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Research Article

Artistically talented students' perceptions of mathematics: View, interest, competence, and relevance

Sugiman[1]*, Ilham Rizkianto[2], Endar Pujiasti[3]

Faculty of Mathematics and Natural Sciences, Yogyakarta State University, Yogyakarta, Indonesia

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Abstract

Mathematics learning in Art Vocational Schools (AVSs), the one that should be tailored to the career-related needs of young adult learners of their era, would inevitably necessitate continuous improvement. Such improvement of mathematics learning quality would be possible when considering the perceptions of Artistically Talented Students (ATSs). This research aimed to describe these students' perceptions of mathematics in four aspects, namely view, interest, competence, and mathematics relevance to art after they attend compulsory mathematics learning for two years. This was phenomenology research involving 30 students from four different majors - painting, visual communication design, ceramic craft, and wood craft - at an AVS located in Bantul Regency, Special Region of Yogyakarta, Indonesia. The data were mainly collected through in-depth interviews and then triangulated with classroom observations. Content analysis methods were implemented to produce themes and their relationship, whilst to ensure reliability, two independent coders conducted the process of coding. Later, the researchers conducted a thematic analysis and drew some conclusions. The results generally showed that, first, ATSs were interested in learning mathematics though most of them labelled mathematics as mechanistic and unattractive. Second, in terms of competence, this study revealed that over half would opine that they lacked mathematics competence. Third, all of them viewed that essentially mathematics could be used in artworks. However, just under half of them considered that mathematics learning contents were relevant to their major. These findings, hence, implied that further research needs to formulate instructional contents that meet the demands of the relevant artistic jobs and students' daily lifes.

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Introduction

Vocational education has an important role as a structure of the education system which bases on knowledge, skill, and creativity for development, work, and competition (Sagocak et al. 2013). Therefore, vocational curriculum generally includes two aspects, namely work-based and school-based learning (Rintala & Nokelainen, 2020). Vocational schools can be regarded as a solution to advance the number of ready-to-work graduates in developing countries (Loyalka et al. 2015; Newhouse & Suryadarma, 2011), especially for those who cannot afford higher education. This encouraged the Ministry of Education and Culture of the Republic of Indonesia to design a policy to increase the number of Vocational Schools by targeting an improved ratio of Vocational Schools vs. General Schools, from 50:50 in 2010 to 70:30 in 2015. To achieve this goal, the constructions of the general schools' buildings were suspended, tools and infrastructures for technical schools were prioritized, and some general schools would be modified to become vocational schools (Mahirda & Wahyuni, 2016; Newhouse & Suryadarma, 2011).

Buabeng-Andoh (2019) states that learning mathematics and science, as well as reading courses in Vocational High Schools (VHSs) can escalate vocational school graduates' opportunities in getting the desired jobs and providing more chances for them to pursue higher education. There is no doubt that mathematics becomes a compulsory subject for

1 Associate Professor, Yogyakarta State University, Yogyakarta, Indonesia, (sugiman@uny.ac.id), Orcid Number: 0000-0003-1931-7537
2 Assistant Professor, Yogyakarta State University, Yogyakarta, Indonesia, (ilham_rizkianto@uny.ac.id), Orcid Number: 0000-0002-9636-6001
3 Professional Mathematics Teacher, SMK N 3 Kasihan, Bantul, Yogyakarta, Indonesia, (endarpujiasti@yahoo.com)

VHS students in Indonesia (Ministry of Education and Culture, 2018) since mathematics arms them with a vital competency for their future (Ozdemir & Onder-Ozdemir, 2017). The same goes for students in Art Vocational Schools (AVSs). Mathematics helps them in creating better artworks. Realized it or not, mathematics has been implemented in fine arts for ages. For example, the carver Flippo Brunelleschi (1377 – 1446) is the first person who created the exact formula of linear perspectives using glass, and Maurits Cornelius Escher (1898 – 1972), a Dutch painter, who is popular with his achievement in integrating art concepts and mathematics (Barnes-Svarney & Svarney, 2012). However, the survey results from the Programme for International Student Assessment (PISA) in 2018 confirm that Indonesian students' performance in mathematics was low with a score of 379, which let Indonesia stood in the 70th position out of 77 countries (OECD, 2019). This performance data could be accessed from the students' means score gained in mathematics in the National Examination. Likewise, data from 2019 showed that the mathematics mean score of VHS students was 35.26 on a scale of 100 (Ministry of Education and Culture, 2019). For this, it is necessary to review the mathematics instructional sensitivity carried out in the classroom. Instructional sensitivity includes what should be taught in the classroom, what is taught in the classroom, and how to evaluate what is being taught (Deutscher & Winther, 2018).

In VHSs, teaching and learning practices influence students' perceptions (Erdem & Yildirim, 2019) including in mathematics. In learning mathematics, students' perception of mathematics becomes one of the factors determining their process and performance in tests. Mutodi and Ngirande (2014) argue that there is a strong positive relationship between mathematics performance and the construction of students' perception. Ozdemir and Onder-Ozdemir (2017), in regard to this, explored the perception of vocational school students about their success in mathematics. Their study shows that students who were successful in mathematics engage themselves in learning thoroughly and wholeheartedly during the learning process (Ozdemir & Onder-Ozdemir, 2017). The students learned mathematics regularly and reviewed the topics they had studied before. Meanwhile, students who were unsuccessful in learning mathematics stated that their failures were caused by their revulsion on mathematics and their reluctance in learning it. The teacher factor has also determined the students' success in learning mathematics. Schukajlow and Krug (2014) examined the relationship between students' performance and their interest and satisfaction in mathematics. The results show that there is a relationship between students' performance and students' interest and delight in mathematics (Schukajlow & Krug, 2014). Those who achieved higher scores in performance tests had a better interest in mathematics and enjoyed mathematics class better than learners who got lower scores.

In addition, Lindberg and Grevholm (2011) in a study aimed at making a stronger connection between mathematics and vocation suggest that when students can use mathematics in understanding the ratio of gears, their motivation likely increases, and their learning outcome improves. The same result is shown when mathematics teachers and vocational teachers collaborate to develop vocational education, resulting in improved students' motivation and learning outcomes. These researchers emphasized the importance of students' awareness of the relationship between mathematics and other subjects. To improve students' motivation and learning outcomes, Lindberg and Grevholm (2011) suggest that teachers show the relevance of use mathematics in vocational education, and vice versa. Kollosche (2017) adds when students understand that mathematics is relevant to what they are, they will follow. This not only motivates students to learn and makes mathematics into the only students' orientation, but also helps them in understanding the experience in mathematics and to build intertwinement with the discipline that likely happens in a lifetime (Kollosche, 2017).

In improving school quality, listening to students' point of view about what make differences on their learning commitment would be advantageous since their opinions could affect the progress of their achievement (Egeberg & McConney, 2018; Rudduck & Flutter, 2000). Most previous studies had been conducted to explore students' opinions on mathematics learning in such vocational majors as medical (e.g. Zwart et al., 2017), technical (e.g. Ozdemir & Onder-Ozdemir, 2017; Tahir & Shahrill, 2014), agriculture (e.g. Muhrman, 2015), public services (e.g. Dalby & Noyes, 2015; Frejd & Muhrman, 2020), but still few studies were conducted in AVS. Therefore, a study related to students' opinions about learning mathematics in AVS needs to be done as an effort to improve the quality of mathematics learning.

In general, students can be categorized as talented and average. In arts, those who have above average ability is called Artistically Talented Students (ATSs) (Clark & Zimmerman, 2004; Prieto & Ferrando, 2016; Wilson, 2009). ATSs are different from students in general, they have outstanding cognitive and non-cognitive potential (Prieto & Ferrando, 2016). Nakano et al. (2016) reveal that academically and artistically talented students have significantly different reasoning abilities, where academically talented students have higher scores in the process of reasoning than

do ATSs. Based on this finding, it can be understood that the treatment given to ATSs cannot be equated with students in general, including in mathematics learning. Wilson (2009) argues that ATSs tend to understand mathematical concepts and ideas when presented in graphs or charts. Therefore, the ideal mathematics learning for AVS students has to be designed based on the characteristics and needs of the students.

Considering the discussion above, this present study was conducted to unveil the perceptions of ATSs to mathematics including its relevance with their expertise. This study is expected to promote mathematics instructions by considering students' points of view so that educators can design development strategies for proper instructional methods.

Problem of Study

The quality of mathematics learning in VHSs, especially in Indonesia, still needs to be improved. Various studies have been conducted to investigate the implementation of mathematics learning in these technical schools. However, most of them have only been conducted for popular majors in vocational schools such as medical, technical, agriculture, and public service. Those investigated the implementation of mathematics for AVSs is still hard to find. In fact, many studies have reported that mathematics and art are interrelated. Another problem faced by AVSs is that ATSs have different learning styles from students in general in that they tend to be unfocused and less interested in general subjects, including mathematics. ATSs learn mathematics and art lessons separately. Mathematics has been taught by professional mathematics teachers without any discussion with art teachers. This causes the implementation of mathematics learning in AVSs non-optimal. To solve these problems, it is necessary to reveal the perceptions of ATSs towards mathematics that they have learned at AVS for two years, those associated with ATSs' needs for artistic work. In more detail, this investigation would disclose their views about mathematics, interests in mathematics, perceptions of mathematical competence, and perceptions of the relevance of mathematics to art.

Research Questions

- How are ATSs' views of mathematics?
- How are ATSs' interests in mathematics?
- How are ATSs' perceptions of their mathematical competence?
- How are ATSs' perceptions of the relevance of mathematics to art?

Research Focus

In this research, ATSs' views of mathematics are focused to explore various students' views and draw their categorizes. Next, ATSs' interests in mathematics are focused on three aspects, namely students' emotion, concern, and the importance of learning mathematics. ATSs' perception of their mathematical competence is centered on students' reflection about their competences without involving any mathematics test. Lastly, ATSs' perception of the relevance of mathematics to art is centralized on four art majors, namely Painting, Visual Communication Design, Ceramic Craft, and Wood Craft.

Method

Research Design

This article is based on phenomenology research aimed at explaining the perceptions of AVS students about their views of, interests in, and perceptions of their competence in mathematics, as well as the relevance of mathematics on their art performance. As qualitative research, the present research explores the interactions, behavior, and perceptions of ATSs. Interviews and observation were carried out to achieve the purpose of this research holistically (Hammersley, 2015).

Before collecting the data, researchers established close relationships with the participants. In this step, researchers informed the participants about the research purpose. The next step was the interview process and its process was recorded. Interviews with participants were carried out one by one outside the classroom. After that, the observation took place during their mathematics and art practice sessions. To avoid interfering with the learning process, there is no discussion with participants during the observation. It was limited to observe the participants' activities in the classroom and students' interactions with their teachers and classmates. The observation was conducted two until four times for each class. The findings during the observation process were noted by the researchers and compared with those gained in the interview. This was in line with the triangulation principles (Creswell, 2014).

Participants

The present study was conducted for three months in an AVS located in Bantul Regency, Special Region of Yogyakarta, Indonesia. Every student enrolled in this school had to pass an artistic aptitude test as described in Table 1. The students, in Grade XI, were 16-17 years old. Based on the result of the test and students' artworks, teachers classified them into two categories, i.e. talented and average in arts. Some of the talented students received a Pratista award from the national art maestro committee.

Research participants were selected based on those who (1) were talented in arts, (2) has attended mathematics instruction at least for two years, (3) produced good artworks relevant to their study program, (4) could communicate well, and (5) were willing to be participants. According to the criteria, teachers determined talented students involved in this research. All participants had sufficient experience in mathematics learning and art tasks. Finally, based on the criteria, there were 30 ATSs (9 females and 21 males) in Grade XI from the four majors, i.e. Painting, Visual Communication Design, Ceramic Craft, and Wood Craft.

Table 1.
The Enrollment Test

Major	Artistic aptitude test	Examples
Painting	Drawing shapes	Cubist objects; cylindrical objects
Sculpture	Drawing shapes	
Visual Communication Design	Creating a poster	Advertising; campaign; propaganda posters
Animation	Drawing an object from three directions	People; animals; vehicles
Batik and Textile Craft	Drawing a decoration	Ornamental flora; batik motif design
Ceramic Craft	Drawing a decoration	
Wood Craft	Drawing a decoration	

Data Collection Instruments

The data on students' perceptions of mathematics were collected by using in-depth interviews. As a triangulation step, observation on students' behavior was conducted during their engagement in mathematics learning activities and in artwork creation practices. Both of the data collection techniques are described as follows.

Interview Form

Interviews were conducted using a semi-structured method. Researchers asked some questions to participants as written in a guideline and might ask other questions according to the participants' answers. The questions consisted of three aspects, namely interest in mathematics (Harackiewicz & Hulleman, 2010), self-efficacy about mathematical competency (Bandura, 2012), and the relevance of mathematics (Bakker, 2014). Before asking those three aspects, the participants were asked to figure out mathematics in three statements to investigate their views about mathematics. The interest aspect consisted of three sub-aspects, namely emotion, concern, and importance of mathematics or its learning. An example of an emotional question was "How do you feel when you learn mathematics?" There were three questions to explore students' perceptions of their mathematical competence; as an example was "Do you feel good at mathematics?" The last aspect was the relevance of mathematics and artwork, as an example, "Do you feel that learning mathematics can help you create better artworks?" All of the questions had previously been discussed with and verified by the collaborative teachers.

Observation Form

To guarantee the credibility of data in this research, the observation was conducted. The technique used in this observation referred to the non-participant observation method (Hammersley, 2015; Liu & Maitlis, 2010). Two observers, who were a collaborative teacher and a researcher, observed students' attention, enthusiasm, engagement, and communication. Besides, observers also saw how students implemented mathematics when they did their art tasks. The observation was focused on students who participated in this research even though they existed in both normal mathematics classrooms and art workshops. There were seven aspects observed. Some of them were their concentration during the learning process, engagement in the class discussion including their questions to the teacher, mathematical equipment (e.g. a ruler, a compass, and a bow) that students brought when working in art, and the mathematics concepts applied. All of the aspects to observe had been discussed with and verified by the collaborative teachers.

Data Analysis

In a qualitative study, the researchers process the raw data to become some meaningful units by coding and categorizing them to find the prominent themes (Erlingsson & Brysiewicz, 2017; Weber, 1990). The qualitative data obtained from the interviews in this research were transcribed. Then, the information in the script was coded independently by two coders. The first coder was one of the researchers and the second one was an independent contributor. After that, these two coders discussed their coding results. When different results were found, they agreed to decide the best ones. Based on the results of the coding, some meaning units were enumerated and confirmed with the results of observation. When the coding results from interviews suit the ones in the observation, they were categorized based on the following main themes: (1) students' views on mathematics; (2) students' interests in mathematics; (3) students' perceptions of their mathematical abilities; and (4) students' views on the relevance of mathematics to art. However, when the coding results from interviews were not in line with the results of observation, the researchers would re-interview the students to clarify the unclear information. After that, the researchers re-coded the second data to find new coding results. After the coding was categorized based on the four main themes, the data were presented in tables and narrative descriptions.

Results

Based on the coding process, some meaning units such as "*I like learning mathematics*", "*I feel I will not be able to master mathematics*", and "*I am interested in learning mathematics because of the teacher*" were noted. The number of meaning units that had been obtained consists of 54 codes. Those codes had been confirmed with the results of observation. After categorized based on the main themes of (1) students' views of mathematics; (2) students' interests in mathematics; (3) students' perceptions of their mathematical competence; and (4) students' views on the relevance of mathematics to art, the results are presented as follows.

Students' Views of Mathematics

After 30 students expressed their views about mathematics within three statements, their answers were classified. In total, 90 statements described their views about mathematics as depicted in Table 2. This table clearly shows that there are three views about mathematics as expressed by the ATSs, namely mechanistic, joyful, and unattractive. For those who viewed mathematics as a mechanistic thing, they tended to think that mathematics was only about numbers and their operations. Whilst students who regarded mathematics as a joyful thing might perceive mathematics as challenging and exciting for them. While for those who view mathematics as an unattractive thing, they likely perceived mathematics negatively. Overall, the table suggests that more than three fourth of the students' statements demonstrate that mathematics is mechanistic or unattractive. Only a few students agree that mathematics is joyful (positive). Through the observation, these findings were confirmed, and it was found that ATSs who hold positive views tend to concern themselves with mathematics and listen carefully during the mathematics learning process than those with negative opinions.

Table 2.
Classifications of Students' Views of Mathematics (n = 30)

I think, mathematics is	Label for Mathematics	Percentage*
Numbers **Formula** **Counting**	Mechanistic	57%
Challenging **Exciting**	Joyful	11%
Complicated **Difficult** **Resentful** **Scary**	Unattractive	32%

** The percentage of students' statements*

Besides students' view aspect, there are other three aspects related to students' perceptions of mathematics, namely interest, competence, and relevance, as shown in Table 3. The interest aspect consists of three sub-aspects, while the number of students for each category can be seen in the right column. Furthermore, the description of the results in each aspect is presented in the next sub-sections.

Table 3.
Classifications of Students' Perceptions of Mathematics (n = 30)

Student perception	Category	Frequency (%)
Interest		
Emotion when learning mathematics	Positive	17 (57%)
	Neutral	6 (20%)
	Negative	7 (23%)
Concern over mathematics performance	Concerned	23 (77%)
	Unconcerned	7 (23%)
Importance of learning mathematics	Important	23 (77%)
	Unimportant	7 (23%)
Competence	Good at mathematics	11 (37%)
	Not good at mathematics	19 (63%)
Relevance	Relevant	12 (40%)
	Irrelevant	18 (60%)

Students' Perception of Their Interest in Learning Mathematics

Students' interest in mathematics deals with the three sub-aspects, namely their emotions when learning mathematics, their feelings when sitting for a performance test, and opinions about the importance of learning mathematics. Findings for each sub-aspect is described as follows.

Students' emotions when learning mathematics: The students' emotion is associated with their feelings when learning mathematics. The findings in this area were classified into three categories, namely positive, neutral, and negative emotions (see Table 3). Positive emotions expressed include *happy, enjoyable,* and so on, negative ones cover such words as *bored, worry, anxious*, and neutral feelings are *ordinary, feel nothing*, etc. Table 3 shows that the number of students with positive emotions is greater than those with negative or neutral feelings. Based on the results of the observation, students who expressed positive emotions in mathematics learning barely showed different attitudes and performance than those who showed negative emotions. This finding is reinforced by the statements from students, such as "*I like math, but the way of my teacher teaches makes mathematics difficult for me"* (P2-M-17) or *"I'm bored and lazy when learning mathematics, but mathematics is a compulsory subject, so I have to keep studying so I can pass the exams and make it to the next grade"* (P11-M-17). Students' answers indicate that positive emotions did not trigger learning enthusiasm, and negative emotions also did not restrain their learning desire, as these negative feelings were triggered by other components, for instance, the teacher-factor or the nature of mathematics.

***Students' concern over their mathematics performance*:** The results of the students' concern on their mathematics performance were categorized into two, concerned and unconcerned (see Table 3). The participating ATSs mostly state that they were concerned with their mathematics performance. They said that they would be sad, disappointed, angry, and sorry when they received bad scores at mathematics tests. When they were asked whether or not some efforts had been done to fix their scores in the next test, those who were concerned with their study answered that they had the desire to learn more and get higher scores for the next test. Furthermore, some students added that the efforts to improve scores could not be done maximally because of time limitation, no supervisor, and limited learning resources. Some students verbally added *"homework, art practice assignments, and art exhibitions leave me with no time to study"* (P8-M-16) or *"I don't have enough money to buy books"* (P15-M-17). Meanwhile, other students who were unconcerned with their study stated that they reluctantly studied more since it would be a useless thing, as proven in the statement, "*no matter how hard I study, I still cannot become good at mathematics*" (P22-M-16).

Both students who were concerned and unconcerned with mathematics pointed out that there were no differences in their learning motivation. Students who claimed to have low learning outcomes expressed several reasons that prevented them from learning mathematics to improve their scores. They also did not show any differences in attitude during mathematics learning in the classroom. Few students - those who stated that they care about their learning outcome and declared that they would improve their score without any reason to hinder their study - paid more attention during the learning process in the classroom.

Students' perceptions of the importance of learning mathematics: Views on the importance of learning mathematics were categorized into important and unimportant (see Table 3). Students who considered mathematics as unimportant claimed that they just needed to learn basic mathematics commonly used in counting. They stated that mathematics learned at AVS cannot be applied in daily lives, so that they concluded that they did not need to learn mathematics at school. An example of a student's statement is *"I think the topics in the mathematics subject given at AVS are inappropriate, the basic mathematics that I got in elementary and junior secondary schools are more often used, such as to measure the*

canvas and frame areas" (P6-F-16). Another student pointed out that mathematics would be suitable to be given for general high school students rather than vocational school students because VHS students prioritized their study in sharpening skills related to their major rather than mastering all topics in theoretical school subjects.

In Table 3, it is evident that some students perceived learning mathematics as important. When they were asked why mathematics is important, they answered because mathematics could be used to count, it was one of the requirements to pass into the next grade, it was required to pursue higher education, and it could be utilized in designing artworks. These are supported by the statements from students, "*I need to calculate profit and loss to determine selling prices"* (P12-M-17) or "*learning mathematics enlarges my chances to be accepted at the college of my choice"* (P25-F-17). There was also a student who realized the importance of mathematics for art, *"I can use mathematics to measure the ratios of animals, trees, humans, and so on, to make the images look more alive"* (P3-M-16). According to the observation results, ATSs who considered mathematics as an unimportant subject showed low enthusiasm and attention during learning. Meanwhile, those who assumed that mathematics is important to pursue higher education and for artworks seemed more passionate than those declaring that mathematics is essential for counting and passing the requirement to go to the next grade and graduate from that school.

Based on the previous descriptions, it can be concluded that ATSs had an interest in mathematics as marked by their positive emotions dominating when they learned mathematics and most students were concerned with their learning outcomes and awareness of the importance of mathematics in the AVS. According to the coding results, students' interest was not always in line with students' desire for learning. Factors underpinning their reasons to learn mathematics are described in the following points.

(1) *Teacher.* A patient and kindhearted teacher might become a cause for motivating students to learn mathematics and make them enjoy and get involved during the mathematics learning in the classroom, as stated, "*My mathematics teacher never complained when I didn't understand mathematics content. It made me more enjoy the process of learning*" (P13-M-16).

(2) *Classmate.* Support from friends could contribute to emerging students' willingness to learn mathematics. When they received a lower score or had difficulties in learning mathematics, their classmates helped and encouraged them to study harder, as proven in the statements "*My classmate is good at mathematics. He helps me to understand the mathematics contents faster"* (P25-F-17), or "*when I got low mathematics scores, my friend offered me to study together"* (P14-M-16).

(3) *Family background.* One of the students asserted that family background could be a reason why she was eager to learn mathematics. The student stated that "*My mother is a mathematics teacher; I have been accustomed to learning mathematics since I was a child*" (P17-F-16).

(4) *Compulsory subject.* Students gave a reason why they were ready to learn mathematics since it was a compulsory subject at school. If they got mathematics scores below the minimum mastery criteria, they would fail to move up to the next grade, hence, they had to learn mathematics. A student stated that "*I have to learn mathematics to move up to the next grade"* (P21-M-16).

(5) *Challenge.* A student claimed, since she entered AVS, she had seen mathematics as a challenge, causing the learning process more stimulating than she had had in the primary and junior high school. She said, "*being able to solve difficult mathematics problems is a challenge that triggers adrenaline and I can get rid of this boredom while painting"* (P1-F-17).

(6) *Gateway to college.* Some students agreed that they wanted to learn mathematics since it was important for college admission tests.

(7) *Benefit.* Some students declared that they learn mathematics since it was useful in their daily life, for instance, to design artworks, sell and buy them, or hold on exhibitions. This is supported by the statement, *"mathematics helps me in calculating the shrinkage of volume in wet to dry clay, so that I can create ceramics according to the desired size"* (P27-M-16).

On another hand, there seem to be six determining factors triggering students' reluctance to learn mathematics.

(1) *Teachers' character and ways of teaching.* Teachers might become a reason why students did not like learning mathematics. This was stated by a student, "*My mathematics teacher is not good at teaching and makes mathematics look more complicated"* (P9-M-16). Therefore, it would be necessary to develop teachers' character and their teaching methods so that students are getting more enthusiastic in learning mathematics.

(2) *Classroom environment.* The non-conducive classroom might also become a reason for students' unwillingness to learn mathematics, as stated by a student, "*the class is too noisy and makes me lazy to focus on the mathematics learning"* (P6-F-16).

(3) *No interest.* No interest in learning mathematics likely became one of the reasons for students when they were asked why they often did not come to the mathematics sessions and were seen as not enthusiastic, like the statement "*I am not interested to learn mathematics in school, being able to count is enough for me"* (P13-M-16). Teachers as a key to success in the teaching and learning process would better help students construct their interest in learning.

(4) *Negative self-perception.* Feeling incapable to master mathematics could be another reason why students might be reluctant to learn mathematics. Some statements showed that students' opinions on their ability in mastering mathematics gave a huge impact on students' interest. A student stated that "*it seems I was destined to be stupid in counting, and event in remembering formulas"* (P26-M-16).

(5) *Uselessness of mathematics.* ATSs' opinions, suggesting that mathematics could not be applied in daily lives, somewhat made them reluctant in learning mathematics at school. From students' answers, it could be seen that the factors why they did not ready to learn mathematics were due to their views, that mathematics cannot give any benefit to their life. A student argued, *"I do not know the significance of learning arithmetic and such others"* (P18-F-16).

(6) *Time constraint.* Limited time could inhibit students from studying mathematics. If parents, teachers, and the school managers helped students to manage their time to study, students probably could be wiser in using their time to study. As the following statements suggest, *"too busy preparing works to be contested makes me unable to join the class"* (P24-F-17), and "*I do not have time to study because I have to focus on preparing an exhibition, to finish the work on time"* (P4-M-16).

Students' Perceptions of Their Competence in Mathematics

Students' opinions towards their competence in mathematics might be one of the prominent themes in the present research. Students' responses on this were categorized into good at mathematics as obtained from some such answers as "*confident, mastering mathematics, smart, …*" and not good at mathematics as taken from words like "*not easy to understand, not smart, not able to, ….*" As described in Table 3, few students believed that they were good at mathematics. During mathematics learning, the students who admitted good at mathematics seemed more active, confident, fully involved in the learning process, and more enthusiastic in solving problems than the ones who claimed themselves as not good at mathematics.

These students were also asked about what would make them good or not good at mathematics. Their responses are summarized in Table 4.

Table 4.
Students' Perceived Motives of Becoming Good or Not Good at Mathematics

I am good at mathematics because			
Myself	*I study actively; I like to solve mathematics problems; I focus on the teacher's explanation*	4	11
Teachers	*My teacher is kind and patient; I like the way my teacher teaches*	4	
Contents	*The mathematics content is easy for me; The content is useful for me*	2	
Family	*My parents are mathematics teachers*	1	
I am not good at mathematics because			
Myself	*I do not like mathematics; I have never learned; It is not easy for me to understand mathematics; My counting ability is low; I am not talented in mathematics; I do not join the mathematics class*	11	19
Teachers	*My teacher cannot teach well*	2	
Contents	*The mathematics contents are difficult; Too many formulas to memorize*	4	
Classroom	*The classroom is very noisy*	2	

The findings, as displayed in Table 4, revealed that most students realized that success in mathematics learning would be determined by themselves. Besides, the teacher factor had probably become one of the causes of students' accomplishments in mathematics. Teacher's character and quality, likewise, might contribute to a cause in better learning outcomes. Hence, it is suggested that teachers design and implement more effective and enjoyable learning strategies that encourage students to fully involve themselves in learning. In addition to this, students who felt good at mathematics likely showed better attitude and performance than those who did not.

Students' Perceptions of the Relevance of Mathematics to Art

Another prominent theme in this research is students' arguments about the relevance of mathematics to art. Students were asked whether mathematics can be applied in art. The interesting part would be that all of the students revealed that mathematics was somewhat relevant to art, whereas from the description before, it was known that some students claimed that they were uninterested in learning mathematics in AVS since they perceived it as futile.

Basically, all of students explained that they considered mathematics relevant to art. Some of the students' statements about the relevance between mathematics and art are presented in Table 5. However, according to Table 3, the majority of them argued that mathematics contents introduced at school were not appropriate for the vocational needs, as proven by the statement, "*I understand that mathematics is needed to make artworks, but I cannot apply the mathematics lessons that I learned in AVS"* (P7-M-16). Meanwhile, a minority of them considered mathematics in AVSs would help them in designing artworks, as described by the statement "*I can use the geometry in AVS to design artworks"* (P19-F-16). During the observation in the mathematics classes, students who stated that the mathematics contents in AVS were suitable for their needs in creating artworks showed a more positive attitude, more attention, and were actively listening to what the teacher said than the ones stating that the mathematics contents in AVS did not meet their needs.

Table 5.
Students' Opinions about the Relevance of Mathematics to Art

The relevance of mathematics to art is demonstrated in ….	
Answers from students majoring in Painting and Visual Communication Design	Measuring canvases and frames Measuring the ratio of figures Determining the appropriate proportion and composition of figures Measuring scales Designing patterns of figures Determining the number of ornaments in every object or figure Determining the proportion of paint colors to obtain new colors Calculating the selling price Determining the object layout in an exhibition
Answers from students majoring in Ceramic Craft	Determining the dimension of clay Calculating the material shrinkage Figuring time and temperature to the burning process of clay Measuring the size of ceramic decoration Drawing patterns of ceramics layer coating Figuring the balance of ceramic glaze Calculating the selling price Determining the object layout in an exhibition
Answers from students majoring in Wood Craft	Measuring wood materials Determining the dimension of objects Calculating the angle size Determining the equilibrium Calculating the selling price Determining the object layout in an exhibition

Based on Table 5, it is apparent that mathematics seemed relevant to four majors in AVSs, namely Painting, Visual Communication Design, Ceramic Craft, and Wood Craft. In general, the contribution of mathematics can be real in specific expertise and common skills of AVS students, especially those in the four majors. Therefore, mathematics likely played an important role in AVS students' success in their professional careers.

Discussion and Conclusion

This present research explored ATSs' perceptions of mathematics related to their view of mathematics, interests in mathematics, perception of their mathematical competence, and their perceptions of the relevance of mathematics to the work of art. Firstly, as stated in the findings, the researchers explored students' views about mathematics. Most of them associated mathematics with mechanistic work and no students perceived it as a need. This finding is consistent with Young-Loveridge et al. (2006) suggesting that students consider mathematics as a thing related to numbers and/or its operations. Besides, Mutodi and Ngirande (2014) also add a similar idea, that many students possibly comprehend the essence of mathematics as computations and procedural activities separated from the real-world context and discovery activities. In accordance with the results which showed that there were no students who

considered mathematics as a need, it might appear because the students could not find the critical relevance of mathematics they learned to the major they took at the vocational school, and their future careers. Moreover, Markovits and Forgasz (2017) claim that some students connect mathematics by something difficult and complicated. The present research supports their findings in which this study found out that the number of the negative perspectives of mathematics (difficult, complicated, scary, and resentful) appeared more than that of the positive viewpoints (challenging, stimulating, and excited). Students who considered mathematics positively inclined to give more attention and listen carefully to the explanation given by the teacher during the mathematics sessions than those who had negative thinking. This finding is in the light of research by Arthur et al. (2017) that students' negative perspectives on mathematics significantly influence their low interest in participating during mathematics learning.

Interest in something can be manifested by a positive feeling, concern, and consideration of its importance (Harackiewicz & Hulleman, 2010). The results of the present study indicated that most students were interested in mathematics, which was marked by positive emotions when they learned mathematics, their concern about their learning outcomes, and they judged learning mathematics as crucial. As mentioned in the findings, in terms of students' emotions, students stated that they experienced positive emotions (57%), negative emotions (23%), and neutral ones (20%) while learning mathematics. However, the study did not see any differences in attitude and learning performance among students with positive emotions, negative emotions, and neutral ones in the classroom. This finding is in line with Mega et al. (2014), suggesting that positive emotions do not guarantee better performance. In the theme of students' concern over their learning outcomes, a lot of students who stated that they did not care about their learning outcomes were reluctant in paying more attention and improving their mathematics scores since they often failed in learning. Such experience might lead a belief that there is nothing they can do to change their fate and makes them stop striving and improving condition (Bernstein & Nash, 2008). Meanwhile, students who concerned about their achievement later showed various responses. Some students who admitted to care but gave some reasons which hinder them from learning, showed considerably low attention and learning performance during mathematics learning. Whilst other students who concerned about their study and attempted to improve their scores might show better performance and attention in learning. This seems to point out that students' learning encouragement give an impact on their attitude and learning performance in the class, and this is in line with Long et al. (2013).

Another aspect to see in the scope of the students' interest in mathematics in this research is their perceptions of the importance of learning mathematics for themselves. A large proportion (77%) of the students considered learning mathematics as important, while the rest, 23% of them, thought that mathematics was trivial. The students with the latter opinion held that mathematics could not be applied in their daily life. They were not enthusiastic and showed little attention during mathematics learning. On the contrary, students who considered that learning mathematics was crucial pointed out various positive attitudes. These students with positive thought claimed that mathematics would be vital to pursue further education and for art, and they seemed more enthusiastic in learning mathematics than those seeing mathematics as vital for counting and a compulsory requirement to move up to the next grade and graduate from this school. Concerning this, Aziz and Bakar (2019) emphasize that when students understand the importance of what they learn, they will enjoy the learning process, while those who do not understand will show negative attitudes in the classroom. From what has been elaborated above, it is understood that this research put forward that the students' interest in mathematics did not affect their attitudes and performance. This finding is consistent with what is affirmed by Koller et al. (2001) that interest does not influence students' achievements in the first year of high school education. Besides, Heinze at al. (2005) add that students' low interest in mathematics does not create negative impacts on their accomplishment in the class.

The current research finding, the student that showed that high interest in mathematics did not always mean a high desire to learn mathematics, implied other possible factors leading students to learn mathematics. This research later indicated that the contributing factors causing AVS students ready in learning mathematics would be teachers, friends, family background, nature of mathematics, the compulsory subject, challenges in mathematics, a gateway to college education, and the benefits of mathematics. Meanwhile, the reasons why students were unwilling to learn mathematics would be addressed to the teachers' character and methods in teaching, classroom environment, low student interest, feeling incapable or nor clever in mathematics, assumption that mathematics is futile, and time constraint. These findings are consistent with research by Ohman (2015), that vocational school students are ready to learn mathematics since it is a compulsory subject. Later, Dimakos et al. (2012) reveal some similar factors contributing to students' preparedness to learn mathematics, namely teachers, books, and parents. Whilst Acharya (2017) discovers factors that complicate learning mathematics as teachers, parents, teaching-learning environment, low students' interest in

mathematics, and negative feelings to mathematics. Likewise, Arthur et al. (2014) in their research indicate that motivation from teachers and methods of teaching influence students' interest to learn mathematics. The same thing is also found by Narendrati (2017), based on the results of interviews with mathematics teachers in VHSs, that students' interest to learn mathematics is affected by learning strategies or methods implemented by the teacher in learning.

Another important message in this present research would be about students' perceptions of their mathematics competences (self-efficacy). Self-efficacy is one's judgment about his or her abilities (Bandura, 2012). It affects the actions chosen by someone to deal with any problems (Thahir et al., 2019). Erozkan (2014) declares that the higher one's self-efficacy in solving problems or tasks, the better achievements in similar situations or tasks. The present research unearthed that the number of ATSs who considered themselves *not good at mathematics* (63%) was greater than that of learners who deemed themselves *good at mathematics* (37%). In mathematics learning, students who perceived themselves good at mathematics seemed more active, confident, involved, and more enthusiastic in solving mathematics test items than the others who considered not doing good at math. These findings are similar to Meral's et al. (2012), that self-efficacy is an important variable that significantly correlates with students' academic performances. Most of AVS students in this research realized that their success in learning mathematics would be determined by themselves. This is also similar to Ozdemir and Onder-Ozdemir (2017) who discover one of the reasons that make the students successful or not in mathematics is because of self-factor, namely behavior and attitudes during the mathematics learning process. More importantly, teachers also became a reason behind AVS students' success in learning mathematics. This finding is in line with Blazar and Kraft's (2017), that teachers give an impact on improving students' self-efficacy and happiness in mathematics learning. The same result is gained by Mutodi and Ngirande (2014) that some factors affecting students' success in learning mathematics cover teachers and methods of teaching, family background, students' opinions that the difficulties in mathematics are challenges or obstacles in learning, and students' confidence.

Bakker (2014), in regard to this, highlights the importance of mathematics learning in vocational schools and its relevance to students' future work and profession, or its utility for vocational practices to develop student's mathematics knowledge to meet the vocational needs. In other words, mathematics learning activity in vocational schools should be designed in such a way that reflects vocational culture or environment, provides a positive impact on students' engagement in mathematics learning (Dalby & Noyes, 2015), is useful for students to deal with various problems in their future workplace (Fatimah & Prabawanto, 2020). Students' opinions towards mathematics' relevance to art would appear as one of the interesting themes appearing in this research. The interesting part would be that all ATSs claimed that mathematics is relevant to art. However, more than half of the ATSs viewed mathematics learned at AVS did not suit their professional needs, while other ATSs considered that learning mathematics at AVS could help them in creating artworks. Students who confirmed that the mathematics contents at AVS were suitable for their needs to create artworks exhibited more positive attitudes, more attention, and listened to the teacher's explanation than those who perceived differently. This result is in line with research by Mazana et al. (2019) that discovers that the relevance of mathematics given at school with its application in their daily life make students do like mathematics. Harackiewicz et al. (2014) add, when what students have learned at school is irrelevant to their daily life, they create distance from the learning process, and their learning motivation becomes low. Kpolovie et al. (2014) confirm that students will be motivated to learn harder when they understand the relevance of what they have learned. Accordingly, it is important for mathematics teachers to show students the benefits of the learning contents for their daily, academic, and professional lives.

This research had successfully uncovered three categories of views of ATSs about mathematics, namely mechanistic, joyful, and unattractive. For the mechanistic view, mathematics would only be about numbers and their operations; for the second view, mathematics was considered as a challenging thing; while for the unattractive view, mathematics was defined as complicated, difficult, resentful, and scary things. Students' interest in mathematics was shown by students' emotions while learning, concern about mathematics learning outcomes, and perceptions about the importance of learning mathematics. Students who exhibited positive emotions tended to be happy and enjoyed the learning process, while those with negative emotions felt bored and worried in learning mathematics. Students who concerned over their mathematics achievement tended to feel sad, disappointed, angry, and sorry when they received bad scores in mathematics tests. While for students who do not concerns about their learning outcomes tend to feel reluctant to learn since they considered mathematics useless. Students might think mathematics important because it could be used to count, it became one of the requirements to move up to the next grade, it could be used

to pursue higher education, and it could be utilized in designing artworks. Regarding students' perception of their competence in mathematics, ATSs who perceived themselves good at mathematics felt confident in learning it and could master the contents better. In contrast, ATSs who saw themselves not good at mathematics performed low self-confidence and were difficult to understand mathematics contents. Furthermore, factors like classroom management by the teacher, support from classmates, family background, mathematics contents, and students' attitudes toward mathematics might become driving factors for those who were good at mathematics; while those with low self-efficacy might blame the unattractive learning method, poor classroom environment, and time limitation. In terms of students' perceptions of mathematics relevance to art, students regarded that basically mathematics was applicable in artworks. However, only a few mathematics concepts taught at the AVS could be employed directly in artworks.

Recommendations

Based on the findings and discussion, the study suggests that teachers use teaching methods that encourage students' interest and involvement in the mathematics learning process, so that students' boredom and anxiety when learning could be reduced. Teachers are also expected to intertwine mathematics contents with students' daily life so that learning becomes more meaningful. Students are also guided to be able to apply mathematics in creating artworks so that students understand the benefits of what they have learned. Mathematics material provided in AVSs should be adjusted to the needs of students in creating works of art. Besides, future research should consider other vocational majors such as culinary, fashion, etc. to see the connection of mathematics learning with vocational needs. Further investigations may also explore the conformity of mathematics learning contents with the learners' professional and day to day needs.

Limitations of Study

There are two major limitations in this study that could be addressed in future research. First, the study focused on one AVS in a region in Indonesia and it was merely carried out within a short space of time. Second, this research did not involve teachers to confirm the data collected from the students.

Declaration of Conflict of Interest

The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article. This research is original work and does not contain any libellous or unlawful statement or infringe on the rights or privacy of others.

Biodata of the Authors

Dr. Sugiman, M.Si. is an Associate Professor in Mathematics Education. He is a lecture and a researcher at Mathematics Education Department, Faculty of Mathematics and Natural Sciences, Yogyakarta State University, Yogyakarta, Indonesia. He is a lecture and researcher. His research interest is in mathematics instructional methodology. He was born in Purworejo, Middle of Java Province, Indonesia on February 28, 1965. **Affiliation:** Yogyakarta State University, Yogyakarta, Indonesia **E-mail:** sugiman@uny.ac.id **Phone:** (+62)8122786314 **Orcid Number:** 0000-0003-1931-7537 **Scopus ID:** 57204035834

Iham Rizkianto, M. Sc. is an Assistant Professor of Mathematics Education in Mathematics Education Department, Faculty of Mathematics and Natural Sciences, Yogyakarta State University, Yogyakarta, Indonesia. His research interest is in innovations in teaching mathematics in secondary schools. He was born in Ponorogo Regency, East Java, Indonesia on March 8th, 1987. **Affiliation:** Yogyakarta State University, Yogyakarta, Indonesia **E-mail:** ilham_rizkianto@uny.ac.id **Phone:** (+62) 81805334461 **Orcid Number:** 0000-0002-9636-6001 **Scopus ID:** 57208748082

Dra. Endar Pujiasti is a Professional Mathematics Teacher at Sekolah Menengah Kejuruan Negeri 3 Kasihan, Bantul Regency, Special Region of Yogyakarta, Indonesia. She was born on November 24, 1965 in Yogyakarta City, Special Region of Yogyakarta, Indonesia. She teaches mathematics since 1992. **Affiliation:** SMKN 3 Kasihan, Bantul, Yogyakarta, Indonesia **E-mail:** endarpujiasti@gmail.com **Phone:** (+62)81329222507

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