Preface

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The 7th South East Asia Design Research International Conference (SEADRIC 2019)

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Faculty of Teacher Training and Education, Universitas Sanata Dharma, has become the host of the 7th South East Asia Design Research International Conference (SEADRIC 2019) from 25 to 27 July 2019. The conference has served as a forum to bring together researchers from the field of education in studying learning from the design research perspective. The forum emerged in the early 2010s with the first three SEADRIC held in 2013, 2014, and 2015 at Universitas Sriwijaya, Palembang. Subsequent SEADRIC events were held at Universitas Negeri Padang (2016), Universitas Lambung Mangkurat, Banjarmasin (2017) and Universitas Syiah Kuala, Banda Aceh (2018). The SEADRIC 2019 has the first SEADRIC which was supported by the Ministry of Research, Technology, and Higher Education of the Republic of Indonesia.

In bringing SEADRIC 2019 into reality, we have envisioned four core values; rigor, impact, prestige, and service, as the building bricks of the foundation of our effort and hard work. We have accomplished these core values through different aspects of the conference.

In terms of *rigor*, we have ensured that all submitted abstracts have undergone double-blind peer review and had clear criteria for abstract acceptance. These criteria filtered two hundred and thirty unique abstracts into two hundred and twenty-one, whose full paper were further selected by 41 outstanding reviewers from different institutions. This thorough selection process has made this conference the best venue to discuss various topics in education, among others are design research, PMRI, problem-based learning, ethnomathematics and problem-solving.

We have strived for *impact* by collaborating with many high-quality national and international journals, ensuring impactful studies to be included in the conference by funding selected participants to accommodate the geographic diversity of our authors. The journals partnering with us are Journal of Physics: Conference Series, Jurnal Pendidikan IPA Indonesia, Journal on Mathematics Education (JME), Jurnal Pendidikan Matematika, REiD (Research and Evaluation in Education), Infinity Journal, International Journal on Emerging Mathematics Education (IJEME) and LLT Journal: A Journal on Language and Language Teaching, which evidently belong to diverse fields and in turn, wider readership. Furthermore, the impact of our conference has also been ensured through the spread of our authors, who do not only come from different parts of Indonesia, but also from other countries.

We have strived for *prestige* by inviting distinguished speakers who are experts in their fields and have obtained an acknowledgement from the Ministry of Research, Technology, and Higher Education of the Republic of Indonesia. We have five keynote speakers from five different countries, i.e. Prof. Toh Tin Lam (National Institute of Education, Singapore), Dr. Wanty Widjaja (Deakin University, Australia), Dr. Maarten Ludovicus Antonius Marie Dolk (Utrecht University, Netherlands), Dr.

Hongki Julie, M.Si. (Universitas Sanata Dharma, Yogyakarta, Indonesia), and Prof. Dr. Masami Isoda (University of Tsukuba, Japan). Furthermore, we have nine invited speakers along with three workshop instructors. The presentations of those speakers can be accessed from the conference website (https://usd.ac.id/seadr).

In terms of for *service*, we have delivered our best through the committee who have taken the participants' best interests at heart; facilitated all the participants throughout the conference; as well as appreciated and recognized outstanding papers by giving the best paper and best student paper awards. Congratulations to the following papers that have won SEADRIC 2019 best paper and best student paper awards, respectively.

1. Reflective Thinking Skills of Engineering Students in Learning Statistics by R. A. Funny (published at J. Math. Educ. **10** 445–458).
2. The Learning Trajectory of Pattern Number Learning Using Uno Stacko Game by I. Risdiyanti and R. C. I. Prahmana (published at J. Math. Educ. **11** 157–166).

The conference theme of SEADRIC 2019 was "Improving Professionalism and Reflective Thinking through Design Research." It has invited us to reflect on the current educational challenges, e.g. globalization and industrial revolution 4.0 and transform them into opportunities through design research. It has acknowledged the need to develop our professionalism so that we can proactively contribute to the advancement of educational science and praxis. It has challenged us to re-think the design research as a method to make learning and teaching innovation possible, but also as a paradigm in building our capacity for innovation.

In this proceedings, you will find a wide variety of perspectives and research findings with regard to educational design research and other topics in the field of education, and we hope that you will have insightful and fruitful conversations during and after the conference.

Finally, we want to thank Sanata Dharma University; Ministry of Research, Technology, and Higher Education of the Republic of Indonesia; Sogang University and SEAMEO QITEP in Mathematics for their contribution to fund the SEADRIC 2019. We also express our deepest gratitude to the many people who have made the conference possible, i.e. the organizing committee, the steering committee, reviewers, student volunteers, and all conference presenters and participants. Your contributions make educational design research a thriving and sustainable field.

Message from Sanata Dharma University Rector

On behalf of Sanata Dharma University, I feel honored to welcome all speakers and participants of the 7th South East Asia Design Research International Conference (SEADRIC 2019). I also would like to extend my warmest regards to all of you. Let us first thank the Almighty God for the grace we have received in attending this conference. I do hope this conference functions as an effective way to strengthen our role and improve our knowledge contribution as lecturers and researchers. I also wish that the 7th SEA-DR 2019 facilitates a fruitful sharing and exchange of ideas related to the conference's theme on "Improving Professionalism and Reflective Thinking through Design Research."

As a Jesuit University, Sanata Dharma is fully aware of the complexity and dynamics of learning because it is highly connected with identity, culture, and its less structured outcome that is difficult to measure. Moreover, learning in general is not merely about technical endeavor but more mental and spiritual one. The success of learning is much affected by the quality of enthusiasm, curiosity, self-esteem, and mode of dialog enjoyed by both students and lectures. Through such understanding, Sanata Dharma University commits to embrace and implement authentic and contextual learning by adopting unique learning paradigm called Ignatian Pedagogy. Employing Ignatian Pedagogy, learning outcome is directed to fully recognize that students are unique but expected to be a whole person having high *competence* in their field of study, capable of having *conscience* in their feeling and mind, and commit to develop their *compassion* to others. It is 3C in short.

To achieve such learning outcomes, Ignatian pedagogy needs a unique learning dynamic. It should provide enough time, space and attention to facilitate students' multi-sensory experiences from head, heart, and hand. Only through such dynamic, learning would be personalized, authentic, and far from being formalistic. In practice, Ignatian pedagogy requires learning activity that follows a 5 steps cycle: start from understanding context, intensively using and recognizing real past experiences, doing some real related actions, employing comprehensive evaluation, and facilitating in depth reflection. Therefore, I position this conference as a highly relevant response to the recent call to all of us in improving our leaning quality while we are witnessing the rapid change of modern learning that is much influenced by sophisticated smart technology.

I do hope that the conference becomes a good avenue not only to discuss our research findings but also to facilitate a fruitful dialogue in which sharing of knowledge, values and awareness that take place with joy and respect to each other. It is through such an orientation that we can proactively contribute to shape up our new generation for the betterment of our society. May the conference be successful and enjoyable. Thank you.

Johanes Eka Priyatma, PhD
Rector of Sanata Dharma University

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Peer review statement

Designing hypothetical learning trajectory in supporting pre-service mathematics teachers to conduct higher-order thinking oriented learning in microteaching course

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Peer review statement

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Designing hypothetical learning trajectory in supporting pre-service mathematics teachers to conduct higher-order thinking oriented learning in microteaching course

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Abstract. Many research revealed that teachers or pre-service teachers still misunderstand about higher-order thinking skills (HOTS) and it impacts their ability in designing learning activities that support students' HOTS. Considering this fact, this research aims to design a teaching and learning trajectory that can support pre-service mathematics teachers to conduct higher-order thinking oriented learning in a microteaching course. This research used design research method as an appropriate means to achieve the research aim. This article presents a hypothetical learning trajectory in microteaching course aiming to support pre-service mathematics teachers to conduct higher-order thinking oriented learning.

Keywords: pre-service teachers, microteaching course, higher-order thinking oriented learning

1. Introduction

The framework of 21st century learning consists of three major elements: life and career skills, learning and innovation skills, and information, media, and technology skills. The framework of learning and innovation skills consists of the so-called 4C's (critical thinking, communication, collaboration, and creativity). These 4C's are said to be the essential skills that prepare students to be ready to participate in the more complex life and work environments in the 21st century.

Regardless the terms used to describe 21st century skills for students, critical and creative thinking skills are also commonly referred as higher order thinking skills [1, 2]. Higher order thinking is a way of thinking at a higher level than memorizing. In revised Blooms' taxonomy, higher order thinking skills (HOTS) is defined among the three top levels of ability in the cognitive domain (analyzing, evaluating, and creating) [3]. Higher order thinking can be conceptualized as a non-algorithmic thinking; a complex thinking when students solve task where no algorithm has been taught to them or solving tasks using known algorithm in unfamiliar situations [4, 5].

Students' HOTS development only can be achieved through HOTS-oriented learning, including planning, implementing, and evaluating. However, some research showed that mathematics teachers or pre-service mathematics teachers face difficulties in understanding HOTS and designing learning activities or problems that promotes students HOTS [6, 7, 5]. Therefore, there is a need to focus on how mathematics teachers or pre-service mathematics teachers can facilitate HOT-oriented learning.

The major goal of teacher education programs is to provide pre-service mathematics teachers the first basis of knowledge and skills for effective teaching, through coursework and practicum experiences. Microteaching course is a course in which the prospective teachers for the first time learn

to manage learning in a structured way. This course is a preparation for practice teaching program in schools. Based on Microteaching Handbook of Sanata Dharma University (2013) [8], student teachers are expected to master some basic teaching by applying the specific approach/learning model through microteaching courses.

Regarding this fact, the need to focus on how pre-service teachers can facilitate HOT-oriented learning leads to the need of activities that are aimed at supporting pre-service mathematics teachers to conduct higher-order thinking oriented learning in microteaching course.

2. Research Methodology

The aim of this research is to develop a local instructional theory to support pre-service mathematics teacher to conduct higher-order thinking oriented learning in microteaching course. For this need, this research used a type of research method namely design research for achieving the research aim. Design research is a type of research methods aimed to develop theories about both the process of learning and the means that are designed to support that learning [9]. Gravemeijer & Cobb [9] define what design research is by discussing the three phases of conducting a design research, namely preparation and design phase, design experiment, and retrospective analysis.

This research is limited only at the first phase that is designing the HLT in supporting the pre-service mathematics teachers to conduct HOT active learning. HLT consists of three main components, those are learning goals, learning activities, and hypothetical learning process [10]. On this research, the learning goals are formulated based on goals of microteaching course and standard academic qualification from Ministry of National Education, while learning activities are formulated based on the learning goals.

This research involved seventeen third-year pre-service secondary mathematics teachers at Sanata Dharma University undertaking microteaching course. The pre-service teachers have learned mathematical content courses and general pedagogy courses.

3. Hypothetical Learning Trajectory

A design and research instrument that proved useful during all phases of design research is the so-called Hypothetical Learning Trajectory (HLT) [11]. HLT is the link between an instruction theory and a concrete teaching experiment [12].

During the lesson, HLT informs researchers and teachers how to carry out a particular teaching experiment. After the reaching experiment, it helps researchers to do retrospective analysis, and the interplay between the HLT and empirical results forms the basis for theory development [13].

In this article, the researchers described Hypothetical Learning Trajectory in supporting pre-service Mathematics Teacher to conduct higher-order thinking oriented learning in microteaching course.

3.1. Learning Goals

The researchers formulate learning goals based on the learning goals of microteaching course that consist of pedagogical and professional competencies and frameworks of 21st century skills [14]. The learning goals are:

a. Understanding and implementing the learning theories, models, and methods that support student-centered learning
b. Designing learning activities that promotes critical and creative thinking
c. Implementing higher-order thinking oriented learning

3.2. Learning Activities

Based on the learning goals, the researchers designed learning activities. However, it is important to analyze standard academic qualifications and competence of teachers based on Minister Regulation of National Education (*Peraturan Menteri Pendidikan Nasional Republik Indonesia*) number 16 (2007) [15]. The competencies of mathematics teachers accommodated in this research are summarized in the following table

Table 1. Teacher's competencies accommodated in this research

Learning goals	Teacher's competencies	Key Ideas	Description
• Understanding and implementing the learning theories, models, and methods that support student-centred learning	Pedagogical competence	• Competence in implementing learning theories • Competence in facilitating the development of students' HOTS • Communicate effectively	The comprehension of learning theories is needed by teachers as guidelines to help select the appropriate models, strategies and methods in teaching
• Designing learning activities that promotes critical and creative thinking • Implementing higher-order thinking oriented learning	Professional competence	• Competence in understanding the concept of mathematics • Competence in designing and implementing of HOTS oriented active learning	• Teachers exhibit deep and thorough conceptual understanding • Teachers have to be able to design HOTS oriented active learning by constructing their comprehension of learning theories and pedagogy. • Teachers could implement their HOTS oriented active learning design effectively

Based on Table 1 above, the researchers design a series of activities to support pre-service mathematics teacher to conduct higher-order thinking oriented learning in microteaching course.

Table 2. Instructional activities in supporting pre-service mathematics teacher to conduct higher-order thinking oriented learning in microteaching course

Key Ideas	Pre-service teachers' competencies need to be developed	Learning activities
• Competence in implementing learning theories • Competence in facilitating the development of students' HOTS • Communicate effectively	• Learning experience • Communication and potential development • Deep conceptual	• Analyzing HOTS-based problem • Designing HOTS-based problem

• Competence in understanding the concept of mathematics • Competence in designing and implementing of HOTS oriented active learning	understanding • HOTS oriented active learning design • Reflective thinking	• Designing learning activities that promotes students' HOTS • Implementing higher-order thinking oriented learning

3.3. Hypothetical Teaching and Learning Process

The hypothetical teaching and learning process in supporting pre-service mathematics teacher to conduct higher-order thinking oriented learning in microteaching course is described as follows.

3.3.1. Analysing HOTS-based problem

When pre-service mathematics teachers are asked to explain why a certain problem is a HOTS-based problem, they might have different arguments as follows.

- The problem is a HOT-based problem because it has a high level of difficulty. For pre-service mathematics teachers who argue that a HOT-based problem should have a high level of difficulty, the lecturer can pose stimulating questions as follows "Does every difficult problem encourage students to analyze, evaluate or create something? Could anyone design a difficult problem that only requires the ability to remember, understand, or apply a concept?". From the questions, it is expected that pre-service mathematics teachers will consider that not all difficult problem is HOTS-based problem. However, it cannot be neglected that HOTS-based problem might have a high level of difficulty since the problem requires complex and non-algorithmic thinking.
- The problem is a HOTS-based problem because it is an application problem. For pre-service mathematics teachers who come to this argument, the lecturer can ask the question "Have you solved an application problem in which the context is (very) familiar to you? Does this kind of problem can be answered through a simple recall of information?". From this question, it is expected that pre-service mathematics teachers consider that HOTS involves solving tasks where an algorithm has not been taught or using known algorithms while working in an unfamiliar context or situations.

3.3.2. Designing HOTS-based problem

When pre-service mathematics teachers are asked to design HOTS-based problem, they might come up with a different result as follows.

- Pre-service mathematics teachers design a word problem that has unrealistic contexts or meaning. For pre-service mathematics teachers who design this kind of problem, the lecturer can facilitate discussion by asking questions as follows "Does this kind of problem will help students to bring their prior experience to build a meaningful interpretation? What will you do to make this problem becomes meaningful for students?". From this discussion, it is expected that pre-service mathematics teachers realize that a contextual problem plays an important role as a starting point of learning for students to explore mathematics notions in a situation that is experientially real for them [16]. Moreover, the openness of contextual problems will stimulate rich discussion among students and it becomes an opportunity for teachers and students to establish an appropriate link between the context and mathematical ideas [17]. In this discussion, the lecturer also emphasizes that contextual problems do not automatically lead to meaningful learning for students; it requires classroom discussion in making this context becomes meaningful for students.
- Pre-service mathematics teachers design a problem that only requires the ability to recall information or apply concepts or knowledge to familiar situations and contexts.
- Pre-service mathematics teachers design a problem where the solution requires applying a well-known algorithm with no justification, explanation, or proof.

For pre-service mathematics teachers who come up with the second and third result, the lecturer can facilitate discussion by asking questions as follows "What will students do when they solve this kind of problem? Does the problem stimulate students to analyze, criticize, verify, make conclusions, evaluate, interpret or predict? How can this problem provoke students' critical and creative thinking?". From this discussion, it is expected that pre-service mathematics teachers realize that HOTS will be developed when students encounter unfamiliar problems, uncertain conditions, or new phenomenon where no specific algorithm has been taught to the students.

3.3.3. Designing learning activities that develops students' HOTS

When pre-service mathematics teachers are asked to design learning activities that develops students' HOTS, they might face some problems as follows.

- Indicators do not measure students' HOTS.
  The indicators formulated by pre-service mathematics teachers do not show students' HOTS. To overcome this lecturer shows pre-service mathematics teachers' lesson plan on the basic competencies and indicators part and let pre-service mathematics teachers to observe and analyze what things that need to be corrected regarding indicators that formulated by their friends. Lecturer gives time to discuss. To start the discussion, lecturer gives a question: "What should be considered by the teacher in formulating indicators so that the indicators can measure students' HOTS?". The possible answer from the pre-service mathematics teachers is operational verbs used. Then lecturer can continue by giving question: "How do you determine the operational verbs in formulating the indicators?". Pre-service mathematics teachers maybe will have difficulty in getting the answer. Therefore, lecturer has to be facilitator in guiding pre-service mathematics teachers to get the answer by asking the pre-service mathematics teachers to search from their mobile phone regarding theory of revised Bloom Taxonomy. Because the operational verbs that can be used to formulate indicators that can measure students' HOTS can be seen on the cognitive process dimensions of HOTS by Bloom. These dimensions are classified into three dimensions, those are analyze, evaluate, and create [18]. From website, pre-service mathematics teachers can get many operational verbs that can be used in formulating indicators. After pre-service mathematics teachers get the example of operational verbs, lecturer gives question: "Based on revised Taxonomy Bloom, which operational verbs that can be used in formulating indicators that can indicate students' HOTS?". At this time, lecturer gives time for pre-service mathematics teachers to discuss. At the end of discussion, lecturer provides confirmation.
- The design of learning activities is unable accommodate the development of students' HOTS
  Usually pre-service mathematics teachers are able to select learning model that can accommodate students' HOTS development correctly. However, pre-service mathematics teachers are not able to design learning activities that can accommodate students' HOTS based on the model. To explore pre-service mathematics teachers' ability in developing activities learning which can develop students' HOTS, lecturer gives question: "Based on your opinion, what do teachers do for developing students' HOTS?". The possibility pre-service mathematics teachers' answers are:
  - Play interesting video
  - Provide challenging contextual problems
  - Ask questions that explore analytical skills

  Based on the question, lecturer offers the next question to explore pre-service mathematics teachers' ability in designing learning activities that can develop students' HOTS, "What kind of contextual problems can teachers provide to develop students' HOTS?", "Do the questions have a high level of difficulty?". After that, lecturer offers the next question, "What kind of question word can be asked by the teacher to explore students' HOTS?", "What words ask, why, who, how?". To answer that question, lecturer gives examples of questions from each question words. These are:
  - Who introduces logic as science?

- When did logic arise?
- What is the difference between statements and open sentences?
- How many conjunctions can be used in compound statements?
- Which is the statement?
- Why is the statement referred to as a compound statement?
- How to prove the theorem?

Then lecturer ask the pre-service mathematics teachers to analyse which question words can explore students' HOTS. At the end of the discussion, lecturer asks them to conclude what things need to be considered by the teacher in designing learning activities that can develop students' HOTS.

- Assessments are unable measure students' HOTS

To overcome this problem lecturer asks pre-service mathematics teachers to discuss. The discussion is started by displaying the example of assessments that do not and do explore students' HOTS. Based on the assessments, lecturer asks them to analyze in group whether the assessments made is able to explore students' HOTS? If so, why. If not, why. Each student in group must share their opinion, so that they can create original and useful ideas [19]. During the discussion, lecturer facilitates by asking related questions "What are the characteristics of the problem that are able to explore students' HOTS?", "How do you design an effective assessment which can develop students' HOTS?". Then, lecturer guides pre-service mathematics teachers to get the answer by analyzing revised Bloom's Taxonomy. By using Bloom's Taxonomy as assessment's framework, pre-service mathematics teachers can structure a lesson effectively [20]. After the pre-service mathematics teachers are able to analyze what kind of assessments that can develop students' HOTS, lecturer provides opportunities for them to design assessments in accordance with the basic competencies that they choose so that the assessments are able to measure and explore students' HOTS.

3.3.4. Implementing higher-order thinking oriented active learning.

When pre-service mathematics teachers are asked to implement higher-order thinking oriented active learning, they might face some problems as follows

- The apperception is unable to develop students' HOTS

Apperception by pre-service mathematics teachers is usually delivered by playing videos or giving images that can arouse students' curiosity. The videos or images that usually given by teachers is related to real context that can be solved with the subject that to be studied. However, the videos or photos displayed do not explore students' HOTS. To overcome this lecturer provides an opportunity for students to discuss apperception as what the teacher needs to do to encourage the development of students' HOTS. After pre-service mathematics teachers discuss, the lecturer asks per-service mathematics students to express their opinions one by one. After sharing their opinions, without justifying students' answers, the lecturer displays a video that shows examples of apperceptions that can support the development of students' HOTS.

After displaying the video, pre-service mathematics teachers are asked to compare between the apperceptions that they have been done during practice with the apperception in the video. Pre-service mathematics teachers reflect on what should be improved in the apperception section to develop students' HOTS.

- Pre-service mathematics teachers are not ready to students' question

During learning activities in class, questions often arise from students. Sometimes, pre-service mathematics teachers are often not ready for students' questions, especially questions with questions asking why and how. Actually, these questions can be used to explore students' HOTS. To overcome this, the lecturer can ask pre-service mathematics teachers to write on a piece of paper, any questions that still make them confused. After that, the lecturer divides pre-service mathematics teachers in groups, and asks them to discuss in groups the answers to the questions that have been written. After group discussion, lecturer asks the representation of group to explain

the results of their group discussion in front of class, and others give feedback. Through this way, pre-service mathematics teaches can brainstorm each other. At the end of the discussion, the lecturer gives confirmation.

4. Conclusion

Based on the explanation of HLT in Supporting Pre-Service Mathematics Teachers to Conduct Higher-Order Thinking Oriented Learning in Microteaching Course, we can conclude that:

- In developing HLT that support pre-service mathematics teachers in conducting HOTS oriented learning, lecturer must consider the following steps: help them to analyze HOTS-based problem, design HOTS-based problem, design learning activities that develop students' HOTS, implement higher-order thinking oriented learning.
- Revised Bloom's Taxonomy can be an effective framework for pre-service mathematics teacher in designing HOTS oriented active learning and HOTS assessment. In accordance to this conclusion, to consider what kind of knowledge that will be achieved by students, it is important for teachers to assess which part in Bloom's taxonomy that is used [21]

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