



SEADRIC 2019

Companion Proceedings
of the 7th South East Asia Design Research
International Conference 2019 (SEADRIC 2019)

**“Improving Professionalism and Reflective
Thinking through Design Research”**

25 - 27 July 2019



**FAKULTAS KEGURUAN DAN ILMU PENDIDIKAN
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**SEADRIC 2019:
Companion Proceedings of 7th South Asia Design Research
International Conference 2019**

**“Improving Professionalism
and Reflective Thinking through Design Research”**

Thursday – Saturday, 25 – 27 July 2019
Sanata Dharma University Yogyakarta, Indonesia

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Preface

It is an honor and privilege to welcome you to the 7th South East Asia Design Research International Conference. The conference's theme, "Improving Professionalism and Reflective Thinking through Design Research," invites 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 acknowledges the need to develop our professionalism so that we can proactively contribute to the advancement of educational science and praxis. It challenges us to re-thinking the design research as a method to make learning and teaching innovation possible, but also as a paradigm in building our capacity for innovation.

Yogyakarta is an artsy and historical city which serves as a fitting cultural, social, political, and economic milieu for the conference. The tagline, "Jogja Istimewa," itself shows how the city has special values to be explored and experienced, and we encourage you to absorb the city's abundance: The Kraton, the cultural and political heart of the city; Fort Vredeburg museum; Malioboro road; Dipowisata urban tourism, to name a few.

The perfect ambience of Yogyakarta will provide us with a convenient space to interact and exchange ideas with colleagues as a means of professional learning. Our goal is for you to get new ideas, tools, and materials from the conference which will contribute to your professional development. The variety of sessions, workshops, and social events will give you opportunities to connect with friends and colleagues to expand your networks. We are excited about the keynote and invited speakers. We believe they will share challenging and innovative ideas about education.

This conference is the result of the hard work, support, and dedication of a number of parties. We wish to thank all the committee members who together make the conference possible. The committee has been working throughout the year to propose sessions, review a record number of submissions, answer queries, arrange the schedule, and response to last-minute requests. We also want to thank Sanata Dharma University; Ministry of Research, Technology, and Higher Education of Indonesia; Sogang University and SEAMEO QITEP in Mathematics for their contribution to funding the conference. Thank you for being here with us. We value your presence at the 7th South East Asia Design Research International Conference. Enjoy the conference!

Yosep Dwi Kristanto, Conference Chair

Albertus Hariwangsa Panuluh, Conference Vice Chair

Contents

Professional Development of Teachers and Development of Teaching Material in Higher Order Thinking Skill (HOTS) with Mathematical Realistic Approach.....	1
Edwar	
Students' Reflection on Maori's Initial Life and Its Relationship with White People in New Zealand through the DESCAs Approach	6
Brigida Intan Printina and Sumini Theresia	
The Comparison of Effectiveness between Think Pair Share (TPS) and Team Assisted Individualization (TAI) Types of Cooperative Learning in Mathematics at Junior High School Students.....	13
Fitriani A., Muhammad Ilyas and Nisraeni	
Analysis of Problem-Solving Skills of Seventh Grade Students of Indonesia Institute of Yogyakarta Junior High School in Triangle Materials after the Implementation of Problem-Based Learning Model	17
Philomena Theresia Nggowa Dapa and Christiana Monica Vianny Abong Elannor	
Learning Design about Proving Trigonometry Identity Using Problem-Based Learning (PBL).....	28
F. X. Catur Supatmono and Stefanus Surya Osada	
Development of Appy Pie Learning Media Based on Metacognitive Approach for Mathematical Reflective Thinking Ability in Geometry	38
R. Amalia, Fadilah and Anwar	
Analysis of Student Learning Outcomes in Proving Trigonometric Identities from Problem Based Learning Class.....	43
Stefanus Surya Osada and F. X. Catur Supatmono	
The Implementation of Blended Learning Mediated by Edmodo to Learn about Work and Energy at Advent Nusra High School Kupang.....	54
Pringgo Acong Nusa Bakti Min Dala and Tarsisius Sarkim	
Design Research for Business Introduction Subject: Developing Think Pair and Share Method to Improving Student's Sharing Skills and Student's Participation Skills	62
Kurnia Martikasari	
STEM Education for Prospective Teachers.....	68
Nisraeni, Ahmad Rustam and Deni Iriyadi	
Development of Computer-Based Learning Media Using Mind Map for Learning Mathematics in Topics of Rectangle and Triangle at Secondary School	73
Lucy Maryeni, Syarifah Nur Siregar, Yenita Roza and Jalinus	

Analysis of Representation Forms on Linear Equations System Two Variables (LESTV) Materials for Class VIII Junior High School.....	85
Yuliana Ina Kii	
The Effects of Flipped Learning Implementation on The Students' Achievements in Language Teaching Media Course	92
Patricia Angelina	
Improving the Communication Skills of Grade VII Students for Animals Classification and Set by Using STEM Approach.....	98
I. N. Setiawan, M. Roostika, S. Utami, H. Julie and A. H. Panuluh	
Student Worksheets Using the PISA Context for Statistics Topic in Class VIII SMP	105
Syarifah Nur Siregar, Kartini, Yenita Roza and Lailatul Baroqah	
Hypothetical Learning Trajectory for Classification of Animals and Sets by Using the STEM Approach.....	114
M. Roostika, I. N. Setiawan, S. Utami, H. Julie and A. H. Panuluh	
Hypothetical Learning Trajectory for Uniform Motion and Gradient Using the STEM Approach.....	118
B. Wulansari, B. L. Handayani, H. Julie and A. H. Panuluh	
Learning Design on Set Materials Using the Model Problem Based Learning	124
Mesak Ratuanik and Marcellinus Andy Rudhito	
Validating the Indonesian Version of Reflective Thinking Questionnaire and Investigation of the Relationship Between Pre-Service Teachers' Reflective Thinking and Academic Achievement	138
A. W. Sabekti, F. Khoirunnisa, Liliarsari and A. Mudzakir	
Overcoming Anxiety in English Language Learning Through Drama Performance.....	145
T. Ramadhani	
Student Perception of Online Quizzes and Interview Pretest Implementation in Pre-Practicum Activity	150
Elisabeth Dian Atmajati, Yosep Dwi Kristanto and Albertus Hariwangsa Panuluh	
High Order Thinking Skills in One of the Private Elementary Schools in Sleman Yogyakarta District (Case Study)	155
Apri Damai Sagita Krissandi, Brigitta Erlita Tri Anggadewi and Sangsang Lusiani Supriyanti	
Reflective Thinking Ability of Teacher Candidate Students Based on Ability Level and Gender	165
E. Rahmadhani, S. Wahyuni, L. Mandasari and Y. Setiawan	
Collaborative Learning Concept for Reducing the Act of Cheating	173
Maria Vincentia Eka Mulatsih	

Hypothetical Learning Trajectory for Classification of Animals and Sets by Using the STEM Approach

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Abstract: STEM approach is an approach to teaching science, technology, engineering, and mathematics in an integrated manner. The aim of this study was to describe the design of teaching and learning process to teach animal classification in science and set in mathematics using the STEM approach. The type of research used in this study was the Gravemeijer and Cobb models which consist of three phases. The research subjects in this study were 34 students of class VII D of SMPN 1 Yogyakarta. The instrument used in this study is the hypothetical learning trajectory. In the design made by the researcher, there were observations by students about animal characteristics and animal placement in the Gembiraloka zoo. From this observation process, the researcher facilitated students to understand how the process of classifying animals in science, and how to make a set, determine the terms of membership of a set, and write down the membership of a set.

Keywords: STEM approach, integrative, and collaboration.

Introduction

The character of modern society that lives in the 21st century is rational, open, forward-thinking, creative, independent, appreciating time and innovating. Their lives are also influenced by the rapid development of technology and communication. To be able to play a role in shaping the character of society in the 21st century, schools, especially teachers are required to be able to present learning that is able to foster these skills. In the 1990s the United States National Science Foundation held a renewal movement in the education sector and the theme raised was Science Technology Energetic Mathematics (STEM) and from this movement the term STEM first emerged. This movement is a movement that seeks to make updates in the learning process related to the four fields, so that the growth of the workforce of the STEM fields can be increased (Firman, 2015). In addition, this movement also intends to open the horizons of Americans so that they are literate with STEM. If this goal is successfully achieved, then the result is US global competitiveness in science and technology innovation can increase. According to the National STEM Education Center, STEM education does not only mean strengthening the praxis of education in STEM fields separately but developing an educational approach that integrates these four fields by focusing on the educational processes that occur in the classroom in solving real problems found in everyday life and professional life (Firman, 2015). In other words, they began to be invited to learn to integrate their knowledge in the four fields to solve problems they encountered in everyday life. According to Bybee (2010), within the framework of primary and secondary education, STEM education aims to develop STEM literate students with the following characteristics: (1) using scientific steps in identifying and solving problems, (2) understanding the characteristics of each STEM disciplinary component so that it can use all four components in an integrated manner, (3) realizing how the roles of each discipline in STEM form a material environment. intellectual and cultural, and (4) willing to study STEM related issues.

According to Reeve STEM education is an interdisciplinary approach to learning where in the learning process occurs students use science, technology, engineering, and mathematics to solve problems, so that they can be well connected with the world of work, and the world global (Firman, 2015). Therefore, STEM-based learning can be used as a solution that can provide opportunities for students to foster an attitude of cooperation and integrate abilities and knowledge in these four fields. Moore et al. explains that STEM is an approach and effort in combining several or all four STEM subjects into one lesson that is based on relationships between subjects and real-world problems



(Firman, 2015). Sanders explained that STEM is an approach that explores two or more STEM subjects and one or more subjects in school (Sanders, 2009).

One of the problems faced by students in our school is that students have not been able to integrate the material obtained separately when solving a problem, for example when students are asked to design the location of animal cages in a zoo if animals will be placed at the zoo it is known. Students have not been able to integrate the knowledge they have acquired about animal classification in Science subjects, and the set in Mathematics. Therefore, in this study, we try to design learning activities that can integrate set material on Mathematics subjects and Classifications of Living Beings on science subjects, so that the knowledge formed by students can be integrative with each other.

Hypothetical learning trajectory (HLT) is a hypothesis or prediction of how students' thinking and understanding develop in learning activities (Wijaya, 2009). According to Gravenmeijer (2004), there are three main components in HLT, namely (1) learning objectives, (2) learning activities and devices / media used in the learning process, and (3) the conjecture of the learning process, which contains the initial understanding students and student strategies that emerge and develop when learning activities are carried out in class (Gravemeijer, 2004). In this study, researchers will design a hypothetical learning trajectory (HLT) that uses the STEM approach to teach animal classification in science and the set of mathematics lessons in class VII D at SMPN 1 Yogyakarta in an integrated manner. The researcher chose the two materials because according to the researchers both materials were interconnected and could be taught in an integrated manner.

Research Method

The type of research used in this study is the Cobb and Gravemeijer model design research which consists of three stages, namely (1) making a design plan; consists of (a) determining learning objectives, (b) determining the starting point of learning, and (c) determining the learning model to be used; (2) testing the design design, and (3) conducting a retrospective analysis (Van den Akker, Gravemeijer, McKenney, & Nieveen, 2006). The results presented by researchers in this paper are only limited to stage one of three stages. The things presented by new researchers are limited to how the HLT design is to teach animal classification and assemblies using the STEM approach.

The subjects in this study were students of class VII D of SMP 1 Yogyakarta. The data collection method that will be used in this study is making field notes, observing, giving written tests, and conducting interviews. The research instruments used in this study were HLT, test sheets, and interview guideline sheets. The stages of data analysis used in this study are the stages of data analysis in qualitative research, namely (1) reducing data, (2) presenting data, and (3) making conclusions and verifying conclusions (Miles & Huberman, 1994).

Discussion

The learning objectives of HLT made by researchers are: (1) students can classify animals found based on the characteristics of the animal, (2) students can explain the characteristics of animals in a classification, (3) students can identify whether an animal enters a particular class or not, (4) students can define the meaning of a set, and (5) students can represent membership of a set.

HLT designed by researchers was conducted into two major stages detailed follows:

In the first stage, students were told to photograph five animals that live around their houses and were asked to write down the characteristics of the five animals based on observations made. Then, the students were made to work in groups of three. Each group later was asked to share their observation results and showed pictures of the animals observed. In the next the task, each group was to identify animals that have similar characteristics. Then students were asked to look for some learning resources available about (1) how the animals they observed breed, (2) how the animal respiration systems are like, and (3) what the animals' digestive systems look like. When the information had been obtained, students were asked to make classifications of animals based on their breeding methods, respiratory and digestive systems. Following their discussion on the classifications, each group was asked to make a poster containing their findings based on the leading questions. Each group were also given the opportunity to add their explanations to the pictures. After that, each group was asked to present the

results of their work during Natural Science class and teacher. Each group was reminded to present different classifications.

Using the results of the group presentations, the Math teacher asked to answer questions, such as: why can animal A, for example a cat, be grouped into groups of animals that breed by giving birth? Give examples of other animals that belong to the group of animals that breed. The Math teacher, then, invited students to draw conclusions about the meaning of the set. To help students draw conclusions about the meaning of the set, the teacher associated the question with the process that happened before, for example about cats that are included in the group of animals that give birth. The teacher asked why cats are included in the set of animals that give birth. From this process, students were expected to make conclusions that the set refers to a collection of objects that have the same characteristics or features. Then, students worked together to add more animals which bear the same characteristics presented during Natural Science class. Then, the students were made to convert all the data they used into graphs. Some were expected to use images or tables. The teacher asked the groups to present the results of their discussion. The teacher ensured that the Math/set poster displayed presented a different representation of the membership of the sets. The procedure was followed with students making conclusions on how to present a set.

Still working in the group, students were given a piece of paper containing the names of sets of numbers, for example a set of integers ranging from - 5 to 4, the set of natural numbers between 12 to 21, or the set of even numbers located between 3 to 15. The groups were tasked to express the statements in different ways. Then, the groups were asked to present the results of their discussion on a poster. The teacher ensured that the poster displayed presented a different representation of the membership of the set. The first stage ended with students concluded about how to present a set.

The second stage began by making students work in groups 3 – 4 students and were told to visit Gembiraloka zoo on a particular day accompanied both Natural Science and Math teachers. During their visit to the zoo, each group was tasked to do the followings: (1) take photos of 15 different animals, (2) record the classifications of the animals while touring in the built-in gardens ranging from the types of food to the living habitats of the animal, and (3) make a video containing reportage two different types of animals in 15 minutes duration. Following their visit to the zoo, students were asked to upload the reportage videos to You Tube channel. Then, other students were asked to watch reportage videos made by other groups. After watching the videos, students were asked to make important notes about the animals described from each video for students to make important notes about things that they felt not right from the reportage their friends made. In the same group, each student was asked to present the notes he had made after watching the video. At the end, each group was asked to summarize the notes from their member and wrote them on the poster. After that, students were invited to discuss the notes that appeared the most especially about things that are not right.

Following that, the teaming-teachers selected thirty photos which were sent by students. These selected photos were returned to the groups, thus each group had thirty photo compilation which they must cut out. The teacher asked the groups to make different classifications to present the results of their discussion. Using a new working sheet from their teachers, the group pasted the photos on the new sheet under a certain classification. In the posters, students were also asked to explain how the classification was made along with the membership requirements for each classification.

Then, the groups continued working by designing a mini zoo containing animals within the collections. After finishing the mini zoo, students were asked to make a video presentation explaining how they built the mini zoo, why they built it, and what difficulties they experienced when making the zoo. After the video was finished, each group was asked to upload it on you tube. Students must watch the videos and rated the content of the video. The most liked videos will be entitled for some presents from the two teachers. A written test, finally, was given to measure their achievement of their learning objective(s).

Conclusion

The context of the exploration of animals that live around the home environment of students can be raised as a context for learning animal classification, understanding sets, and how to represent the set. Another context that can be used to achieve this goal is the context of visiting zoos and discussion activities related to visits to zoos. To see the achievement of the objectives and the implementation of this HLT, researchers need to conduct a trial to the field.

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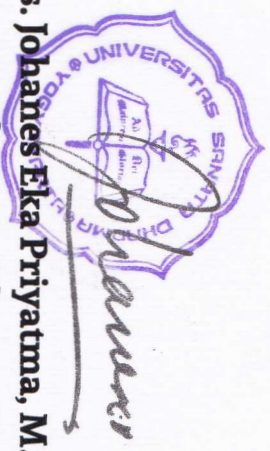
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Yogyakarta, 27 July 2019



Drs. Johannes Eka Priyatna, M.Sc., Ph.D.
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