THE IMPLEMENTATION OF RECEPTION-ORIENTED CAM WITH WORKSHEETS TO IMPROVE GRADE 10 STUDENTS' CONCEPTUAL UNDERSTANDING OF QUADRATIC EQUATIONS AND FUNCTIONS IN A CHRISTIAN SCHOOL

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ABSTRACT

Based on observations and summative test results, the researcher identified that students' difficulties in learning quadratic equations and functions was conceptual understanding. Conceptual understanding enables students to analyze, integrate, and apply a concept in different situations. The purpose of the research was to see if the implementation of the Reception-Oriented CAM with worksheets improved students' conceptual understanding and to find an effective way to implement the method. The researcher used a two-cycle Classroom Action Research of Pelton's with seven grade 10 female students at a Christian school in Tangerang as the research subjects. Data was collected by test sheets, observation sheets, feedback sheets, and documentation. The result showed that the Reception-Oriented CAM with worksheets could improve students' conceptual understanding in learning quadratic equations and functions. Another result showed that an effective way to implement Reception-Oriented CAM with worksheets was through implementing all the phases of the method thoroughly by giving more time in phase three and giving detailed instruction to the students

Keywords: Classroom Action Research, concept attainment, reception-oriented CAM, worksheets, conceptual understanding.

ABSTRAK

Berdasarkan pengamatan dan hasil tes sumatif, peneliti mengidentifikasi bahwa kesulitan siswa dalam belajar persamaan dan fungsi kuadrat adalah dalam memahami konsep. Pemahaman konsep memungkinkan siswa untuk menganalisis, mengitegrasi, dan menerapkan konsep dalam berbagai situasi. Tujuan penelitian ini adalah untuk melihat manfaat penggunaan *Reception Oriented CAM* dengan lembar kerja untuk meningkatkan pemahaman konsep dan menemukan suatu cara yang efektif dalam penerapan metode tersebut. Penelitian tuindakan kelas dua siklus dengan model Pelton ini mengambil subyek tujuh siswi kelas 10 di suatu Sekolah Kristen di Tangerang. Data dikumpulkan dengan lembar tes, observasi, lembar umpan balik, dan dokumentasi. Hasil penelitian menunjukkan bahwa metode *Reception Oriented CAM* dengan lembar kerja dapat meningkatgkan pemahaman konsep siswa dalam pembelajaran persamaan dan fungsi kuadrat. Hasil penelitian juga menunjukkan bahwa cara yang efektif untuk menerapkan *Reception Oriented CAM* dengan lembar kerja adalah dengan cara memberikan waktu yang cukup pada langkah ke tiga dan memberikan instruksi dengan detail kepada siswa-siswa sebelum pembelajaran dimulai.

Kata Kunci: PTK*, konsep matematika, reception-oriented CAM*, lembar kerja*, pemahaman konsep

The Implementation of Reception-Oriented Cam with Worksheets to Improve Grade 10 Students' Conceptual
Understanding of Quadratic Equations and Functions in A Christian School
Dea Dri Astuti, Dylmoon Hidayat

INTRODUCTION

This research was conducted based on the conditions of students who were learning Mathematics topic quadratic equation and function. The researcher taught students of this class and found some issues. The majority of students of this class were active in asking and arguing their opinion, but they tended to be individual to finish exercises given by the teacher. During the teaching and learning process, the researcher observed students and found that students were very obsessed to get high score in summative test. When the researcher tried to explain how the concept could be gained, they were ignored it and only answered the simple way to solve the problem. Moreover, when the researcher gave other questions which is different to the example given, they would be confused immediately and could not solve the question. The researcher identified that the problem which students were facing is lack of conceptual understanding.

Conceptual understanding is one of mathematical proficiency. Conceptual understanding refers to an integrated and functional grasp of mathematical ideas, further, the students know more than isolated facts and method and understand why a mathematical idea is important and the kinds of context in which is it useful (Kilpatrick, Swafford, & Findell, 2001, p.118). This crisis appears when the students unable to classify, infer, comprehend, and apply the concept quadratic equation and function. This inability leads students to fail in completing and solving the questions given by the teacher. Briefly, students cannot understand why and how a concept is integrated to solve questions given either real life or procedural questions.

The goal of learning Mathematics should not only exercise Mathematics problem, but more to apply and create innovation through Mathematics. The ideal condition of learning mathematics is through learning mathematics with understanding. Mathematics is "a way of thinking" and "a tool" (Reys, 2007, p. 3). Only through deep understanding of mathematical concept students can use Mathematics as a way of thinking and tool. Mathematics is a study which underlies as a foundation for students to enhance their study in another field such as sciences, social sciences, research, business, management, and government. Citizens who cannot reason mathematically are cut off from whole realms of human endeavor; not only of opportunity but also of competence in everyday tasks (Kilpatrick, Swafford, & Findell, 2001, p. 1). Therefore, students really need teaching and learning process which bring them into deep conceptual understanding in order to give meaningful experience of learning Mathematics in order to glorify God. "Mathematics learning should be a tool to bring studets to see and admire God as the great creator" (Saragih, Hidayat, & Tamba, 2019). Further, through meaningful Mathematics learning students that is bridged by understanding of Mathematics concepts, students are expected to use it for the glory of the Lord in His creation.

Based on research done by Latterell & Wilson (2013), they conclude that from kindergarten through the undergraduate experience, most students do not even know what Mathematics really is, it implies narrow perspective about Mathematics and the importance

The Implementation of Reception-Oriented Cam with Worksheets to Improve Grade 10 Students' Conceptual
Understanding of Quadratic Equations and Functions in A Christian School
Dea Dri Astuti, Dylmoon Hidayat

of Mathematics. The researcher found that students of this class had narrow perspective about learning mathematics. Their assumption toward learning mathematics was merely about solving questions easily and quickly to get high score. Learning mathematics should bring students an experience for understanding a concept so that they could know why and how a concept is important and useful in different situation. The students are expected to use mathematics as a tool and a way of thinking to create innovation and solve problem as result of their understanding of a concept they learn.

"God created human beings with curiosity, a desire to know, and ability to search for understanding and truth" (Stonehouse, 2003, p. 15). God enables students to learn Mathematics with understanding rather than only construct their understanding on their own. "The fact that man is in the image of God means that man is like God in the following ways: intellectual ability, moral purity, spiritual nature, dominion over the earth, creativity, ability to make ethical choices, and immortality" (Grudem, 1994, p. 383). As a responsibility of God's grace, students should sharpen their intellectual ability through learn Mathematics with deep understanding. Thereby, students can change their behavior toward God, neighbor, and created world. "A full understanding of man's likeness to God would require a full understanding of who God is in his being and in his actions and a full understanding of who man is and what he does" (Grudem, 1994, p. 383). Accordingly, if students can learn Mathematics with understanding, they will understand the meaning of Mathematics itself and use it wisely for the glory of the Lord.

Some research that was conducted by Kiswandi, Soedjoko, & Hendikawati (2013), Anjum (2015), and Isnaini (2017) found that students who were taught with concept attainment model had higher conceptual understanding compared to expository and traditional teaching. Following this, the researcher considered to use Reception-Oriented Concept Attainment Method to overcome this problem. The Concept Attainment Model was uniquely designed to help students to enhance and enrich their understanding about concepts of their experiences and give students experience to train their critical thinking especially in testing hypothesis (Eggen & Kauchack, 2012, p. 251). Further, the Reception-Oriented CAM is one of Concept Attainment method which provides steps to improve students' conceptual understanding through identify, testing concept attain by making hypothesis, and analyzing problem. This method provides many chances for students to share their thoughts and questions. By that, this method should be suitable for students' context in this research. Thus, after the implementation of the method, students should gain a deep understanding of the concept quadratic equation and function.

LITERATURE REVIEW

According to Kilpatrick, Swafford, & Findell (2001, p. 118), conceptual understanding refers to an integrated and functional grasp of mathematical ideas where students know more than isolated facts and method and understand why a mathematical idea is important and the kinds of context in which is it useful. "Conceptual Mathematics understanding is the

knowledge that involves a thorough understanding of underlying and foundational concepts behind the algorithms performed in Mathematics" (Hope, 2006, as cited in Ghazali & Zakaria, 2011, p. 684). Furthermore, conceptual knowledge involves understanding what mathematical concepts mean (Reys, 2007, p. 21). Through the explanation experts above, the researcher concludes that conceptual understanding is a comprehension about being able to analyze, integrate, and apply a concept in different situations in which knowing why and how the concept is used.

According to (Lestari & Yudhanegara, 2015, p. 81), the indicators of conceptual understanding are: (a) identifying and making example and non-example, (b) interpreting meaning symbol, table, diagram, image, graph, and mathematical sentence, (c) comprehending and applying mathematical ideas, and (d) inferring a concept. "A significant indicator of conceptual understanding is being able to represent mathematical situations in different ways and knowing how different representations can be useful for different purposes" (Kilpatrick, Swafford, & Findell, 2001, p. 119). According to (Eggen & Kauchack, 2012, p. 247), students' knowledge and concept understanding could be measured through four-ways, which are: defining the concept, identifying characteristics of the concept, connecting the concept with the other concepts, and identifying or (giving example from concept that have not been found before.

Through the explanation experts above and the conditions of students of the research, the researcher concludes the indicator of this research as follows (1) classifying different mathematical situation based on the concept, (2) inferring relevant concepts to solve the problem, (3) comprehending mathematical sentence or representation, and (4) applying a mathematical concept. Based on Bloom taxonomy (Krathwohl, 2002), the researcher used the category level of cognitive from C2-C3, that are classifying (C2), inferring (C2), comprehending (C2), and applying (C3).

The quadratic equation and function topic are an abstract in Mathematics, which is very important for students to expand another concepts in Mathematics if the can grasp the concept comprehensively, by that students must understand the concept thoroughly. A quick example of the use of quadratic equation and function is understanding created world that God's had designed, especially in physics, for example, a projectile motion and construction of the bridge that has a quadratic shape. Moreover, students could see the beauty of God' creation through learning quadratic function, e.g. turtle shell has a basic quadratic shape. In this case, students can relate the concept of Mathematics and the use of the concept in real life. Beside that, they can see the beauty of God's creation as what Christian education expected that is the learning must be Christ-centered. Accordingly, conceptual understanding enables students to represent the mathematical concept and apply it in a different way. By this idea, through learning quadratic equation and function with conceptual understanding students have more opportunities to glorify God because they learn about it accordingly.

The term Concept Attainment Model (CAM) is based on the work of Jerome S. Bruner, Jacqueline J. Goodnow, and George A. Austin in book "Study of Thinking". In this book, it is explained that categorizing helps to reduce the complexity of environment and necessity for concept learning (Kumar & Mathur, 2013, p. 165). The variation of CA (I) or Reception-

Oriented Concept Attainment is begun when a teacher gives example and non-example simultaneously until students can make a single hypothesis and apply the hypothesis into new examples (Eggen & Kauchack, 2012, p. 226). Reception-Oriented CAM is "more direct in teaching students the elements of a concept and their use in concept attainment" (Prabhakaram & Bhaskara, 2006, p. 14). In the reception-based paradigm, "the data is presented in form of discriminate units and the learners are informed that there is one common concept in the positive (yes) examples that the learners have to decipher" (Markant & Gureckis, 2014, as cited in Suleiman 2016, p. 2678).

Through experts' explanations above, Reception Oriented CAM refers to emphasize on students' hypotheses and critical thinking of presented exemplars to determine a concept. Through deep understanding and thinking critically, students have the chance to learn mathematics. Through the process of critical thinking and make hypothesis, students have experiences to gain conceptual understanding through the implementation of Reception-Oriented CAM. This method can help and facilitate students to dig more concepts. Grudem (1994, p. 384) says that the redemptive way to recover the image of God is through "renew knowledge" progressively and to be more like God in our thinking". Hopefully, through learning Mathematics with understanding, students can renew their knowledge and use it wisely to create innovation in order to glorify God. The researcher admits that it is a long journey to achieve it, it includes many aspects of students' lives, but at least through the experience of learning Mathematics with understanding, students can see the work and the God's providence through learn Mathematics by understanding.

According to Weil J & Joyce B (1978), as cited in Suleiman, 2016, p. 2678, the phases of Reception-Oriented CAM as follows,

1. Presentation of information related and not related to the concept in question, and the learners formulate a hypothesis of what the concept is.

2. Testing the hypothesis by categorizing additional unlabeled data and by providing other examples that fit with the attributes of the concept.
3. Analysis of the thinking that led to the conclusion of what the intended concept was.

Furthermore, according to Khirwadakar (2007, pp. 114-115), the steps of reception-oriented CAM as follows,

1. Phase one: Presentation of Data and Identification of Attributes: Teacher presents data to the learner, the learners are informed that all positive examples have commonality attributes, learners are asked to compare and justify the attributes of different example, and they are asked to name their concept and state the rule or definition of the concept according to its essential attributes.

2. Phase two: Testing Attainment of Concept: Students are asked to identify additional unlabeled examples of the concept and then by presentation of their own examples and the teacher and students together confirm or disconfirm the framed hypotheses.

3. Phase three: Analysis of Thinking Strategy: Students try to analyze the strategy through which they attain a concept and students find out whether they focused on attributes or concepts and how they reached to the concept.

According to Eggen & Kauchack (2012, p. 227-235-32), the steps of Reception-Oriented CAM as follows,

1. Introduction: the teacher gives an introduction to students about how to identify concept through "yes" or "no" of the example given.
2. Examples and hypothesizing: the teacher shows an example and a non-example to students and ask students to make a hypothesis about the concept.

3. The Analysis Cycle: the teacher gives another example and non-example and the teacher asks students to analyze their hypotheses to know whether their hypotheses valid or not with the new information.

4. Closure and Application: the teacher asks students to identify the main characteristic of the concept.

Through the explanations' experts of Reception-Oriented Concept Attainment Method above, the researcher considered the steps from Khirwadakar (2007, pp. 114-115), as the main steps of the research and adjusted the steps with the students' condition. Below are the steps that the researcher used in this research,

1. Phase one: Presentation of data and identification of attributes: Teacher presents the concept by labeled example, Students select the example and inquiries whether it is positive or negative, Teacher asks students to state the rule of the concept according to the essential attributes,

2. Phase two: testing the attainment of concept: Teacher asks students to identify unlabeled example given, Teacher confirms students' hypothesis, and Teacher asks students to restate the attributes of the concept.

3. Phase three: analysis of thinking strategy: the teacher asks students to discuss the given problem, the teacher asks students to analyze and explain the problem, and teacher evaluates the strategies

The source of data and its attributes of the concept that is required in the steps of Concept Attainment Model need to be known before, so that when students are presented an example, they were asked to represent the attributes (characteristics) from the examples, and the teacher takes note of it (Huda, 2014, 84). The researcher used worksheets to help students follow the lesson with Reception-Oriented CAM and help teacher to control the class. "Worksheets are written materials containing explanations that provide guidance on activities that students will take in the course of teaching any topic" (Saka, Akdeniz, & Enginar, 2002, as cited in İnan & Serdar, 2017, p. 1373).

The Implementation of Reception-Oriented Cam with Worksheets to Improve Grade 10 Students' Conceptual
Understanding of Quadratic Equations and Functions in A Christian School
Dea Dri Astuti, Dylmoon Hidayat

Recent research showed the effectiveness of implementing the concept attainment model. Ostad & Soleymanpour (2014) conducted a study of the impact of concept attainment and mastery learning, they found that these methods can be used to enhance student academic achievement and metacognitive skills in the classroom. Kaur (2018) study also support that students who taught with this teaching model had a higher score than the students taught through the traditional method. Moreover, Kiswandi, Soedjoko, & Hendikawati (2013) also found that students' conceptual understanding in understanding "set" concept which used concept attainment model and class which used cognitive growth model was better than students in the class which used expository model. The research conducted by Anjum (2015) also found that the concept attainment model is more effective than the traditional method in understanding geometry concept. Moreover, Isnaini (2017) found that students who taught by concept attainment model with realistic Mathematics education had higher conceptual understanding compared to traditional teaching.

RESEARCH METHOD

The researcher used Classroom Action Research (CAR) as the method of the research. Classroom Action Research (CAR) is a process to analyze learning problems in class through self-reflection in order to solve the problem with various planned actions in real situation and its effect analysis (Sanjaya, 2009, p. 26). Furthermore, Pelton (2010, p. 4) describes action research of each term especially classroom action research (CAR), that are: action is about what teacher does in the classroom and research refers to methods, habits and attitudes that will be used. The class can be understood as a group of students who being learn in the same time accept the same lesson from the teacher, thus it is not about classroom (Arikunto, Suhardjono, & Supardi, 2012, p. 3). The researcher used classroom action research with Pelton's model. This model has five steps which are issue identification, data collection, action planning, plan activation, and outcome assessment. The instruments used in this research were test sheet, method observation checklist, mentor and colleague feedback, and documentation (lesson plan and students' test result). Below is the latticework of test sheets.

Bloom's Taxonomy Level	Indicator	Number Question	Explanation
Formative Test in Plan Activation 1			
C2	CU-1	1	The question is about classifying the roots of quadratic equations.
C2	CU-3	2	The question is about finding quadratic equation when given its roots.

The Implementation of Reception-Oriented Cam with Worksheets to Improve Grade 10 Students' Conceptual
Understanding of Quadratic Equations and Functions in A Christian School
Dea Dri Astuti, Dylmoon Hidayat

C2	CU-2	3	The question is about arranging new quadratic equation with given its roots from old quadratic equation.
C3	CU-4	4	The question is about finding two numbers when given the value of adding and multiplying of the numbers.

Formative Test in Plan Activation 2			
C2	CU-1	1	The question is about classifying whether through the points given can be found quadratic function.
C2	CU-2	2	The question is about finding quadratic function when given conditions which the value of discriminant larger than zero, its roots, and the passing points of the function.
C3	CU-4	3	The question is about finding quadratic function when given condition that the graph of the function has a turning point and a passing point.

Below is the latticework of reception-oriented CAM observation sheets.

Indicator	Statement	Number Statement
Phase I: Presentation of Data and Identification of Concept	Teacher presents concept by labeled example	5
	Teacher asks students to compare attributes of positive and negative example	6
	Teacher asks students to state the rule of concept according to the essential attributes	7
Phase II: Testing Attainment of concept	Teacher asks students to identify unlabeled example given	8
	Teacher confirms students' hypothesis	9
	Teacher asks students to restate the attributes of the concept	10
Phase III: Analysis of	Teacher asks students to discuss given	11

The Implementation of Reception-Oriented Cam with Worksheets to Improve Grade 10 Students' Conceptual
Understanding of Quadratic Equations and Functions in A Christian School
Dea Dri Astuti, Dylmoon Hidayat

Thinking strategy	problem	
	Teacher asks students to analyze and explain the problem	12
	Teacher evaluates the strategies	13

This research was conducted with enough time, meaning that it was done by careful planning and not in hurry. The researcher also compared theories from three different experts to validate the conclusion and analyze each variable research. Further, the researcher used more than three methods as described before. The data that has been collected would be analyzed quantitatively and qualitatively. Quantitative data was coming from students' formative and summative test result and method observation rating scale. Whereas, qualitative data was coming from journal reflection, students' performance rating scale, and documentation data that were a lesson plan, power point text, and worksheets. To calculate the score of students' conceptual understanding, the researchers calculated the score gained by the students from the maximum score 10.

Next, the researcher converted the score gained into five scale classification. The clasification is according to Widyoko (2014, p. 262), that is scale >4,2 is very proficient, > 3,4 – 4,2 is proficient, > 2,6 – 3,4 is proficient enough, > 1,8 – 2,6 and ≤ 1,8 is not proficient. To calculate method observation, the researcher analyzed it descriptively based on category of the score gained. The researcher prepared the observation form with five scales. The explanation is scale 1 (less), scale 2 (enough), scale 3 (good), scale 4 (very good), and scale 5 (satisfactory). The Reception-Oriented CAM was said to be implemented if the observer checked at least in scale 2 (enough), further marked as 100% implemented.

Analysis and Discussion

The researcher analyzed the data collected quantitatively and qualitatively. Below is the discussion analysis of each variable.

Reception-Oriented CAM

Through the journal reflection, the researcher evaluated that the strength of the implementation of Reception Oriented CAM in Plan Activation 1 could help students to be more enthusiastic, engaged, and active. "CAM promotes active learning by engaging the learners to use their experiences and logic, make their own analysis, and comparing and contrasting ideas, instead of a one-way presentation by the trainer" (Saphier, Haley, & Gower, 2008, as cited in Suleiman, 2016, p. 2678). As mentor and colleague feedback in plan activation 1, students who had an active role would engage and followed Reception-Oriented CAM precisely. The researcher analysed that students who engage and follow the learning could active to show argument. "Engagement is also important to place students in active role in a cognitive area" (Blumenfield, Kempler, & Krajcik, 2006 as cited in Eggen & Kauchack, 2012, p. 75). In other words, students who had an active role in which showing arguments to present their understanding over concept being learned could engage and involve during the teaching and learning process.

Furthermore, the mentor teacher also gave feedback about students who are slow to understand. The researcher analyzed that these students struggled to follow the lesson. "Struggling learners, a student who is considered a struggling learner cannot learn at an average rate from the

The Implementation of Reception-Oriented Cam with Worksheets to Improve Grade 10 Students' Conceptual
Understanding of Quadratic Equations and Functions in A Christian School
Dea Dri Astuti, Dylmoon Hidayat

instructional resources, texts, workbooks, and materials that are designed for the majority of students in the classroom" (Bloom, 1982, as cited in Burden & Byrd, 2010, p. 87). Moreover, their test result also below the average, in other words, their performance are not as good as the average and high achiver students. McCoach & Siege as cited in Anditya, Panggabean, & Dirgantoro (2017) stated that "Underachievers exhibit more negative attitudes toward school than the average and high achievers do". Therefore, researcher has responsibility to give pay more attentions and instructions to the struggling students, so that they can follow the lesson. Accordingly, it is the role of Christian teacher about being care and knows students' need specifically. Here, the Christian teacher takes role as a shepherd, shepherding students to God, as Jesus Christ does, He is our shepherd. Shepherd always focused his/ her eyes on the sheep and knows his or her sheep well (Graham, 2009, p. 130-131). Therefore, not only struggling students who need more attentions and special treat, but also all students need to be understood and treated as their needs.

The researcher evaluated that in implementing phase 3 of Reception-Oriented CAM took much time. This phase was about thinking strategy, students needed more time to think strategy and arrange hypotheses, therefore, in this phase took much time to be accomplished. In this phase, students began to analyze the strategies to attain concept in constructing process whether they did one at a time or several at once (Joyce, Weil, & Calhoun, 2009, p.118). Therefore, in this phase needed extra time to finish and give students time to internalize it.

In Plan Activation, 2 the strength of the implementation was passive students were more engaged and time allocation was better than Plan Activation 1. From the colleague teacher feedback, the researcher concluded that all students already involved to give the argument, especially students who have not yet asked. The mentor teacher gave feedback about being careful to use term "equation and function". The researcher realizes that term definition in mathematics really important. So that, the researcher as a teacher had to explain and use the term precisely and clearly. In addition, based on the method observation, implementation Reception-Oriented CAM in both Plan Activation 1 and 2 were implemented 100%.

Especially struggling students, he or she needs frequent feedback, corrective instruction, special instructional pacing, instructional variety, and perhaps modified materials" (Educational Research Service, 2004, as cited in as cited in Burden & Byrd, 2010, p. 87). The use of worksheet in Plan Activation 1 was not applied maximally, as mentor teacher feedback that students needed more example to do worksheets. The researcher analyzed that students need more instruction and example to fill the worksheets. The worksheets were arranged based on the steps of Reception-Oriented CAM and the flow of the implementation of method was helped by the instruction in the worksheet. By that, when students fill the worksheets students follow the Reception-Oriented CAM. Based on the feedback, students still got confused how to do worksheet, it also could be seen that students still a bit confused about how to the steps of Reception-Oriented CAM. In this Plan Activation, students had to know how to identify a question, make hypothesis about a question, and make strategy to solve a problem. There were many new things that they had to do. Thus, it was natural if they got confused. The researcher reflected on it and made some changes about the procedure of the worksheets.

In Plan Activation 2, the researcher set the goal for the worksheets that was the worksheets would be used as the requirement before the summative test. As a result, students could fill the worksheets completely. In this Plan Activation, students had become accustomed to how to fill the

The Implementation of Reception-Oriented Cam with Worksheets to Improve Grade 10 Students' Conceptual
Understanding of Quadratic Equations and Functions in A Christian School
Dea Dri Astuti, Dylmoon Hidayat

worksheets and follow the step of Reception-Oriented CAM. Worksheets helped students to learn the quadratic equation and function in preparing test and following the teaching and learning process with Reception-Oriented CAM.

Conceptual Understanding

Below is the comparison of formative test that was conducted in plan activation 1 and 2.
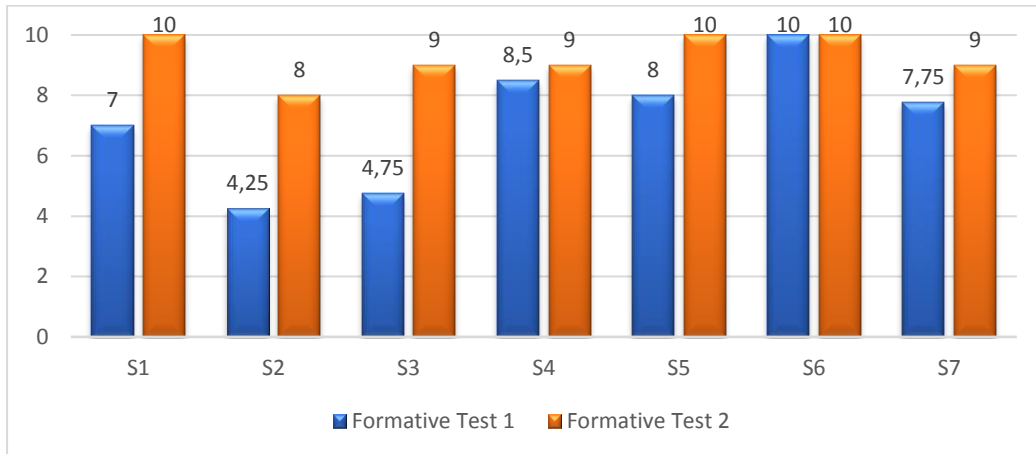
Based on the diagram, all students improved their conceptual understanding. S1 improved her conceptual understanding around 42.8%. S2 improved her conceptual understanding around 88.2%. S3 improved her conceptual understanding around 89.4%. S4 improved her conceptual understanding around 5.8%. S5 improved her conceptual understanding around 25%. For S6, her score was maximum from formative test 1 and formative test 2. S7 improved her conceptual understanding around 16.1 %. Below is the average comparison of indicators from Plan Activation 1 and 2.
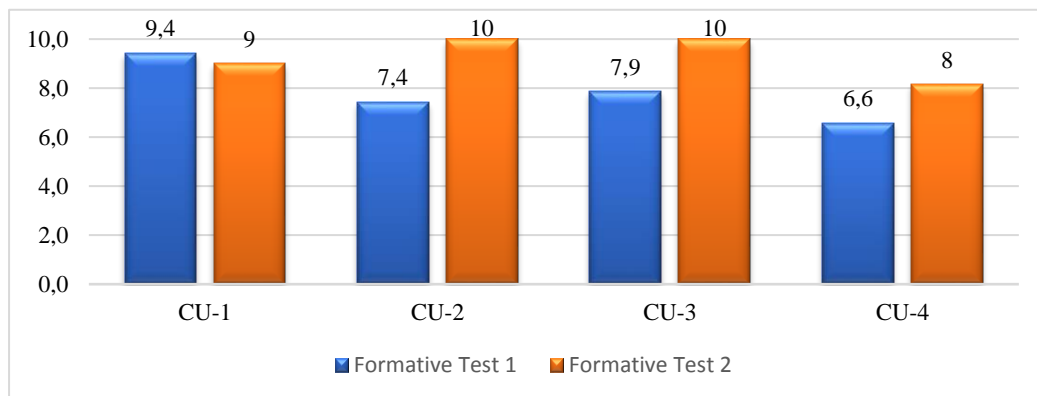
Based on the diagram, CU-1 is decreasing around 4.25 %. The indicator is about classifying different mathematical situation based on the concept and the average of students conceptual understanding CU-1 in Plan Activation 1 is in very proficient category, moreover the decreasing of this indicator is not significant. Therefore, the decreasing of this indicator is still can be accepted. The improvements average of CU-2 is around 35.13 %, CU-3 are around 26,58%, and CU-4 are around 21.21%.

CONCLUSION

The Reception-Oriented CAM can improve students' conceptual understanding in topic lesson quadratic equation and function. All students improved their conceptual understanding. The effective way to implement Reception-Oriented CAM with worksheets is through implementing all phases appropriately and thoroughly that are, phase one: presentation of data and identification of concept, phase two: testing attainment of concept and phase three: analysis of thinking strategy. The researcher specifically concludes that for phase three need extra time for students to analyze students' thinking strategy.

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The Implementation of Reception-Oriented Cam with Worksheets to Improve Grade 10 Students' Conceptual
Understanding of Quadratic Equations and Functions in A Christian School
Dea Dri Astuti, Dylmoon Hidayat

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