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Implementation of Computational Thinking and Ignatian Pedagogy in Geometry subject for Elementary School Pre-Service Teachers

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Abstrak

Penelitian ini bertujuan untuk mendeskripsikan implementasi Computational Thinking pada flipped classroom pada mata kuliah Geometri Berbasis Pedagogi Ignasian pada calon guru SD di Universitas Sanata Dharma. Metode penelitian yang digunakan adalah deskriptif. Subjek penelitian adalah mahasiswa PGSD Universitas Sanata Dharma angkatan 2017. Teknik pengumpulan data yang digunakan adalah observasi, wawancara, dan dokumentasi. Data dianalisis dengan menggunakan analisis kualitatif. Penelitian ini menyimpulkan bahwa implementasi dengan langkah-langkah pembelajaran, yaitu (1) konteks, (2) pengalaman, (3) tindakan, (4) evaluasi, (5) refleksi. Pada langkah ini dikembangkan empat aspek Computational Thinking, yaitu (1) dekomposisi, (2) pengenalan pola, (3) abstraksi, (4) algoritma. Hasil refleksi pembelajaran menunjukkan respon bahwa siswa menyukai desain pembelajaran.
Kata Kunci: Berpikir Komputasional, Pedagogi Ignasian, Geometri.

Abstract

This study aims to describe the implementation of Computational Thinking in the flipped classroom in the Geometry course based on Ignatian Pedagogy for prospective elementary school teachers at Sanata Dharma University. The research method used is descriptive. The research subjects were pre-service teacher Sanata Dharma University class 2017. The data collection techniques used were observation, interviews, and documentation. The data were analyzed by using qualitative analysis. This research concludes that the implementation by learning steps, namely (1) context, (2) experience, (3) action, (4) evaluation, and (5) reflection. In this step, four aspects of Computational Thinking are developed, namely (1) decomposition, (2) pattern recognition, (3) abstraction, and (4) algorithm. The results of the learning reflection show the response that students like the learning design.
Keywords: *Computational Thinking, Ignatian Pedagogy, Geometry.*

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INTRODUCTION

The digital era is no longer a rare thing for students today. Digital things seem to be a necessity for Generation Z. All sources of information and knowledge are straightforward and fast to obtain. This affects the student's lifestyle and learning style, as stated by Gallardo et al (Gallardo-Echenique et al. 2015). First, most students represent the first generation to grow up with this new technology. They have been characterized by their familiarity and confidence in Information and Communication Technologies (ICT). Likewise, Prensky expressed in Moussa (Moussa 2018) that our students have changed radically; today's students are no longer the people our educational system was designed to teach. Therefore, the descriptive material becomes less attractive to students than the material presented in images or videos. In line with Mustapa and Naeeni's statements 3, teachers must also adapt to accommodate students' needs (Mustapha and Naeeini 2017).

Esti Utami (2020) once noted that the brain's ability to absorb lessons is the first 20 minutes. So you can imagine if a lecturer speaks for at least 100 minutes in front of the class, how much energy is wasted because students can absorb only 20 minutes, especially if they find it easier to get knowledge from the internet than from lecturers. It needs to be realized by the lecturer; the way of teaching that is usually done is not necessarily still following the current situation. This statement has also been expressed by Anderson et al. (Hartnett, Brown, and Anderson 2014) that today's learners have new ways of learning (i.e., when, where, what, and how), requiring new teaching methods. That is where lecturers need to adapt to students' conditions, needs, and learning styles because adapting the teaching strategies to the students' learning styles will give better results (Franzoni and Assar 2009). The substance of the material's depth must still be the idealism of the learning process, but the method used may need to be changed. There is no exception for elementary school pre-service teachers of Sanata Dharma University, especially they will become prospective elementary school teachers. Because what future teachers learn will affect student knowledge (Guerriero 2013). Lecturer creativity in the learning process is the main thing to inspire students when they later become teachers, especially in teaching style, teacher/student relationship, content, and environment in teaching courses (Guerriero 2013; Williams et al. 2016).

Subjects that are often difficult for students are mathematics. One of them is the Elementary School Geometry and Measurement course. The backgrounds of the high school students are very diverse, starting from SMA IPA, IPS, and various types of SMK, which triggers the diversity of students' mathematical abilities in studying mathematics courses. The author's experience as a lecturer while teaching Elementary School Geometry and Measurement courses in previous years have always encountered almost the same obstacles, namely the relationship between geometry concepts. Students still tend to memorize formulas when they feel inadequate or uninterested in interpreting each building concept further.

The author's habit before starting the lesson is to do a pretest. What is often found from the pretest results is a misconception of some concepts of defining geometric shapes. So the author has taken one of them with a group presentation that discusses cases in everyday life, which are then linked to geometry. However, some students were still reluctant to explore the idea further during the discussion. Sometimes, one does not need to listen to a presentation from a group presenting. As a lecturer, the author's concern regarding the students' inaction is how they will teach the concept correctly if they experience misconceptions but do not want to explore the right (Aprinastuti 2015). The author found a misunderstanding among students on the concept of a rhombus shape.

Not only have the correct concept of material but also welcome the era of industrial revolution 4.0, students are also required not only with hard skills but also soft skills. The demands for soft skills are reflected in 21st-century skills (Boholano 2017; Chu et al. 2016; Bialik and Fadel 2015), which are famous for 4C, namely critical thinking, creativity, collaboration, and communication. Of course, this requires more student competence to compete in the global era. An additional skill recently appearing to be developed is

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Computational Thinking (CT). Wing characterized computational thinking as "solving problems, designing systems, and understanding human behavior by drawing on the concepts fundamental to computer science (Wing 2006; Siu-Cheung Kong 2019). It needs to be owned by students, especially student teacher candidates (Yadav, Stephenson, and Hong 2017; Kong, Bai, and Kong 2018).

Aspects of computational thinking (CT)

The CT contains an aspect often referred to as the four cornerstones (Sentance and Csizmadia 2017; Bee[illegible]er 2017; Wing 2006; Siu-Cheung Kong 2019).

1. Decomposition is a way of thinking about artifacts in terms of their parts. The parts can then be understood, solved, developed, and evaluated separately. The researcher can observe in the classroom: (i) breaking down artifacts into constituent parts to make them easier to work with, (ii) Breaking down a problem into more straightforward versions of the same problem that can be solved in the same way (recursive and divide and conquer strategies).
2. Generalization (Pattern) is solving new problems based on previous problem solutions. It involves identifying and exploiting patterns. The following behaviors can be observed in the classroom: (i) Identifying patterns and commonalities in artifacts, (ii) Adapting solutions or parts of solutions so they apply to a whole class of similar problems, and (iii) Transferring ideas and solutions from one problem area to another.
3. Abstraction is the process of making an artifact more understandable by hiding detail. The following behaviors can be observed in the classroom: (i) Reducing complexity by removing unnecessary detail, (ii) Choosing a way to represent an artifact, to allow it to be manipulated in practical ways, (iii) Hiding the full complexity of an artifact (hiding functional complexity), (iv) Hiding complexity in data, for example by using data structures, (v) Identifying relationships between abstractions, and (vi) Filtering information when developing solutions.
4. Algorithmic thinking is the ability to think in sequences and rules to solve problems. Pupils develop a core skill when they write their computer programs. The following can be observed in the classroom: (i) The first set involves formulating instructions to achieve the desired effect. (ii) Developing instructions to be followed in a given order (sequence): (iii) Formulating instructions that use arithmetic and logical operations, (iv) Writing sequences of instructions that store, move and manipulate data (variables and assignment), and others.

To implement the learning process, an accompanying pedagogy is needed. The Ignatian Pedagogy Paradigm (IPP), as a unique learning approach at Sanata Dharma University, a Jesuit university, is still a force for implementing practical learning activities (Harendita et al. 2019; Suparno 2019). The Ignatian Pedagogy Paradigm (IPP) is an educational paradigm that uses the Ignatian method to direct a retreat (Suparno 2019). The IPP cycle includes context, experience, reflection, action, and evaluation to foster competence, compassion, and conscience for learning actors (Pousson and Myers 2018; Suparno 2019).

Ignatian Pedagogy Paradigm (IPP)

IPP contains the main aspects namely as follows:

1. Context, this context is linked to all the factors that support or hinder the learning process. For administrators and teachers, this means: (i) Personal recognition and care for students by teachers; (ii) an enabling environment for learning and growth in engagement with values. From the student's point of view, this context is linked to a willingness to learn and a readiness to grow.
2. Experience, the Ignatian Pedagogy ensures that students have a complete learning experience, mind, heart, and hands. In the book Ignatian Pedagogy: A Practical Approach issued by the International Center for Jesuit Education in Rome, it is said that experience is a crucial element in education: "In Jesuit schools, learning experiences are expected to move students beyond feelings. In this pedagogy, Ignatius underlines

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the affective/evaluative stage of the learning process because he realizes that in addition to allowing a person to 'taste and feel' to deepen his experience, significant feelings are motivational forces that move one's understanding to engage and act. "

3. Reflection, this section is key to the Ignatian Pedagogy Paradigm. (This is why this pedagogy has become popularly known as the Pedagogy of Reflection). Reflection is a process by which students make learning experiences their own (appropriation), obtaining meaning and meaning from learning experiences for themselves and others. If learning stops with experience, then this is not Ignatian. Because there will be a deficiency in the element of reflection where students are forced to consider the meaning and human meaning of what they learn and integrate that meaning as a responsible student who grows as a person who is competent, aware, and compassionate (competence, conscience, and compassion)
4. Action, action is not just an activity but contains attitudes, priorities, commitments, habits, values, ideals, and internal growth of humans to act for others. Ignatian pedagogy defines the term, regarding Ignatius' particular models, seeking not only to serve God but to excel in this service, to be something more (magical) than what is required: "The term 'action' refers to internal human growth based on experience as well—already reflected as its external manifestation. The action includes (i) internalized options; (ii) Externally expressed choices. Ignatius seeks not only arbitrary action or involvement but while respecting human freedom,
5. Evaluation evaluates the student's progress in accepting school goals and student goals. Again from Ignatian Pedagogy, it is written: "However, Ignatian Pedagogy leads to the formation, which not only concerns but also goes beyond mere academic expertise. We are concerned about students' overall growth as persons (persons for others). So periodic evaluation of student growth in attitudes, prices, and actions, and personal consistency for others and others are essential. "

The author's experience running the IPP cycle is exciting, especially at the reflection and action stages. This experience will be more optimal if combined with current-generation Z students (Wibawanto 2016). Wibawanto (2016) stated that to be able to teach students well. In addition to needing mastery of the teaching material to be given to students, it is also necessary to have the ability to understand how and the student's learning environment, and ornaments. If we agree that the way generation Z students learn and interact with the rapidly developing digital technology environment, then the behavior change caused by the penetration of technology in their lives will be significant.

One learning model that can develop CT, accommodate technology, and not focus on traditional learning is the flipped classroom model (Siu-Cheung Kong 2019). As the name implies, a flipped classroom is a way to "reverse" the standard order by making the classroom a means of discussion or completing assignments (Sari, Siregar, and Lubis 2021) while supporting material has been previously presented in the LMS. Presentations are made in the form of video recordings or other conditions, listened to, and studied at home (or anywhere) through their digital devices. At the same time, the class, which is generally used to hold lectures, has changed its function to become a means of discussion and a place for completing assignments. In addition to optimizing digital devices, this method can also reduce the possibility of students committing plagiarism (Pousson and Myers 2018). These designs are encouraged to develop and implement Computational Thinking in a flipped classroom learning model based on Ignatian Pedagogy in Sanata Dharma University students' geometry course from the description above.

The flipped classroom implementation results will become input and evaluation for elementary school students in geometry and measurement courses.

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METHOD

The method of research is a descriptive study. This study describes the implementation of computational thinking and Ignatian pedagogy in flipped geometry classrooms for elementary school pre-service teachers. The subject of research is Pre-Service teacher study program students for the 2019 academic year.

The data were collected by (1) observing, which was observed during the implementation of design learning, (2) the questionnaire, which was distributed to the student, and (3) interviewing, which was conducted in an informal setting. The instrumentations of this research were (1) observation guidelines, (2) the questionnaire, and (3) interview guidelines. The procedures were (1) observing the implementation of the game, and (2) interviewing the teachers. The two-step analysis plan was qualitative by analyzing the results of observation data compared with the interview results and questionnaire. Data that has been gathered then analyzed using descriptive qualitative. The analysis steps of the explanatory data model were (1) data description, (2) data reduction, (3) checking data validity, (4) data analysis, and interpretation based on substantive theory.

RESULTS AND DISCUSSION

The Elementary School Geometry and Measurement course provide learning experiences about various geometry and measurement concepts relevant to the elementary school level through a flipped learning model based on the Ignatian Pedagogy Paradigm. PPI has four aspects: context, experience, reflection, action, evaluation, the studyof geometry, and measurement, including the idea of measurement and contextual space so that studentsare expected to relate the concept to problems in everyday life. Learning is carried out using various methods to develop students' CT skills. Students are also invited to apply a constructive approach through CT integration to builddecomposition, pattern recognition, abstraction, and algorithm skills.

Context

The student context includes diversity in groups, social interactions in the classroom between students and faculty,and students. Context exploration was carried out in the first lecture and at the beginning of each lesson through sharing experiences, observations, social interaction in groups, and videos uploaded on the learning page. The contextof the problems revealed in this lecture includes cases or issues in the everyday environment, which, consciously or not, are related to geometry. Context exploration was also carried out with online quizzes using each device at the beginning of the lesson. The purpose of exploring this context is to see the students' initial abilities from thematerial that has been studied in learning.USD.ac.id. Quizzes are done individually using the quizizz.com platform. This implementation follows the first Ignatian pedagogy step, namely context. The flipped classroom activity thatstudents carry out before taking the quiz is to study the material that has been given in the learning management system.

Figure 1. Students take a pretest with a Quizziz platform

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Decomposition, Experience

After the quiz is complete, the lecturer gives discussion questions. Students are asked to gather in study groups todiscuss the material presented in a large group. One large group consists of 4 study groups. The material that has been uploaded to belajar.usd.ac.id is divided into four major parts. Each group breaks down their tasks and makes a simple mind map or poster. The small group will discuss this poster and present it to the large group. In CT theory, this process is a process that can be saidto be a process of decomposition or breaking down big problems into more straightforward issues (Sentance and Csizmadia 2017). Meanwhile, interms of Ignatian pedagogy, this activity is a step to providing experience to students. Students have a complete learning experience, mind, heart, and hands because their activities also involve this (Sentance and Csizmadia 2017).

Abstraction, Reflection

Reflection is carried out after the presentation by asking students to summarize the representations made by each study group in the large group. Then students are required to summarize all material using the Canva application. It shows that there is a reflection process (Csizmadia, 2015).

Students are also asked to reflect on cases in everyday life from the material presented and then finish with geometry. In this case, the process of abstraction is seen (Csizmadia, 2015).

Figure 2. Students make problem breakdowns smaller and explore experiences

After the small group finished completing the material and answering the discussion questions, each small grouptook turns presenting in front of the other groups in one large group.

Figure 3. Students convey the results of small group discussions to large groups

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Figure 4. The results of student reflections in the form of posters

Algorithm, Action

The action was carried out with a field trip to Gua Cemara Beach, Yogyakarta, Indonesia. Students take action bydesigning projects that positively impact the tourism sector at Gua Cemara Beach. The activity is carried outin the following steps:

1. Students sketch a building that can be a combination of building spaces, for example, which will beused as a project on the beach of Gua Cemara.
2. Students and lecturers carry out joint field trips to confirm the sketches that have been made. Students will practice measuring and calculating volume and surface area depending on the interests of the project being developed.
3. Students revise building sketches and make posters for project activities to be displayed in gallery walking activities.
4. Students participate in the project poster walking gallery activity, then choose their favorite group by attaching a star to the group that is considered the most creative.

Apart from being an activist movement that impacts the surrounding environment (Csizmadia, 2015), students also learnalgorithmic thinking because they compile work steps thoroughly. This statement is in line with what Czismadia said (Csizmadia, 2015),namely, think in terms of sequences and rules to solve problems.

Evaluation

Evaluation is carried out in a formative and summative manner. Formative evaluation is carried out during learningby looking at students' performance when presenting the material and the results of reflections and observation reports on learning cases. Summative evaluation is carried out using written examinations but is based on concrete activities, namely as follows.

Semi Written Exam

1. Students take a lottery to enter the room (there are eight students for each session).
2. Students take a lottery question, then paste it on the folio sheet, then work on it for 15 minutes.
3. Students leave the room and change to the following session.

Practice Exams Proving Formulas

1. The lecturer prepared 24 sets of media materials and tools to be used.
2. After finishing the semi-written exam room, students move to the next room to take the lottery and prove the geometric formula using the available media within 5 minutes.
3. Students present the proof of the formula for 3 minutes.

The evaluation has fulfilled the last stage of the Ignatian Pedagogy step (PI) by systematically evaluating student growth in attitudes, priorities, and actions, consistent with others for others and as essential. This is confirmed by Harendita (2019) for the last step of PSI.

CONCLUSION

This study concludes that the implementation of computational thinking in a flipped classroom based on Ignatian pedagogy in geometry for pre-service teachers at Sanata Dharma University is carried out by learning steps, namely (1) context, (2) experience, (3) action, (4) evaluation, (5) reflection. In this step, four aspects of Computational Thinking are developed, namely (1) decomposition, (2) pattern recognition, (3) abstraction, and (4) algorithms. The results of the learning reflection show the response that students like the learning design.

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