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OVERCOMING ISSUES WITH MATHEMATICAL COMMUNICATION: A GUIDE FOR GRADUATE STUDENTS IN MATHEMATICAL PROOF

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ABSTRACT: The Institute of Teacher Training and Education Pontianak Department of Mathematics Education says students struggle to prove premises or theorems. Instead, this study encouraged students to enhance their mathematical communication skills as supporting evidence. This initiative used case studies for qualitative research. The study included two real-world analysis-trained undergraduates. This study collected data through examinations and interviews. Study methods included data reduction, display, and conclusion. Based on the investigation, theoretical analysis, and discussion, students' difficulties answering mathematical proof questions stem from their limited use of mathematical symbols and their lack of mathematical proof experience. However, didactic anticipation through mathematical communication has increased students' mathematical proof problem-solving skills. Students experiencing trouble with mathematical proof difficulties may try mathematical communication.

Keywords: Mathematics Communication; Mathematical Proof; Square and Triangle; Learning Media

1. INTRODUCTION

The National Council of Teachers of Mathematics (NCTM) deems mathematical evidence important to a standard mathematical approach utilized in schools. Children are expected to understand the subject matter because the standard's mathematical process components include mathematical evidence. Math comprehension is important for current and future educators. Professionals discuss mathematical proof regularly because normal arithmetic students may struggle with it. Several international research (Ozdemir & Ovez, 2012; Guler, 2016; Selden & Selden, 2003) demonstrated that many students struggle to support their claims. This is a common problem for researchers teaching undergraduates actual analysis.

Educational Personnel Education Institution and Mathematics Education Program Study Program investigation at the Pontianak Institute of Teacher Training and Education found that students fail to explain premises or mathematical theorems (Hodiyanto, 2017). This phenomenon has been observed elsewhere, according to Andri (2013) and Maya and Sumarmo (2014). Mathematical proofs are difficult for students to create, execute, and verify. Identifying key information in a mathematical statement is tough. According to Weber (2003) and Recio and Godino (2001), failing to discern between proved and unproven information is a major concern. There is also a tendency to replace unproven evidence with accepted proof. Any math class can have these issues.

Other reasons, like as the instructor's structuralist formal approach, may cause again issues. Mathematics training frequently follows a methodical lecture type pattern, according to Soejadi (2000). This sequence covers theory, definition, and theorem exposition, instructional examples, and problem-solving exercises. It is considered that formal thinking students can understand and engage with mathematical concepts, therefore presenting them in a certain order is fine. The following considerations support structuralist thinking. Theoretical reasoning seems to be hampered by students' increasingly poor mathematical proof understanding when taught structuralistically. Finding an alternative is crucial. This study emphasizes mathematical communication to improve students' proof-related skills. Many aspects must be examined when assessing mathematical communication's ability to improve students' proof skills. Communication in mathematics is vital for idea exchange and deeper mathematical learning. In mathematical communication, problem-solving notions are reflected, discussed, and maybe revised (Suryadi, 2013; NCTM, 2000). Students will also be encouraged to critically analyze and solve challenges. Students struggle with problem-solving because they must apply many concepts and propose alternative solutions. Students may easily exchange, compare, justify, explain, and discuss difficulties with these educational resources. Students learn procedural knowledge, conceptual comprehension, and other mathematical skills through class interactions, according to Takahashi (2006). Student-to-student interactions that examine mathematical concepts from different perspectives can also help students understand the subject better and improve their ability to discourse, justify, explain, and communicate. Additionally, pupils often dislike arithmetic.

After a thorough evaluation, investigating mathematical communication activities may help aspiring educators overcome the challenges of teaching mathematical proof. Thus, the study is titled "Mathematical Communication as a Viable Approach to Addressing Challenges Faced by Prospective Student Teachers in Proof at IKIP PGRI Pontianak." The main study issue addresses the challenges prospective instructors have learning mathematical proof in actual analytical courses, with a focus on mathematical communication. Information is used to create this research question.

2. RESEARCH METHOD

Qualitative research methods based on postpositivist philosophy involve researchers. These methods study natural phenomena, unlike experimental procedures. The strategies emphasize meaning rather than generalization, purposeful or snowball sampling, linked triangulation data collecting, and inductive/qualitative data analysis (Sugiyono, 2013: 15). Qualitative researchers say data collecting involves researcher-data source interactions. Researchers and data providers will face limitations in data collecting, analysis, and reporting due to their various histories, viewpoints, beliefs, interests, and perceptions (Sugiyono, 2013: 21).

This case study examined students' struggles with real analytic evidence before and after mathematical communication. Case studies are detailed, rigorous, and in-depth analyses of an organization, institution, or specific symptoms, according to Arikunto (year). Ardianto (2016: 8) defines case studies as a thorough, consistent, and in-depth analysis of each event in accordance with the underlying principle. Two undergraduate mathematics teaching students from IKIP PGRI Pontianak participated in the investigation. Participants who learned real analytic notions answered mathematical proof questions worse. This study collected data through examinations and interviews. Interviews are used to employ didactic anticipation in mathematical communication, while exams are used to identify student difficulties with mathematical proof problems. Data analysis involved reducing, displaying, and drawing conclusions.

3. RESULTS AND DISCUSSION

Results before Anticipation of Didactics

The researcher identified the two students with the lowest mathematical proof abilities after the pretest. Pretest findings, before didactic expectation and mathematical communication, are explained here. Participants in this early review had legitimate analysis training.

Subject Answer One Answer No. 1

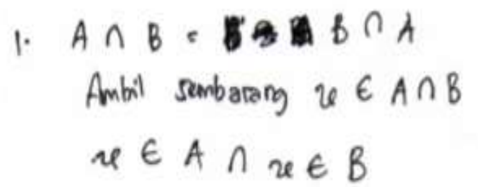

Figure 1. Subject Answer one No. 1

Question one requires students to prove AB = BA to prove the commutative property. Subject 1 did not illustrate and apply the equal set definition, which asserts that A and B are equal if and only if A and B are subsets of A. Subject 1 redefined the intersection of two sets incorrectly. Defining A B as the set of elements x that belong to both A and B as x| x A x B is the correct solution for subject 1.

Answer No. 2

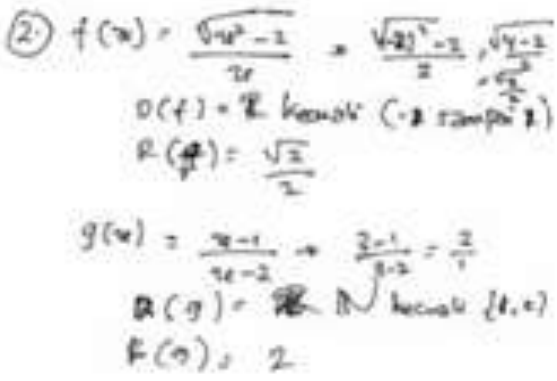

Figure 2. Subject Answer one No. 2

Students must establish the scope and extent of known functions in real number universes in question 2. Students must find the domain (D) and range (R) of the functions f(x) = x2 2 / x and g(x) = (x-1)/(x-2). Subject 1 misidentified D(f) and R(f) when identifying f(x)'s domain and range. It should also be noted that Subject 1 still misidentifies D and R (g). The domain of function f is the real numbers excluding the closed interval from negative to positive square root of 2. Function f covers all real numbers. Domain of function g is real numbers excluding 2, range is all real numbers. These domain and range values are correct.

Answer No. 3

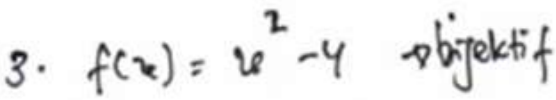

Figure 3. Subject Answer one No. 3

The third question concerns the bijective functions f(x) = x2 - 4 and g(x) = x - 3. Please specify the denominator if this has not been empirically proven. The question wasn't answered by Subject 1. Since g(x) = x - 3 is bijective and f(x) = x2 - 4 is not injective, the answers are not interchangeable or commoditized.

Subject Answer Two Answer No. 1

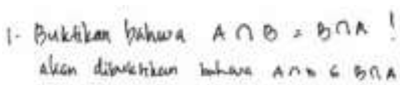

Figure 5. Subject Answer Two No. 1

Subject 2 started utilizing the definitions of the two sets, according to the original response. However, Subject 2 has struggled to develop these ideas and provide evidence.

Answer No. 2

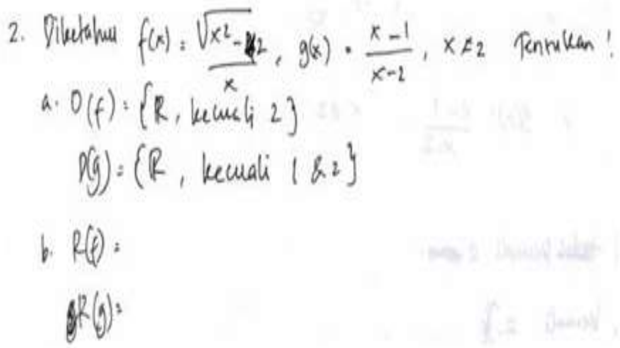

Figure 6. Subject Answer Two No. 2

Subject 2's answer was wrong, according to the second answer. Even when viewing R as a set of real numbers, topic 2's portrayal of a set and an element within R-containing sets is flawed. This solution may be wrong, but subject 2 should be written as D (f) = R/ 2, which represents the set of real numbers excluding 2.

Answer No. 3

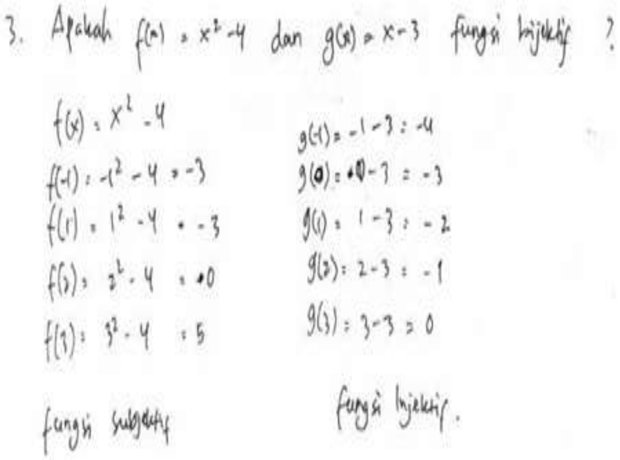

Figure 6. Subject Answer Two No. 3

The third response suggests subject 2's proof is flawed. To establish a function's bijectivity, proof for both its injectivity and surjectivity must be presented. Furthermore, similar to the solution suggested for point 2, the evidence presented lacks a particular example relevant to the domain. However, it is crucial that the idea under consideration be wide and firmly rooted in the current definitions of surjective and injective functions. Subjects 1 and 2's responses reveal that, notwithstanding earlier education, they have a general incapacity to appropriately tackle actual basic analytical concerns.

Results after Anticipation of Didactics

Prior to the presentation of the didactic stimulus, the degree of student replies is rather low. The current study focuses at how students and instructors employ didactic anticipation in the context of mathematical communication. Following the transmission of educational expectations, the examination will focus on student replies.

Subject Answer One Answer No. 1

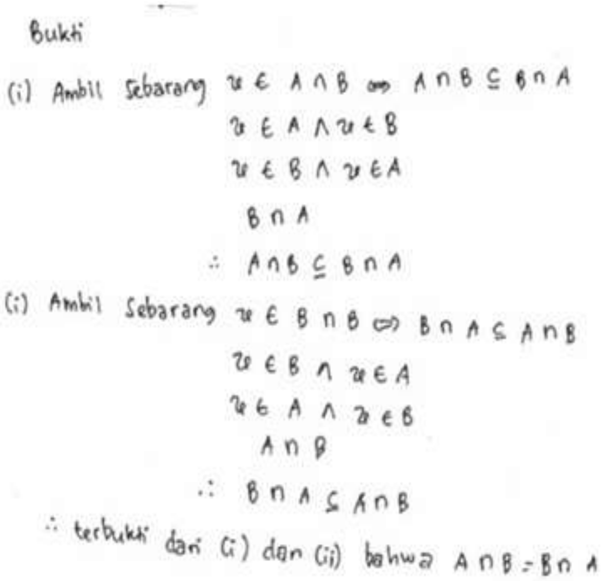

Figure 7. Subject Answer One No. 1

Even the individuals differ, subject 1's response following didactic anticipation changes suggests a valid solution. Define the set before starting the proof. This suggests that AB and BA must be proven within BA before starting subject 2's evidence.

Answer No. 2

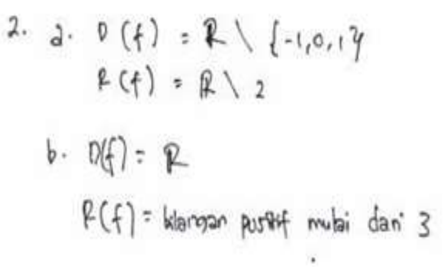

Figure 8. Subject Answer One No. 2

Subject 1 must be addressed after didactic anticipation. Option D (f) is mostly right. However, while the remaining possibilities are correct, defining the exception as D(f) = R [2, 2] is erroneous. Subject 1's performance prior to adopting didactic expectations, on the other hand, reveals inaccurate responses and written work.

Answer No. 3

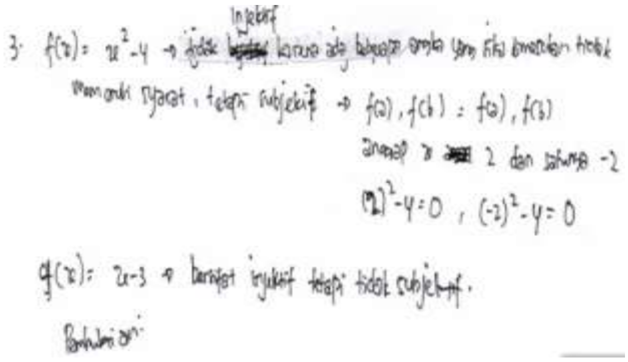

Figure 9. Subject Answer One No. 3

The proposed didactic adjustments are aimed to induce a reaction to subject 1. Subject 1's argument about the function f(x) = x2 - 4 is true since it fails to meet the criteria for being a bijective function because it cannot satisfy the conditions of an injective function. Subject 1 correctly recognizes the domain where an is not equal to b, specifically where -2 is not equal to 2. Remember that f(2)=f(-2). Despite include g(x) as a bijective function, which is both injective and surjective, subject 1's claim that g(x) = x - 3 is not bijective is false.

Subject Answer two Answer No. 1

Figure 10. Subject Answer Two No. 1

Subject response 2 shows that growing pedagogical standards support the equality of the intersections of sets A and B and B and A.

Each phase should include comprehensive information, such as intersection definitions (x belongs to set A and x belongs to set B).

Answer No. 2

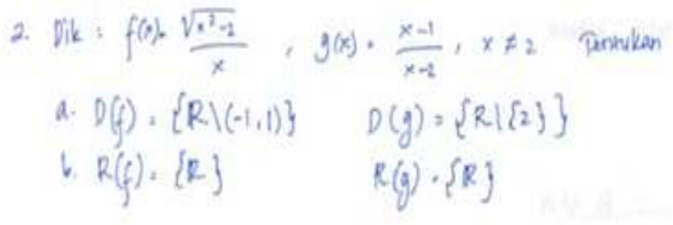

Figure 11. Subject Answer Two No. 2

Response 2 changed before didactic activities due to an expectation of didactic involvement. Subject 2 misrepresents the collection's composition and elements. Subject 2 answered wrong. D (f) = R 2 and R (f) = R should have worked. D and R (g) replies are very accurate.

Answer No. 3

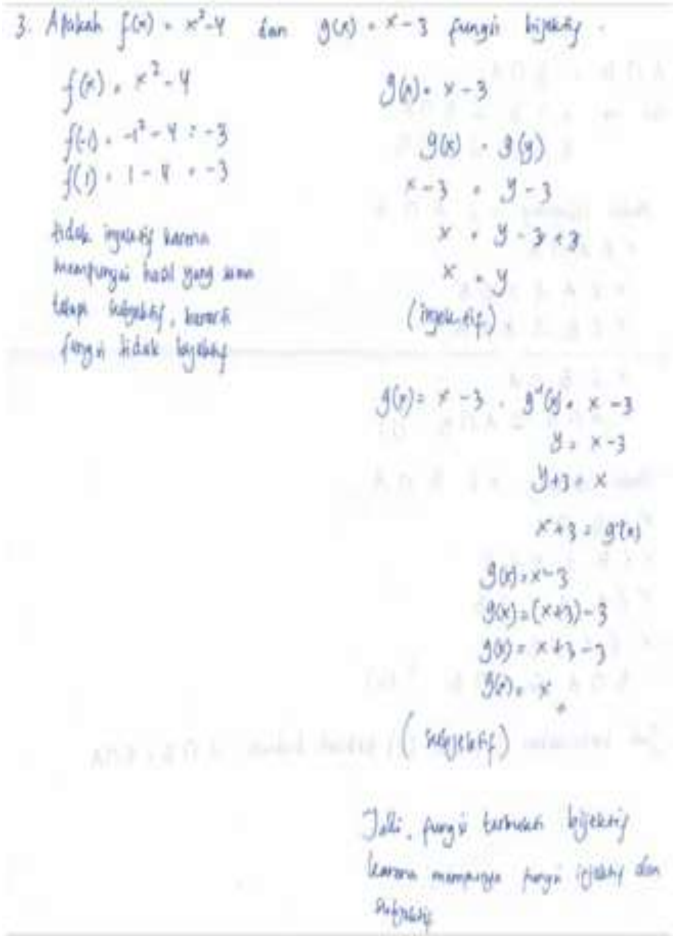

Figure 12. Subject Answer Two No. 3

The second participant answered after learning about the instructional adjustments. Subject 2 disproves f(1)=f(-1). Subject 1 is right that f(x) = x2 - 4 is not bijective since it lacks injectivity. Subject 2 nearly proves the function g(x) = x-3 is clever. Include the subject 2 demonstration or prove the bijectivity of g(x) with a well-structured response to complete the solution. Instead of introducing injective functions, Subject 2 should start with random real values for x and y. This is like determining g(x)'s injectivity. To prove g(x) is surjective, the above statement is true. Some members A have the function g(a) = b, where an is chosen as b + 3, just like any member B.

4. DISCUSSION

Previous mathematical communication research found that subjects 1 and 2 had trouble answering true analytical introductory inquiries through mathematical proving capacity. Even after considering didactic expectation, these issues continued. The respondents answered questions 1 and 2 incorrectly and wrote wrong answers. Students received topical teaching before the pretest. Still, the results are disappointing. This suggests that current instructional methods are ineffective, prompting academics to anticipate mathematical discourse pedagogy. Several international research (Ozdemir & Ovez, 2012; Guler, 2016; Selden & Selden, 2003) demonstrated that many students struggle to support their claims. The researcher anticipates didactic hurdles in material communication to help students understand evidence. Student test results show that didactic preparation through mathematical communication improves students' capacity to solve real analysis introduction issues. After receiving the anticipated didactic material, topic 1 students who had struggled to answer problems 1 and 3 solved them, albeit with some typographical errors. Subject 2 can now answer the question after didactic preparation, but she cannot support it. Students' capacity to solve issues and use a variety of ideas and solutions has helped them overcome many academic challenges. Students can communicate, compare, explain, and examine issues using these technologies. Helping students exchange ideas in class improves their mathematics skills, including procedural and conceptual understanding (Takahashi, 2006). Collaborative interactions that explore multiple mathematical ideas can help students articulate, elucidate, rationalize, and discuss mathematical concepts.

5. CONCLUSION

Empirical evidence, theoretical analysis, and scholarly discourse suggest that pupils' poor competency in mathematical symbols and reasoning causes them to struggle with mathematical proof questions. However, didactic anticipation through mathematical communication has increased students' mathematical proof problem-solving skills. Thus, students that struggle with mathematical proof difficulties may try mathematical communication. Researchers propose several recommendations based on the study's findings to stimulate further research and benefit educators and academics. The suggestions are: What challenges students while solving mathematical proofs? 2. Asking a variety of questions about real analysis introduction reveals student obstacles. Mathematical communication can boost mathematical evidence credibility. Its usefulness increases when combined with advanced models or instructional methods.

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