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LINEAR PROGRAM PROBLEM-SOLVING SKILLS BASED ON SEQUENTIAL AND GENDER THINKING STYLES DURING ONLINE LEARNING

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Abstrak: Penelitian ini bertujuan untuk menggambarkan keterampilan pemecahan masalah program linear ditinjau dari gaya berpikir dan jenis kelamin yang berurutan ketika sekolah menerapkan pembelajaran online karena pandemi covid-19. Penelitian ini adalah studi kualitatif yang menghasilkan data deskriptif. Subjek penelitian ini terdiri dari dua siswa putra dan dua siswi putri kelas XI MIPA SMA MTA Surakarta. Penelitian ini dimulai dengan menentukan subjek penelitian dengan menggunakan kuesioner gaya berpikir, diikuti dengan tes pemecahan masalah program linear dan wawancara. Memeriksa validitas data menggunakan triangulasi metode. Hasilnya menunjukkan keterampilan pemecahan masalah program linear; 1) Siswa sekuensial beton laki-laki dan perempuan melakukan secara sistematis dan kurang hati-hati; 2) Siswa pria dan wanita sekuensial abstrak mengumpulkan data secara lengkap dan menganalisis informasi yang diperoleh secara teratur serta siswa sekuensial abstrak perempuan kuat dalam decoding tertulis dan simbol; 3) keterampilan pemecahan masalah siswa dengan abstrak berurutan lebih tinggi daripada siswa berurutan konkret; 4) siswa laki-laki dengan gaya berpikir berurutan berkinerja lebih baik dalam memecahkan masalah matematika daripada siswa perempuan dengan gaya berpikir berurutan.

Kata kunci : *Pemecahan masalah, Gaya berpikir Sekuensial, Jenis kelamin*

Abstract: The study aims to describe linear program problem-solving skills reviewed from sequential thinking styles and genders as schools implement online learning due to the covid-19 pandemic. This research is a qualitative study that produces descriptive data. The subject of this study consisted of two male students and two female students of class XI MIPA High School MTA Surakarta. The study began by determining the study subjects using a thinking style questionnaire, followed by linear program problem-solving tests and interviews. Check the validity of the data using triangulation methods. The results show linear program problem-solving skills; 1) Sequential students of male and female concrete perform systematically and less carefully; 2) Abstract sequential male and female students collect complete data and analyze the information obtained regularly as well as female abstract sequential students strong in written decoding and symbols; 3) students' problem solving skills with sequential abstracts are higher than concrete sequential students ;4) male students with sequential thinking styles perform better at solving math problems than female students with sequential thinking styles.

Keywords: *Problem solving, Sequential thinking style, Gender*

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INTRODUCTION

The COVID-19 pandemic that hit various countries, is no exception for Indonesia. Indonesia reported the first case on March 2, 2020, allegedly contracted from foreigners visiting Indonesia. Cases in Indonesia continued to grow, as of March 29, 2020 there have been 1,115 cases with 102 deaths. Indonesia's death rate is 9%, including the highest mortality rate (World Health Organization, 2020). Data update as of July 25, 2021 in Indonesia, in the last 1 week there has been a decrease in cases by 17.5% and the death rate this week increased by 34.5% deaths in the last 1 week (Data Uptade Covid-19 Di Indonesia, 2021).The covid-19 pandemic impacted all sectors, including education sectors such as face-to- face learning that had to be transformed into distance learning/online learning. Dewi argues that online learning is now a solution during the COVID-19 pandemic (Dewi, 2020). Minister of Education and Culture The Republic of Indonesia issued a Letter Circular No. 3 of 2020 on Unit Education number 36962/MPK. A/HK/2020 on The Implementation of Education in The Emergency of Coronavirus Disease (COVID-19) learning is done online in order to prevent the spread of coronavirus disease (COVID-19) (Menteri Pendidikan, 2020). Various social media applications support learning are sought to make the most of online learning such as youtobe, google classrom, whatsApp and others.

Online learning applied at all levels of the school is experiencing various obstacles, not least the high school level. High school math learning experienced various problems in learning, based on the results of interviews conducted with several teachers in high school mathematics in Surakarta, especially SMA MTA Surakarta showing resultslearning mathematics is very different from face-to-face learning and obtained some obstacles during online learning, among others: (1) aspects of planting attitudes and character are less optimal, (2) monitoring the activeness of students in learning is very limited, (3) there are some students who are constrained by tool problems and signal affordability making the delivery of material also less optimal, as well as (4) emotional connection with students less intertwined.

Some students convey online learning constraints such as being constrained by tool problems and signal affordability making learning less optimal, getting bored when the learning material is a video with a duration of more than 30 minutes and they convey face-to-face learning is better than learning online. This is in line with Purwanto et al opinion most students consider face-to-face learning better than online learning (Purwanto et al., 2020). During the online learning process some teachers said there are still many students who are less optimal in learning and solving math problems students are very minimal at the time of working on the problem.

The results of research conducted by the Organization For Economic Cooperation and Development (OECD) which is a research institute through the programme PISA (Programme for international Student Assessment) shows that the ability of Indonesia students to solve OECD-tested

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questions is still low, performance in mathematics has been hump-shaped and mathematical performance fluctuated more in the early years of PISA but has remained relatively stable since 2009. Indonesia has participated in PISA since 2001, the average math scores of PISA results in 2003, 2006, 2009, 2012, 2015 and 2018 are 360, 391,371, 375, 386, 379 respectively (OECD, 2019). The results of The Third International Mathematics and Science Study (TIMSS) also reflect the low ability of math problem solving students marked in 2015 Indonesia came in 44th position out of 49 countries (Mullis, I. V. S., Martin, M. O., Foy, P., & Hooper, 2016).

Solving math problems is important in math learning, teachers focus not only on student results but in the process of problem solving should also be an important focus. Polya (Polya, 1973) defines problem solving as trying to find a way out of a difficulty in order to achieve a goal that is not so easily attainable immediately. In fact, students have generally understood the concept of materials they have learned, but they have not been able to connect and use concepts to solve the problems they face (Indriyana et al., 2017). In line with Adjie and Maulana opinions (Adjie, 2007) the ability in a problem includes a skill, because in problem solving involves all aspects of knowledge (memory, understanding, application, analysis, synthesis, and evaluation) and attitude willing to accept challenges.

Each student has a distinctive way of thinking, and one of the factors that influences a student's problem solving skills is characteristic of the student's way of thinking, which is a typical way of thinking that a person uses in observing and mental activity, i.e. regulating and processing information in the cognitive field (Lestanti, M. M., Isnarto, I., & Supriyono, 2016). According to Zhang (Zhang, 2002) three of the seven thinking styles statistically contribute to academic performance. This style of thinking is a liberal, global, and conservative thinking style. Gregorc, a professor of curriculum and teaching at the University of Connecticut, concluded that the possibility of the human brain in terms of managing information is two: concrete and abstract perceptions. Then the possibility of the brain in terms of regulating information is divided into two sequential (Linear) and random (Nonlinear) (Gregorc, 1982). But the study focused on sequential thinking styles.

Basically people are created differently, one of which is gender differences namely men and women. SMA MTA Surakarta implements separate men's and women's classes, which is the appeal of researching problem solving reviewed from gender. Davita and Pujiastuti (Davita & Pujiastuti, 2020) mathematic problem solving skills between men and women have differences, the difference lies from how male students and students can solve problems, so there is a gap between male and female participation rates. Gender is the sociocultural and psychological dimension of men and women. Gender roles are social expectations that define how men and women should think, feel and perform (Santrock, 2008). The concept of gender is a male and female character formed by society both culturally and

socially (Eckert P and Sally McConnel–Ginet, 2003). The goal of the study was to learn students' linear program problem-solving skills with sequential thinking styles reviewed from gender during online learning due to the COVID-19 pandemic.

RESEARCH METHOD

This study is a qualitative study that produces descriptive data. The subjects of this research are two male students and two female students of class XI MIPA High School MTA Surakarta, Central Java, Indonesia. The activity of taking subjects begins with the provision of thinking style questionnaires through google form as a guideline for grouping students. This style of thinking questionnaire developed Gregorc's theories of concrete sequential (SC), sequential abstract (SA), random concrete (RC) and random abstract (RA) (Gregorc, 1982). However, in this study focused on concrete sequential and abstract sequential styles, each of these thinking styles is reviewed from gender. The thinking style questionnaire was distributed to 23 male students and 36 female students, from the questionnaire were selected 2 male students representing concrete sequential thinking style (SC) i.e. FRL subject and abstract sequential thinking style (SA) i.e. WSL subject and 2 female students representing concrete sequential thinking style (SC) i.e. ANP subject and abstract sequential thinking style (SA) i.e. EKP subject. Data collection techniques are carried out with linear program problem solving tests and interviews. The data validity technique carried out in this study is a triangulation method. The data analysis techniques used are reducing data, presenting data, drawing conclusions and verifying data.

RESULTS AND DISCUSSION

Linear program troubleshooting test of indicator determines maximum profit from contextual problems related to linear two-variable program. The linear program troubleshooting test has one problem and the problem solving test is as follows, "A bicycle trader wanted to buy 46 bikes for supplies. The trader wants to buy a mountain bike at a price of Rp 2,000,000.00 per piece and a race bike at a price of Rp 2,500,000.00 per piece and plans not to spend more than Rp 100,000,000.00. If the advantage of mountain bikes is Rp 800,000.00 and racing bikes are Rp 900,000.00, then determine the maximum profit received by the trader!".

1. SC Subject

The following are the problem solving abilities of male and female students with concrete sequential thinking styles.

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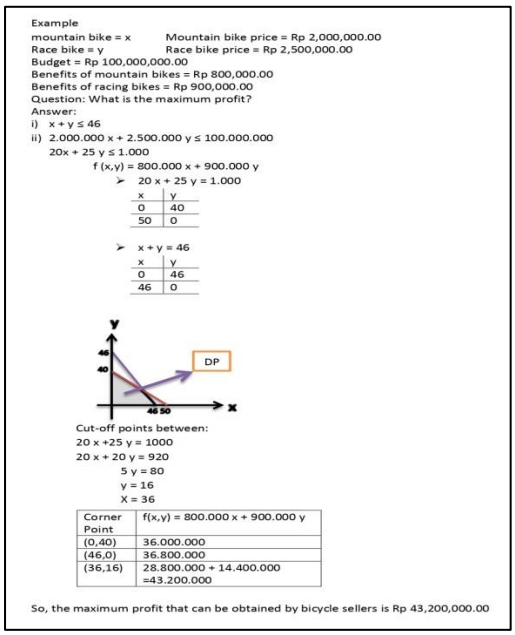

Example
mountain bike = x Mountain bike price = Rp 2,000,000.00
Race bike = y Race bike price = Rp 2,500,000.00
Budget = Rp 100,000,000.00
Benefits of mountain bikes = Rp 800,000.00
Benefits of racing bikes = Rp 900,000.00
Question: What is the maximum profit?
Answer:
i) x + y ≤ 46
ii) 2.000.000 x + 2.500.000 y ≤ 100.000.000
20x + 25 y ≤ 1.000
f (x,y) = 800.000 x + 900.000 y
➢ 20 x + 25 y = 1.000

x	y
0	40
50	0

➢ x + y = 46

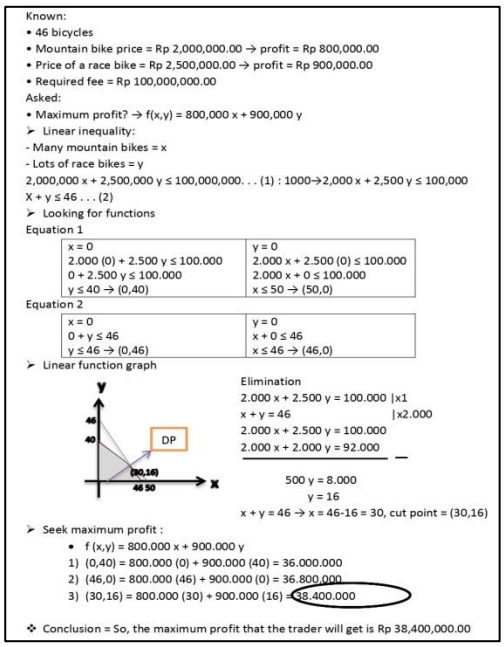
x	y
0	46
46	0

Cut-off points between:
20 x +25 y = 1000
20 x + 20 y = 920
5 y = 80
y = 16
X = 36

Corner Point	f(x,y) = 800.000 x + 900.000 y
(0,40)	36.000.000
(46,0)	36.800.000
(36,16)	28.800.000 + 14.400.000 =43.200.000

So, the maximum profit that can be obtained by bicycle sellers is Rp 43,200,000.00

Figure 1. Male Students Answer (FRL Subject)


Known:
• 46 bicycles
• Mountain bike price = Rp 2,000,000.00 → profit = Rp 800,000.00
• Price of a race bike = Rp 2,500,000.00 → profit = Rp 900,000.00
• Required fee = Rp 100,000,000.00
Asked:
• Maximum profit? → f(x,y) = 800,000 x + 900,000 y
➢ Linear inequality:
- Many mountain bikes = x
- Lots of race bikes = y
2,000,000 x + 2,500,000 y ≤ 100,000,000. . . (1) : 1000→2,000 x + 2,500 y ≤ 100,000
X + y ≤ 46 . . . (2)
➢ Looking for functions
Equation 1

x = 0	y = 0
2.000 (0) + 2.500 y ≤ 100.000	2.000 x + 2.500 (0) ≤ 100.000
0 + 2.500 y ≤ 100.000	2.000 x + 0 ≤ 100.000
y ≤ 40 → (0,40)	x ≤ 50 → (50,0)

Equation 2

x = 0	y = 0
0 + y ≤ 46	x + 0 ≤ 46
y ≤ 46 → (0,46)	x ≤ 46 → (46,0)

➢ Linear function graph

Elimination
2.000 x + 2.500 y = 100.000 |x1
x + y = 46 |x2.000
2.000 x + 2.500 y = 100.000
2.000 x + 2.000 y = 92.000 —
500 y = 8.000
y = 16
x + y = 46 → x = 46-16 = 30, cut point = (30,16)
➢ Seek maximum profit :
• f (x,y) = 800.000 x + 900.000 y
1) (0,40) = 800.000 (0) + 900.000 (40) = 36.000.000
2) (46,0) = 800.000 (46) + 900.000 (0) = 36.800.000
3) (30,16) = 800.000 (30) + 900.000 (16) = 38.400.000
❖ Conclusion = So, the maximum profit that the trader will get is Rp 38,400,000.00

Figure 2. Female Students Answer (ANP Subject)

Male Students interview (FRL Subject):

P-FRL01 : After reading the question carefully, do you understand the meaning of the problem?

S-FRL01 : I understand what that means.

P-FRL02 : Why is the 2,000,000 x +2,500,000 y ≤ 100,000,000 being simplified to 20x + 25 y ≤ 1,000?

S-FRL02 : Make it easier to draw the graphics

P-FRL03 : How do I get a cut point between two straight line equations and what are the coordinates?

S-FRL03 : I eliminated from 20 x +25 y = 1000; 20 x + 20 y = 920 then found y =16 and the substitution of the value was obtained x = 36

P-FRL04 : Are you sure of the cut point (36.16)?

S-FRL04 : Sure, I checked first. Turns out I was wrong to be (30,16)

P-FRL05 : Do you feel the solution you did is right?

S-FRL05 : Not yet ma'am, because there is one corner point of the wrong completion

Female Students interview (ANP Subject)

P-ANP01 : After reading the question carefully, do you understand the meaning of the problem?

S-ANP01 : I understand what that means.

P-ANP02 : Why is the 2,000,000 x +2,500,000 y ≤ 100,000,000 being simplified to 20x + 25 y ≤ 1,000?

S-ANP02 : Let it be easier to calculate and simpler the numbers.

P-ANP03 : The corner point of the settlement area that you get is sure it's all right?

S-ANP03 : Sure, because of the settlement area I'm in
Tkan is also precise.

P-ANP04 : Do you feel the solution you did is right?

S-ANP04 : Yes, sure because it is what my teacher taught

P-ANP05 : What can you deduce from your work?

S-ANP05 : So for maximum profit obtained is Rp 38.400.000.00 with a supply of 30 mountain bikes and 16 racing bikes

a. Male Students (FRL Subject)

The reading and thinking stage can mention what is known and asked in detail. This is in line with Novianti et al (Novianti, 2017) being able to repeat known data information and request data smoothly. The exploration and plan stage, the subject draws the residential area from the constraints of linear inequality that is known precisely and correctly. The Strategy Select stage, the subject determines the angle point of the acquired completion area, but in determining the intersection point between the equations the two straight lines are incorrect due to lack of precision. The subject systematically works on problem solving, this is the opinion (Sa'diah, 2017) (Zhang & Sternberg, 2005) and Gregorc (Polya, 1973) who say that the subject of concrete sequential (SC) work systematically, step by step.

The stage of finding an answer, the subject replaces the coordinates of all the angles that have been obtained into the objective function. Finally, the review and discussion stage, the subject concludes the answer obtained, but the answer obtained is wrong because the determination of one corner point is wrong and does not double check the answer obtained.

b. Female Students (ANP Subject)

The reading and thinking stage, the subject can mention what is known and asked in detail. This is in line with the opinion of Novianti et al. (Novianti, 2017) students can repeat known data information and request data smoothly. In the exploration and plan stages, the subject can draw the settlement area from the known boundaries of linear inequality, but there is one wrong straight-

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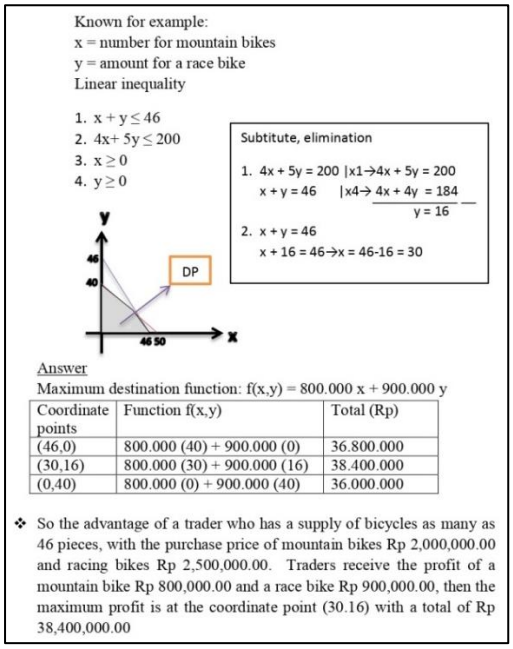
line equation in the image graph. Choose the strategy stage, the subject determines the corner point of the acquired settlement area, the corner point of the acquired settlement area there are three, among others in determining two corner points there are wrong, thus causing the answer to be obtained incorrectly. An subject systematically working on problem solving, this is the opinion (Sa'diah, 2017) (Zhang & Sternberg, 2005) and Gregorc (Polya, 1973) who says that the subject of concrete sequential (SC) works systematically, step by step or in detail.

The stage of finding the answer, the subject of the answer appropriately and the review and discussion stage, the subject summarizes the answer obtained appropriately and re-examines the answer obtained.

2. SA Subject

The following are the problem solving abilities of male and female students with concrete sequential thinking styles.


Known for example:
x = number for mountain bikes
y = amount for a race bike
Linear inequality

1. $x + y \leq 46$
2. $4x + 5y \leq 200$
3. $x \geq 0$
4. $y \geq 0$

Subtitute, elimination

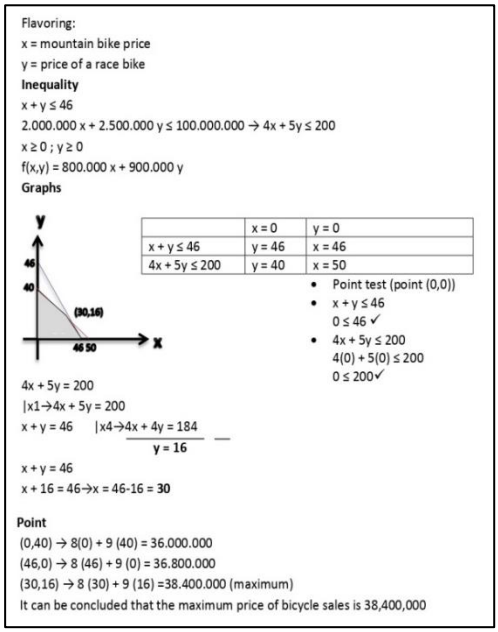
1. $4x + 5y = 200$ |x1→ $4x + 5y = 200$
   $x + y = 46$ |x4→ $4x + 4y = 184$
   $y = 16$
2. $x + y = 46$
   $x + 16 = 46 \rightarrow x = 46-16 = 30$

Answer
Maximum destination function: f(x,y) = 800.000 x + 900.000 y

Coordinate points	Function f(x,y)	Total (Rp)
(46,0)	800.000 (40) + 900.000 (0)	36.800.000
(30,16)	800.000 (30) + 900.000 (16)	38.400.000
(0,40)	800.000 (0) + 900.000 (40)	36.000.000

❖ So the advantage of a trader who has a supply of bicycles as many as 46 pieces, with the purchase price of mountain bikes Rp 2,000,000.00 and racing bikes Rp 2,500,000.00. Traders receive the profit of a mountain bike Rp 800,000.00 and a race bike Rp 900,000.00, then the maximum profit is at the coordinate point (30.16) with a total of Rp 38,400,000.00

Figure 3. Male Students Answer (WSL Subject)


Flavoring:
x = mountain bike price
y = price of a race bike
Inequality
$x + y \leq 46$
$2.000.000\,x + 2.500.000\,y \leq 100.000.000 \rightarrow 4x + 5y \leq 200$
$x \geq 0\,;\, y \geq 0$
$f(x,y) = 800.000\,x + 900.000\,y$
Graphs

	x = 0	y = 0
x + y ≤ 46	y = 46	x = 46
4x + 5y ≤ 200	y = 40	x = 50

- Point test (point (0,0))
- $x + y \leq 46$
  $0 \leq 46$ ✓
- $4x + 5y \leq 200$
  $4(0) + 5(0) \leq 200$
  $0 \leq 200$✓

$4x + 5y = 200$
|x1→ $4x + 5y = 200$
$x + y = 46$ |x4→ $4x + 4y = 184$
$y = 16$
$x + y = 46$
$x + 16 = 46 \rightarrow x = 46-16 = \mathbf{30}$

Point
(0,40) → 8(0) + 9 (40) = 36.000.000
(46,0) → 8 (46) + 9 (0) = 36.800.000
(30,16) → 8 (30) + 9 (16) =38.400.000 (maximum)
It can be concluded that the maximum price of bicycle sales is 38,400,000

Figure 4. Female Students Answer (EKP Subject)

Male Students interview (WSL Subject)

P-WSL01 : After reading the question carefully, do you understand the meaning of the problem?

S-WSL01 : I understand what that means.

P-WSL02 : What do you ask about why it wasn't written?

S-WSL02 : I usually do it like this

P-WSL03 : Where does $4x+ 5y \leq 200$ be found from?

S-WSL03 : Oh, it's derived from simplification of 2,000,000 x +2,500,000 $y \leq$ 100,000,000, I divide by 500,000

P-WSL04 : Do you feel the solution you did is right?

S-WSL04 : Sure, because the move is right.

P-WSL05 : What can you deduce from your work?

S-WSL05 : So for maximum profit obtained is Rp 38,400,000.00 with a supply of 30 mountain bikes and 16 racing bikes.

Female Students interview (EKP Subject)

P-EKP01 : After reading the question carefully, do you understand the meaning of the problem?

S-EKP01 : I understand what that means.

P-EKP02 : What do you ask about why it wasn't written?

S-EKP02 : I forgot, I immediately focused on answering.

P-EKP03 : Inequality 2,000,000x+2,500,000 $y \leq$ 100,000,000 why is it simplified to $4x + 5y \leq 200$?

S-EKP03 : Because it makes it simpler and easier to make the graphics

P-EKP04 : Do you feel the solution you did is right?

S-EKP04 : Sure, because the steps are appropriate

P-EKP05 : What can you deduce from your work?

S-EKP05 : So for maximum profit obtained is Rp 38,400,000.00

a. Male Students (WSL Subject)

The reading stage and think of the subject writes all what is known in detail and collects the data in detail, this corresponds to Gregorc (Polya, 1973) who says that the subject sequentially abstract (SA) collects data before making conclusions. What is asked in the question is not written. The subject writes down what is known and answered, but what is asked in the question is not written. The exploration and plan stage, the subject draws the area of resolution from the constraints of linear inequality that are known precisely and correctly. The select strategy stage, the subject determines the angle point of the settlement area obtained.

Male abtrak sequential subjects (WSL subjects) can manage the information obtained on a regular basis, this corresponds to the opinions of (Zhang & Sternberg, 2005), (Zollinger, 2010)

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and Gregorc (Polya, 1973) which means that abstract sequential subjects (SA) describe the sequence of events logically. Abstract sequential thinking processes are logical, rational and intellectual. The stage of finding an answer, the subject subsistences the coordinates of one corner point i.e. the intersection point between two straight-line equations into an objective function. Finally, the review and discussion stage, the WS subject concludes the answer obtained, even if the answer is wrong and rechecks the answer obtained.

b. Female Students (EKP Subject)

The reading and thinking stage, the subject writes all what is known in detail and collects the data in detail, this corresponds to Gregorc (Polya, 1973) who says that the subject sequentially abstract (SA) collects data before making conclusions. The subject writes down what is known and answered, but what is asked in the question is not written. Subjects in understanding mathematical problems have a tendency to process and manage abstract information and information obtained regularly as well as present facts in the form of mathematical symbols, this corresponds to the opinions of (Zollinger, 2010) and Zhang &Sternberg (Zhang & Sternberg, 2005) who say that abstract sequential subjects (SA) strong in written decoding, verbal and image symbols.

The exploration and plan stage, the subject draws the residential area from the constraints of linear inequality that are known precisely and correctly. The select strategy, the subject determines the angle point of the settlement area obtained and calculates the intersection point between the two straight-line equations precisely. Female abtrak sequential subjects (EKP subjects) can manage the information obtained on a regular basis, this corresponds to the opinions of (Zhang & Sternberg, 2005), (Zollinger, 2010) and Gregorc (Polya, 1973) which means that abstract sequential subjects (SA) describe the sequence of events logically. Abstract sequential thinking processes are logical, rational and intellectual. The stage of finding an answer, the subject subsistences the coordinates of one corner point i.e. the intersection point between two straight-line equations into an objective function. Finally, the review and discussion stage, the subject concludes the answer obtained, even if the answer is incorrect and re-examines the answer obtained.

3. Male and Female Students

The read and think stage, SC subjects better understand the issue than SA subjects and male and female students both understand the known and questionable issues. Explore and plan stage, SA subject is more precisely planning problem solving than SC subject and male students are superior to

female students. Step choose strategies, SC subject is more complete in calculating according to problem solving planning than sa subject and male students are superior to female students. The find and answer stage, sequential subjects both male and female substitute all corner points of the settlement area to the destination function. The review and discuss phase, SA subjects are more likely to complete the results of calculations than SC subjects and female students are superior at this stage than male students.

Student troubleshooting skills with sequential abstracts (SA) higher than students concrete sequential (SC). This is in similar to the research of (Lestanti, M. M., Isnarto, I., & Supriyono, 2016) (Zollinger, 2010) and Myers & Dyer (Myers, 2006) Students with an abstract sequential thinking style (SA) show significantly higher critical thinking values than students with a concrete sequential thinking style (SC). The problem-solving skills of male students' linear programs with sequential (concrete and abstract) thinking styles are better than female students with, this is a superior opinion (Kusumaningsih et al., 2018) (Erdem & Soylu, 2017) and Zhu (Zhu, 2007) which says that male students perform better at solving math problems than female students.

CONCLUSIONS AND SUGGESTIONS

Linear program problem-solving skills based on sequential thinking styles and genders during online learning are male and female students with concrete sequential thinking styles (SC) working systematically and less thoroughly in problem solving. Abstract sequential male and female students collect complete data and analyze the information obtained regularly as well as female abstract sequential students strong in written decoding and symbols. Students' problem solving skills with sequential abstract (SA) are higher than concrete sequential (SC) students and Male students with sequential (concrete and abstract) thinking styles performed better at solving math problems than female students with sequential (concrete and abstract) thinking styles.

The researchers suggest further research in high school to strengthen math problem-solving abilities in terms of thinking and gender styles. This research should not be directed only at students with sequential thinking styles and single thinking styles, but also for students with abstract thinking styles and dual thinking styles.

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