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THE CHARACTERISTICS OF PROSPECTIVE TEACHER IN MATHEMATICAL COMMUNICATION ABILITY

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Abstract
The purpose of this study was to describe the characteristics of the mathematical communication skills of prospective teacher candidates at STKIP Al Hikmah Surabaya, Indonesia. This type of research is a descriptive study with a qualitative approach. The subjects of this study were 9 student teacher candidates for the 7th semester with the consideration that they had carried out practical program activities in the field. The results of this study indicate that the characteristics of mathematical communication can be seen from three aspects, namely accuracy, completeness, and fluency. All subjects have fulfilled these three characteristics properly and clearly

Introduction

Lately, teacher communication in pursuing is often discussed in the world of education, especially in this COVID-19 epidemic [1]. The learning process is carried out by using a lot of communication even though it is online. In this case the teacher is the communicator and the student is the communicant. According to Permendikbud no. 22 (2016) which is about the standard of primary and secondary education process states that the learning process in educational units is held interactively. In order to realize interactive learning, good communication skills for a teacher are needed.

Communication skills are very important for a teacher [2]. Silver [3] states that the art of communication, including listening and speaking, should be as good as reading and writing. Teachers need all these skills to be good at their professional fields. High communication skills will make them good teachers, because they can transfer knowledge, skills, and values at the same time. Communication skills consist of oral and written communication skills.

Communication skills are a provision for teachers to interact with students in learning, for example when teachers make presentations, explain material, guide discussions, ask questions, and present material in writing. Bee [4] states that effective communication skills will affect the quality of learning. Teachers who have excellent communication skills, can explain the material well, are easily understood by students, and make the learning atmosphere more interesting so that students are more enthusiastic. This atmosphere and learning process are believed to improve student achievement. Ehrenberg et al (1995) said that students taught by teachers with higher verbal abilities learned more than students taught by teachers with lower verbal abilities.

Communication is an essential part of learning mathematics [6]. In learning mathematics, Lestari et al [7] says that mathematics communication is the process of conveying ideas or messages whose message is about mathematics. Thus mathematical communication can be interpreted as the process of conveying ideas, ideas, concepts, and mathematical material. Wilkie [8] states that mathematical communication is the ability to communicate mathematical knowledge appropriately and effectively.

The National Council of Teachers of Mathematics (NCTM) [9] states that the objectives of learning mathematics are so that students can solve problems, communicate knowledge, provide mathematical reasons, learn values in mathematics, and have confidence in solving mathematics. Polya [10] said that communication is an important factor in learning mathematics. In line with Polya, Olteanu [11] states that the quality of teacher communication affects the teaching and learning process of mathematics. For this reason, it is necessary to describe the characteristics of mathematical communication for prospective teacher students, so that it can be developed and improved.

Mathematical communication can increase students' self-confidence, so that it will be a provision to increase understanding of mathematics [12]. This communication can also increase students' mathematical knowledge in depth, and can provide clear and precise responses [13]. Cai et al [14] suggests a rubric for assessing student responses to open-ended questions by paying attention to 3 aspects, namely mathematical knowledge, strategy, and mathematical communication. Mathematical knowledge includes understanding mathematical concepts and principles, using proper mathematical terminology and notation, applying algorithms completely and correctly.

For the strategy can use the relevant formal or informal characteristics in addition to the information provided, identify all important elements of the problem and show an understanding of the relationship of these elements, reflect appropriate and systematic strategies for solving problems, provide clear evidence related completion process, complete and systematic completion [12]. In the communication aspect, namely providing a complete response with clear and unambiguous explanations or descriptions, including complete and appropriate diagrams, communicating effectively to the audience, presenting strong, logical and complete supporting arguments, and including examples and non-examples.

Lim and Pugalee [13] added that to compile an assessment rubric, it requires writing skills that have aspects using clear, detailed, accurate explanations and easy-to-understand answers. Using mathematical language, mathematical words and symbols correctly, using mathematical terminology, choosing algorithms and showing fluency in calculating, and choosing the right algorithms and calculations. Meanwhile, Kimberly [15] formulated an assessment rubric that the answers were accurate and clearly communicated, the answers to questions were correct, used mathematical symbols and language correctly, and were ready for presentation.

Furthermore, this study is interested in describing the characteristics of mathematical communication of prospective teachers through accuracy, completeness, and fluency in verbally expressing mathematical material.

Materials and methods

This research is a qualitative research which aims to describe the characteristics of prospective teacher in mathematics communication skills.

The subjects of this study were 9 student mathematics teacher candidates in semester 7 from STKIP Al Hikmah Surabaya, Indonesia. The topic of this research is the one variable linear equation. To determine the research subject, the snowball method was used. The main instrument of this research is the researcher himself, with the supporting instrument of assigning mathematical communication tasks. Data collection techniques with video recordings of mathematical communication tasks in the learning process of one-variable linear equations and inequalities. The video was recorded in full for two hours of lessons. The video recording data is transcribed into written data and presented in tabular form. To obtain quality qualitative research, diligent observation is carried out, extending the observation time, and triangulation of data.

Data analysis was performed by reducing data, presenting data, interpreting data, and drawing conclusions. Data reduction aims to identify data relevant to the research question. It aims to focus data. Irrelevant data are reduced or ignored and are not used any further than this research data. For this reason, the data resulting from this reduction process can provide more specific data and make it easier for researchers to carry out analyzes at a further stage.

Results and discussion

Based on the results of the study, the data on the characteristics of students' mathematical communication abilities were obtained as follows:

Mathematical Communication Accuracy on Mathematical Facts

The subject of this study has revealed a number of mathematical facts on the data including the following:

Subject 1 says verbally the variable x, the notation of addition, the symbol of numbers 7 and 15, and the sign "=", when explaining the equation $x + 7 = 15$. The subject correctly expresses the variable, notation, and symbol of numbers in examples of open sentences in the form of $x + 7 = 15$.

Subject 2 expresses the variable x, the subtraction notation, the symbols 1 and 5, and the sign "=". These notations and symbols are expressed orally when explaining how to solve linear equations of one variable by means of substitution. The example of the equation described is $2x - 1 = 5$, where x is a natural number variable. The verbal expression is also conveyed when the subject explains the process of solving the equation. The subject's oral expression is carried out precisely and accurately.

In subjects 3 and 4 there is a similarity expressing verbally the variable x, symbol of numbers 6 and 10, sign of addition operation, and sign "=". This fact was expressed when the subject gave the second example of a one-variable linear equation, namely x

+ 6 = 10. This expression also occurred when the subject explained the process of solving the equation. The spoken expression is carried out precisely and accurately.

Data subject 5, 6, 7 also said verbally the variable x, numbers 3 and 18, as well as the sign "=". This expression was conveyed when the subject explained an example of a one-variable linear equation in the form of $3x = 18$. The expression was also continued when the subject explained the process of solving the equation in two ways. The first method divides the two sides of the equation by the number 3, while the second method multiplies the two sides by the number 1/3. The expression of the subject is done precisely and accurately.

Subject 8 explains about the variables n, numbers 2, 5, and 16, the addition operation symbol, the inequality symbol>, and the "=" sign. These mathematical facts are expressed when the subject explains an example of a linear inequality of one variable in the form $2n + 5 > 16$, here n is an integer less than 10. These variable expressions, notations, and symbols are also expressed when the subject explains the process of solving the inequality with precise and accurate.

The data of subject 9 describes the variable x, and the notation of numbers 2 and 8, as well as the sign of inequality “<”, which is expressed verbally when the subject explains the example of the linear inequality of one variable in the form $2x < 8$. This mathematical fact is also expressed verbally during the process of solving the question. The linear. Variables, number notation, and symbols are expressed verbally precisely and accurately.

From the description and data analysis that has been explained, it can be concluded that the research subject has accurately disclosed mathematical facts. Mathematical facts revealed consist of number symbols, operation symbols, and equation and inequality notations.

The Accuracy of Oral Mathematical Communication on Mathematical Concepts

For some concepts and examples of concepts generated from the subject, namely the concept of open sentences (subject 1), one variable linear equation (subject 2), examples of single variable linear equations $2x - 1 = 5$ (subject 3), linear equations $x + 6 = 10$ (subject 5), linear equation $3x = 18$ (subject 6). The following is the concept of one variable linear inequality (subject 7), for example the linear inequality of one variable $2n + 5 > 16$ (Subject 8), one variable linear inequality $2x < 8$ (Subject 9).

To clarify the meaning of an open sentence the subject gives an example of an equation in the form of $x + 7 = 15$. Mathematical sentence $x + 7 = 15$ is an example of an open sentence, because it cannot be determined its true value, because it depends on the substitute number of the variable x. If x is replaced by the number 8, the sentence is true, whereas if it is replaced by a number other than 8, the sentence will be wrong.

The concept of the linear inequality of one variable was expressed verbally by the subject, namely "open sentences that have a relationship less than, more than, less than equal to, or more than equal to, with the first power variable". Some of the examples presented are $2n + 5> 16$, $2x <8$, and $-2/3\ y \geq -6$.

Explanation of the concept and examples of the concept of the linear inequality of one variable that have been described, expressed verbally accurately by the subject

The Accuracy of Oral Mathematical Communication of Procedures

The procedure in question includes two things, namely the activity stage to complete an activity and the step-by-step method in solving a problem with certainty. In this research, the procedure is the method and the steps taken to solve the problem.

The results of the subject's data regarding the procedure are as follows: The procedure for solving a linear one-variable equation by multiplying or dividing the two segments by the same number is expressed to solve the equation 3x = 18. The two segments are divided by 3 so that the data in Figure 1 are obtained. Then, the two sides are multiplied by the same number, the data in Figure 2 is obtained below:

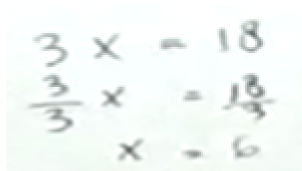

Figure 1.The two segments are divided by 3

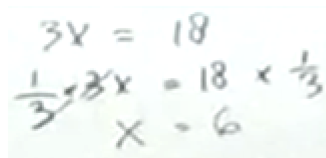

Figure 2.The Two Sections Divided 3

The procedure for solving the linear inequality of one variable by adding or subtracting the same number to the data is expressed orally when the subject explains the solution 2n + 5 > 16. The procedure is used by subtracting the two segments by the same number, namely 5, so that the data is obtained as in Figure 3.

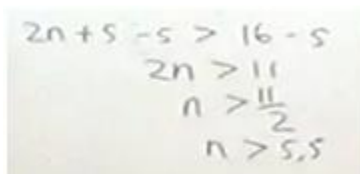

Figure 3. Subtracting both sides by the same number

The procedure for solving the linear inequality of one variable by multiplying the two sides by the same positive number is expressed orally to solve the linear inequality of one variable 2x <8. Both sides are multiplied by the same number, namely ½, so that the data in Figure 4 below are obtained.

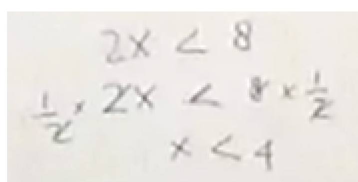

Figure 4. Both Sections Multiplied by ½

The procedure for solving the linear inequality of one variable by multiplying both sides by the same negative number. Before the subject explains the procedure for solving the linear inequality of one variable in the form -2/3 y ≥ -6, by multiplying the two sides by the same negative number, namely -3/2, the subject introduces and illustrates that 8 > 2.If the two sides are multiplied by - 3, then you will get -24 > -6 is false, in order to keep it true, the sign of inequality must be reversed to ≤. This introduction and illustration is used as a reference that in solving the linear inequality -2/3 y ≥ -6, if it is multiplied by the same negative number, the sign of the inequality must be reversed, so that the inequality remains true so that the data in Figure 5 below is obtained:

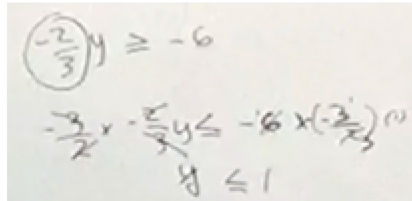

Figure 5. Both Sides Multiplied by the Same Negative Number

From some of the descriptions above it can be summarized that the procedure for solving the linear equation x + 6 = 10, by subtracting the two sides of the equation by 6. The subject verbally expresses the procedure for solving the equation 3x = 18, by dividing the two sides by the number 3, also expressed if the two sides multiplied by the number 1/3. Both of these procedures are logical and satisfy algebraic manipulation procedures. For the linear inequality solving procedure 2n + 5 > 16, the subject expresses by subtracting the two sides by the number 5. The subject's verbal expression when explaining the procedure for solving the inequality 2x <8 by means of the two sides multiplied by the same positive number, namely 1/2, is very precise and accurate. Likewise, the oral expression regarding the procedure for solving the inequality (-2) / (3) y ≥ -6 has been conveyed correctly, namely by multiplying the two sides by a negative number (-3) / (2), and reversing the data of the inequality, and preceded by an explanation. Then an illustration to explain why the sign of inequality must be reversed. Subjects can verbally disclose all of these procedures precisely and accurately.

The Accuracy of Oral Mathematical Communication about Operations

This section describes the subject's verbal mathematical communication in expressing and explaining a number of operations. Operations that were expressed verbally by the subject were addition, subtraction, multiplication and division.

The subject verbally expresses the subtraction operation and the multiplication operation appropriately, to get the correct replacement value for x in the equation 2x - 1 = 5.Before explaining the solution to the equation x + 6 = 10, the subject gives an introduction with the equality added or subtracted by the same number , the results remain the same and correct.

The explanation of the division operation, the multiplication operation, to solve the equation 3x = 18 has been clearly and accurately expressed by the subject. One of the explanatory quotes is "if 3x = 18 is multiplied by 1/3, the value of x = 6 will be obtained." The addition and division operations, in the process of solving the inequality 2n + 5> 16 have been disclosed precisely and accurately. For example, a quote from the subject's oral expression is "here 2n plus 5 minus 5 is more than 16 minus 5, so 2n is more than 11, then n is more than 11/2". To solve the inequality 2x < 8, the operations used are the multiplication and division operations. Meanwhile, to solve the inequality - 2 / (3) y ≥ -6 operations expressed verbally, namely the multiplication operation and the division operation. All operations are disclosed clearly, and accurately. For multiplication operations with negative numbers that result in inequality having to reverse the sign, the subject provides an introductory explanation that is presented inductively by providing an illustration or example, namely "8 is more than 2, if both are multiplied by -3 it will get -24 more than -6, this is worth false so that the correct one is -24 less than -6, the sign must be reversed”.

Based on some of the descriptions above, it is concluded that the subject's oral mathematical communication meets the characteristics of accuracy in verbally expressing mathematical facts, namely notations, symbols, variables, and number symbols. This accuracy can be seen when the subject expresses notations, terminology, concepts, procedures, and operations. The results linier with argument from Taylor [16], he said that mathematical communication is the ability to communicate mathematical knowledge appropriately and effectively.

Completeness of Oral Mathematical Communication

Mathematical communication skills are categorized as complete if the expressions conveyed orally are sufficient to explain mathematical material. The aspects that will be analyzed the completeness of the subject's oral communication include terminology, concepts, definitions, formulas, procedures, operations, and mathematical principles or models. Completeness analysis is based on a group of data, and / or one data that requires completeness.

Some of the concepts and examples expressed by the subject are the definition of an open sentence, the definition of a one-variable linear equation, examples of one-variable linear equations $2x - 1 = 5$, linear equations $x + 6 = 10$, linear equations $3x = 18$, definitions of one variable linear inequalities, for example the linear inequality of one variable $2n + 5 > 16$, the linear inequality of one variable $2x < 8$, and the linear inequality of one variable $-2 / 3y \geq -6$.

The definition of a one-variable linear equation is expressed verbally, namely "an open sentence which has the same relationship with (=) and the variables are first power". This expression is complete in explaining the concept of a one-variable linear equation. Another concept of the linear inequality of one variable is expressed verbally, namely "open sentences that have a relationship less than, more than, less than equal to, or more than equal to, with a first power variable. The explanation of this concept fulfills the indicators of completeness of oral mathematical communication because it is sufficient to explain the PtLSV concept.

For completeness of oral communication, the procedure for solving one-variable linear equations by means of substitution. The procedure for solving the equation $2x -1 = 5$, using the substitution of the x value with the original number, is verbally expressed precisely and accurately. The subject takes the step of substituting the x value with the original number sequentially so that the correct replacement value for x is obtained, which is number 3. This procedure is expressed in a complete oral mathematical communication.

The procedure for solving one-variable linear equations by adding or subtracting the two sides with the same number. In the example of the procedure for solving the linear equation $x + 6 = 10$, by subtracting the two sides of the equation by the number 6, the correct replacement for x is the number 3. This procedure has been completely disclosed by the subject.

The procedure for solving the linear inequality of one variable by adding or subtracting the same number. For the procedure for solving the linear inequality $2n + 5 > 16$, the subject expresses by reducing the two sides by the number 5, so that the correct solution for n substitutes is obtained, which is the make number that is more than 5. This procedure has been fully verbalized.

In addition, there is also a procedure for solving the linear inequality of one variable by multiplying both sides by the same positive number. The expression of the subject verbally when explaining the procedure for solving the inequality $2x < 8$ by means of the two sides multiplied by the same positive number, namely 1/2, so that a substitute for x is obtained, which is a number less than 4.While the procedure for solving the linear inequality is one variable by multiplying the two sides. The verbal expression regarding the procedure for solving the inequality $(-2) / (3)\ y \geq -6$ has been conveyed completely, namely by multiplying the two sides by a negative number (-3) / (2), and reversing the sign of the inequality. The procedure for reversing this sign of inequality has been preceded by an explanation and illustration of why the sign should be reversed.

Operations expressed verbally by the subject in the learning process, namely addition, subtraction, multiplication, and division. The subject verbally expresses the subtraction operation and the multiplication operation in full, so that the correct replacement value for x is obtained in the equation $2x - 1 = 5$, which is number 3 with the same number, the result remains the same and true. The explanation for solving the equation $x + 6 = 10$ is done by the subject. This operation has been fully described by the subject.

From this discussion it can be concluded that the subject has verbally expressed the concepts, procedures, and operations completely, so that these oral expressions can explain mathematical material. Thus, this results same with argument of Sample [12] that an understanding of the relationship of these elements, reflect appropriate and systematic strategies for solving problems, provide clear evidence related completion process, complete and systematic completion.

Fluency of Subject Communication

The fluency of the oral communication of this research subject is analyzed based on the fluency of the subject in expressing mathematical facts, mathematical terminology, concepts, procedures, operations, and mathematical principles, as well as the entire learning process. Fluency appears in the subject in expressing verbally without stuttering, and there is no long pause, so as to complete the material that has been prepared.

Expressions about the meaning of open sentences are conveyed smoothly, without stuttering, there are no long pauses. Likewise, the verbal expression about the understanding of the linear one-variable equation was conveyed by the subject without pause and without stuttering.

When the subject explains the procedure for solving one-variable linear equations by means of substitution, oral expressions about the form of the equation $2x - 1 = 5$, the variable x in the equation, the explanation that x is a natural number, and all explanations in the solving process are expressed smoothly, indefinitely, and there are no long pauses to show that communication is smooth. The subject also explained verbally an example of solving a linear equation of one variable $x + 6 = 10$ without hobbling, and without long delays both when explaining the form of the equation, and when explaining the process of solving it.

The procedure for solving one-variable linear equations by multiplying or dividing the two sides by the same number is expressed verbally by the subject. All the oral expressions in this section are conveyed without delay, and without stuttering. Furthermore, the subject's verbal expression about the linear inequality of one variable, namely "linear inequality is an open sentence which has a relationship less than, more than, less than or equal to, and more than or equal to, with a variable to the power of one", was expressed without a long delay. , and don't stutter. In the procedure for solving the linear inequality of one variable $2n + 5 > 16$, by subtracting the two segments with the same number, namely 5, the S1 subject explains verbally without long intervals, and does not stutter. Likewise, the verbal explanation of the S1 subject in solving linear inequalities by multiplying the two sides with the same positive number, and examples of their solution, are expressed without stuttering and without long delays. For solving the inequality by multiplying both sides by the same negative number is explained fluently.

From this description it can be concluded that the subject's communication in explaining mathematical facts, concepts, procedures, and operations can be expressed orally fluently, without stuttering, and with no long pauses.

Conclusions

To sum up, we can be concluded that the characteristics of oral mathematical communication consist of accuracy, completeness, and fluency. The subject's mathematical communication fulfills the characteristics of accuracy in verbally expressing mathematical facts such as notations, symbols, variables, and number symbols. The accuracy of mathematical communication can also be described based on the accuracy of the subject in explaining orally about concepts, terminology, procedures, and operations, principles or mathematical models. Several concepts and examples of the concept of open sentences, one variable linear equations, examples of one variable linear equations, the concept of one variable linear inequalities, examples of one variable linear inequalities have been expressed verbally accurately. The procedure for solving linear equations and inequalities of one variable by substituting, adding or subtracting the two sides with the same number, and multiplying or dividing the two sides with the same number has been verbally accurately expressed. Likewise, the subject's expression in explaining the operations of addition, subtraction, multiplication, and division related to the concepts and procedures for solving equations and linear inequalities of one variable has been accurately expressed orally.

The second description of the characteristics of oral mathematical communication is completeness, where mathematical communication is said to be complete if the oral expressions conveyed are sufficient to explain mathematical material. The subject has expressed several concepts and examples are the definition of an open sentence, the definition of a one-variable linear equation, examples of one-variable linear equations, definitions of one-variable linear inequalities, examples of one-variable linear inequalities. Likewise, the procedure for solving linear equations and inequalities for one variable has been fully expressed orally. The third characteristic of oral mathematical communication is fluency. Subjects have explained mathematical facts, concepts, procedures, and operations with fluent oral expressions, not stuttering, and there is no long delay so that they can complete the material that has been prepared.

References

[1]. J Crawford, K Butler-Henderson, J Rudolph, B Malkawi, M Glowatz, R Burton, ... and S Lam. COVID-19: 20 countries' higher education intra-period digital pedagogy responses. *J App Lear & Teac*, 2020, DOI: 10.37074/jalt.2020.3.1.7.

[2]. A Khan, S Khan, SCZia-Ul-Islam, and M Khan. Communication Skills of a Teacher and Its Role in the Development of the Students' Academic Success. *J Edu and Prac*, 2017; 8(1), 18-21.

[3]. F Silver. "Why is it important for teachers to have good communication skills." *Retrieve from Online on 11*. 2018, 08-16.

[4]. S B Bee. The impact of teachers’ communication skills on teaching: Reflections of pre-service teachers on their communication strengths and weaknesses. *Hum lang teach*, 2012; 14(1).

[5]. R G Ehrenberg and D J Brewer. Did teachers' verbal ability and race matter in the 1960s? Coleman revisited. *Econ Educ Rev*, 1995; 14(1), 1-21.

[6]. R M Elsheikh and S D Nadji. Math Keyboard Symbols and Its Effect in Improving Communication in Math Virtual Classes. *Int J Inf and Educ Tech*. 2013;3 (6). P.638

[7]. R D Lestari, S Rahayuningsih and H J Wiyono. Profil Kemampuan Komunikasi Matematika Tertulis Siswa MA dalam Memecahkan Masalah Permutasi Ditinjau dari Perbedaan Gender. *MAJAMATH: J Mat dan Pend Mat*, 2019; 2(1), 56-63.

[8]. K J Wilkie. Upper primary school teachers' mathematical knowledge for teaching functional thinking in algebra. *J Math Teac Educ*, 2014; 17(5), 397-428.

[9]. National Council of Teacher of Mathematics. *Principles and Standards for School Mathematics*. Reston, NCTM Rahman, VA, 2000

[10]. G Polya. *How To Solve It*. Princeton University Press, Princeton, 1973

[11]. L Olteanu. Construction of tasks in order to develop and promote classroom communication in mathematics. *Int j of math educ in scie and tech*, 2015; 46(2), 250-263.

[12]. L Sample. *Oral and Written Communication in Classroom Mathematics*. University of Nebraska: Lincol, 2009

[13]. B Wilson. *Mathematical Communication through Written and Oral Expression*. Lincol, University of Nebraska, 2009

[14]. J Cai, S Lane, and M S Jakabcsin. The role of open-ended tasks and holistic scoring rubrics: Assessing students' mathematical reasoning and communication. *Communication in mathematics, K-12 and beyond*, 1996, 137-145.

[15]. H Kimberly. *Mathematical Communication, Conceptual Understanding, and Students' Attitudes toward Mathematics*. Lincoln, University of Nebraska, 2008.

[16]. L Taylor. Facilitating effective mathematical communication. *Res and Teac in Dev Educ*, 1991; 7(2), 93-99.