, compiling HLT, developing student worksheets, the flow of learning objectives and student learning activities, identifying competencies and instruments to check student competency achievements, and ending with micropractice and peer teaching using lesson plans that have been developed based on student activities. The stage before the micropractice and peer teaching is a process of mathematics transposition from mathematics as scientific knowledge, into mathematics that students need at school.

The form of lecture design is in the form of SLP. The resulting SLP has been discussed with several experts and obtained input for improvement. In general, experts did not comment on the structure of the lecture sequence, but on the technical aspects. One of the inputs from experts included attention to process standards and content standards from the mathematics curriculum. At the time of compiling the lesson plans, students may not go out of these signs. The results of expert review 1 (code: IS) on the question "Please provide input for the process of preparing learning plans by prospective teacher students designed in the lesson plan, what process improvements need to be made?" The answers are as follows.

The preparation process is good and coherent; however, some improvements are needed in the preparation of the lesson plan, including the following: (a) it is necessary to reexamine the lecture achievement (LA) formulation, especially related to general skills and special skills. Existing sentences need to be adjusted to show skills not knowledge; (b) for Course LA (CLA), it is necessary to arrange hierarchically starting from CLA 1 onwards which describes the stages to achieve LA through this course; (c) sentences in the course description need to be rechecked so that they have more meaning in sentences and adjust the current curriculum terminology; (d) for sub-CLA it is necessary to formulate following the order in the CLA; (e) microteaching is a learning activity that trains students in several teaching skills separately, so it is necessary to add discussion activities related to these basic teaching skills before students carry out peer teaching activities.

Expert 2 (Code IH), on the same question, also gave a similar comment. IH commented on the focus of the compiled SLP. In the SLP 1 draft, as an exercise, students were asked to focus on the set material. However, after receiving input from IH, the focus of the material was removed. Students are welcome to choose the material that they understand best.

In terms of student independence in preparing lesson plans, IH commented as follows:

Following the methods designed in the lesson plans, which include classical lectures, individual lectures, and independent activities, these learning materials facilitate students to be independent. The fulfilment of CLA is largely determined by the success of students in implementing group and individual tasks, considering the ability to design mathematical material (algebra, arithmetic, geometry, and statistics) has different characteristics. It is necessary to prepare a form of control (guarantee) to ensure students complete the assignments well. If this has been determined in the form of a student portfolio, it should be made explicit in SLP.

On the same question, regarding student independence in preparing lesson plans, IS stated the following.

This learning material will encourage students to independently prepare lesson plans, not just relying on copy and pasting from the Internet, so this independence process needs to be built starting from the responsibility of communicating the indicator from BC that has been determined.

From the opinions of the two experts, information was obtained that the SLP compiled involved step-by-step transposition activities described in each meeting in the lecture. The transposition activity was carried out in 3 lectures from the planned 16 lectures. SLP also encourages student independence in preparing lesson plans independently. With gradual activities, it is believed that students will work on progress independently. In its development, the design of lectures in the form of SLP needs to be added a control mechanism, to ensure that students compose independently. This design supports the findings of previous research that this self-study policy is needed at this time and in the future [71]. Learning step-by-step is one way to self-study [72]. The research summary from phenomenon observed to the research implications can be seen in Figure 4.

*3.4. Limitation.* The findings of this study were limited to subjects in the mathematics education study program. The main subjects of this study consisted of 4 prospective

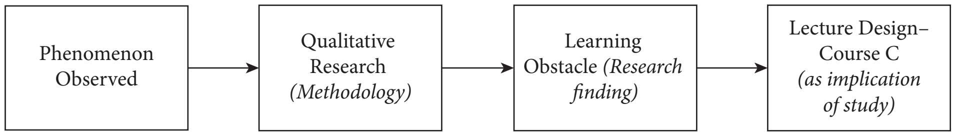


Figure 4: Research summary.

mathematics teacher students (later reduced to 3) who had practiced teaching in schools. The research subjects then developed to 8 lecturers of Course A, B, and C. Supporting respondent data comes from 6 teacher institutions spread across Central Java, Yogyakarta, Banten, and South Sulawesi. The learning obstacles found in this study occurred based on the phenomena found in the subjects. This phenomenon was traced in depth to the lecturers and teaching materials used in course A, B, and C. Courses A, B, and C at other teacher institutions may have different names. The characteristic of course A is about school curriculum analysis, course B is about learning media, and course C is about making a lesson plan.

The research subject is an academic community (prospective teacher students, lecturers, and managers) at the State University of Semarang. The research took place from July 2020 to January 2022. Because it is qualitative research, of course, the generalization of these findings depends on the characteristics of students in each local LPTK. To use the results of this study, lecturers and/or administrators of study programs outside the subject can observe the lecture curriculum, focusing on mathematics learning planning lectures. Another limitation is that the research was carried out in 3 varying conditions, namely, online, hybrid, and offline courses. These conditions may lead to different results in the future. Attention to the various limitations of these conditions is highly recommended.

## 4. Conclusion

The description above shows that, in learning planning by prospective teacher students, learning obstacles are found in a series of educational programs to become mathematics educators. Students concluded that they did not have empirical knowledge of the curriculum and analysis of the school curriculum. Students also have not been able to compile HLT and choose media that are appropriate to the material and apply it correctly in learning. This is from the facts and analysis carried out in lectures in courses A, B, and C. Prospective teacher students also have not been able to determine the media and how to apply the media to encourage students to actively learn. The series of obstacles in courses A, B, and C convinced researchers that prospective mathematics teacher students experienced learning obstacles in preparing lesson plans. The obstacles were elaborated into three types: ontogenetic, didactic, and epistemological obstacles. The results show that ontogenic obstacles occurred through curriculum format changes, but these obstacles did not affect the research subjects. Didactic obstacles occurred due to imperfect learning materials and SLP that did not reflect the lecture process to encourage constructive activities among all students. Epistemological obstacles occurred because of lack of opportunities for students to practise and communicate with their instructors to validate or confirm the success of their lesson plans. These learning obstacles are used as information to develop a learning planning lecture design as part of the implications of this research.

There are 2 things that are suggested in this study, namely, (1) curriculum analysis lectures (course A) are not placed in semester 1. New students need to adapt to the teacher culture, master mathematics, and understand the regulations that apply in the field; and (2) student-teachers must analyse the suitability of course material for technology in Course B. The conclusions of this study indicate that building a new lecture design, it can be started by analysing learning obstacles based on the phenomena that occur. The application of lecture design, testing its effectiveness, and seeing student responses can be used as starting material for further research. The topic of learning evaluation can be used as the next topic to continue this research.

## Data Availability

The interview data for my research subjects are published openly through the YouTube page. Meanwhile, video interviews with teaching lecturers and video focus group discussions are placed on Google Drive with closed access. We will open access upon request and with a strong enough reason.

## Conflicts of Interest

The authors declare that they have no conflicts of interest.

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