Contribution of Auditory Learning Style to Students’
Mathematical Connection Ability

Karlimalah and F Risfiani
Department of Elementary School Teacher Education, Universitas Pendidikan
Indonesia, Tasikmalaya Campus
Jl. Dadaha N0. 18 Tasikmalaya 46115 Indonesia

*karlimah@upi.edu

Abstrak. This paper presents the results of the research on the relation of mathematical concept with mathematics, other subjects, and with everyday life. This research reveals study result of the students who had auditory learning style and correlates it with their ability of mathematical connection. In this research, the researchers used a combination model or sequential exploratory design method, which is the use of qualitative and quantitative research methods in sequence. The result proves that giving learning facilities which are not suitable for the class whose students have the auditory learning style results in the barely sufficient math connection ability. The average mathematical connection ability of the auditory students was initially in the medium level of qualification. Then, the improvement in the form of the varied learning that suited the auditory learning style still showed the average ability of mathematical connection in medium level of qualification. Nevertheless, there was increase in the frequency of students in the medium level of qualification and decrease in the very low and low level of qualification. This suggests that the learning facilities, which are appropriate for the student's auditory learning style, contribute well enough to the students' mathematical connection ability. Therefore, the mathematics learning for students who have an auditory learning style should consist of particular activity that is understanding the concepts of mathematics and their relations.

1. Introduction
Mathematics is one of the structured subjects, having a nature that is continuous from simple concepts to more complex concepts. This nature indicates that interdisciplinary concepts in math subjects are related to each other or having mathematical connections. The ability to make connections in mathematics is a standard of the process of mathematical power required by everyone in solving math problems and daily life problems [5]. This mathematical connection can be developed in students in effective mathematics learning. One of the requirements to implement effective learning, according to Slameto [8], is "teachers need to consider individual differences". Learning style is one of the individual differences that must be considered by the teacher. In line with that statement, May [4] states, "we all use a range of learning styles at different times, and the most effective mathematical thinkers are flexible". This statement shows that by utilizing the learning style of students, we will have more effective math learning. Another opinion is given by May [4], "pupils may adopt different styles as they first explore and understand, and then rehearse and apply, each new concept". These two opinions indicate that learning styles can determine how students understand something initially, as an ingredient to be applied in other new concepts. This application of a new concept is known as students’ mathematical connection ability. Thus, there is a link between learning styles and the students’ mathematical connection ability.
The mathematical connection ability is very important for students. The linkage between learning styles and mathematical connection ability can be utilized by teachers to develop mathematical connection ability. The main thing that teachers need to know is the students’ learning style. The statement about the need for teachers to understand the learning styles of students is based on relevant research results obtained previously. In the studies conducted by Halim [3] and Sagitasari [7], they found that learning styles can influence students’ learning outcomes and achievement. According to Purwanto [6], learning outcomes are often used as a measure to find out how far a person has mastered the material already taught. Thus, based on the learning results, the students’ mathematical connection ability can be determined.

Based on these statements, teachers must recognize the learning styles of students and develop what kind of learning can be carried out in accordance with the learning style of students to develop students’ mathematical connection ability. Since there are no studies which have revealed the contribution of learning styles to students’ mathematical connection ability and also considering the importance of teachers’ knowledge about the learning style of students to create effective learning, it was necessary to conduct a research to find out how much contribution of auditory learning style to students’ mathematical connection ability. This was done as an effort to create effective learning to build students’ mathematical connection ability in accordance with students’ learning style.

2. Experimental Method

In this research, the researchers used a combination model or sequential exploratory design method which is the combination of qualitative and quantitative research methods in sequence. Qualitative research methods were used to set the setting of auditory learning styles and the mathematical connection ability. The instruments used were a learning style questionnaire and math test for students who had an auditory learning style. The findings of hypotheses in the first stage of the research were then tested by the subsequent research by using quasi-experiment nonequivalent control group design.

The population was the sixth-grade students of an elementary school in Kecamatan Tamansari Tasikmalaya City. The sample was determined by purposive that is the sixth-grade students of SD Setiamulya. Then, the data collection was conducted by giving the test, then continued with data analysis by using SPSS software. Here are the main steps in this type of research [9].

![Figure 1. Combination Method, Sequential Exploratory Design](image)

3. Result and Discussion

Based on the results of data collection, some findings were found related to the auditory learning style in elementary school in Kecamatan Tamansari Tasikmalaya city. The home room teacher at the school, had an auditory teaching style that was recognized from some characteristics appeared during the lesson. When teaching, the teacher did not tend to use the media, the use of books and student worksheet did not dominate the learning process, the teacher also created self-made questions
spontaneously and asked them orally, the learning activities were mostly lectures and question and answer sessions, and discussing problems in a discussion was more preferable. These characteristics made it possible to create a learning environment which was suitable for students who had an auditory learning style. The learning conditions were formed based on the principle of bringing the world of students to the world of teachers and delivering the world of teachers to the world of [2]. Each interaction with the students, each curriculum design, and each interactional method was made by considering the student’s character and the demands of the curriculum as well as the teaching facilities implemented by the teacher in accordance with the student’s learning style. In this case, the teacher had learned the auditory learning styles possessed by the students which were seen during the learning, so the teacher provided auditory learning facilities. Thus, the provision of learning facilities in the classroom was implemented in accordance with students’ learning style. Adjustment of learning to the students’ learning style is a balancing effort between internal and external stimuli [1]. Therefore, a learning, which is implemented in accordance with the students’ learning styles, can enhance motivation, increase the value of learning, increase self-confidence, improve self-respect, maintain a positive attitude and continue to utilize skills [1]. Therefore, learning in the auditory classroom with auditory teaching style can influence well the development of students’ mathematical connection ability.

Furthermore, to determine the students’ mathematical connection ability with learning facilities that suited the students’ learning style, a test was conducted. The results of the tests, which performed before (pretest) and after the learning (posttest), showed the existence of students’ mathematical connection that was at medium qualification with the frequency was 12 students (44.4%). These results indicated that student’s mathematical connection ability was almost sufficient.

In developing the mathematical connection ability, varied learning activities were undertaken in accordance with students’ learning style, so the results were better than before (Table 1 of the Posttest column). Based on the pretest and posttest data, it was found that students’ mathematical connection ability after the learning demonstrated good progress and there were also a change that is an increase in high-level qualification as much as 22.1% and a decrease in very low and low level of qualification. So that the provision of learning facilities in accordance with auditory learning style indicated the development of mathematical connection ability in students who possessed very low, low and high level of qualification of mathematical connection ability. It can be seen in Table 1 as follows:

| No | Qualification | Pretest |          | Posttest |          |
|----|---------------|---------|----------|----------|----------|
|    |               | Student Frequency | Percentage | Student Frequency | Percentage |
| 1  | Very High     | 0       | 0 %      | 0        | 0 %      |
| 2  | High          | 2       | 7.5 %    | 8        | 29.6 %   |
| 3  | Medium        | 12      | 44.4 %   | 12       | 44.4 %   |
| 4  | Low           | 7       | 25.9 %   | 5        | 18.5 %   |
| 5  | Very Low      | 6       | 22.2 %   | 2        | 7.5 %    |
|    | Total         | 27      | 100 %    | 27       | 100 %    |

To obtain valid results, a covariance analysis was performed with the aim of controlling the effects of other uncontrolled variables. For example, the view that each student has another learning style (visual or kinesthetic), in addition to the auditory learning style. Thus, in order to overcome the effects of other learning styles that might have an effect on the students' mathematical connection ability during pretest, the control of possible influences was made, then a covariant analysis (ANKOVA) was performed. The covariance analysis was performed by using SPSS 16.0 application and the following regression result was obtained:

Regression equation: \( Y = (\beta_o + \beta_i) + (\delta_o + \delta_i) * GB \)

Description: \( \beta_o \) = Intercept of Learning Style
\( \beta_i \) = Learning Style Coefficient
\( \delta \) = Coefficient of Learning Style

GB = Grade of Benefit

Table 1. Recapitulation of Frequency of Students’ Mathematics Connection Ability in Auditory Class

| No | Qualification | Pretest |          | Posttest |          |
|----|---------------|---------|----------|----------|----------|
|    |               | Student Frequency | Percentage | Student Frequency | Percentage |
| 1  | Very High     | 0       | 0 %      | 0        | 0 %      |
| 2  | High          | 2       | 7.5 %    | 8        | 29.6 %   |
| 3  | Medium        | 12      | 44.4 %   | 12       | 44.4 %   |
| 4  | Low           | 7       | 25.9 %   | 5        | 18.5 %   |
| 5  | Very Low      | 6       | 22.2 %   | 2        | 7.5 %    |
|    | Total         | 27      | 100 %    | 27       | 100 %    |
\[ \Delta_o = \text{Covariates} \]
\[ \Delta_i = \text{Correlation coefficient} \]
\[ Y = (23.901 + 0) + (0 + 0.638) \times GB2.00 = 23.901 + 0.638GB2.00 \]

Based on the regression equation, it can be seen that the coefficient of students' auditory learning style was categorized as high. Although there were other things that affected (23,901). Furthermore, other SPSS output results showed R Square value of 0.507. This value indicates that the learning style contributes moderately to the students' mathematical connection ability as much as 50.7%. (Table 2)

### Table 2. Tests of Between-Subjects Effects

| Source            | Type III Sum of Squares | df | Mean Square | F      | Sig. |
|-------------------|-------------------------|----|-------------|--------|------|
| Corrected Model   | 6521.164\(^a\)         | 2  | 3260.582    | 26.779 | .000 |
| Intercept         | 3237.302                | 1  | 3237.302    | 26.588 | .000 |
| GB                | 1387.436                | 1  | 1387.436    | 11.395 | .001 |
| X                 | 4406.535                | 1  | 4406.535    | 36.191 | .000 |
| Error             | 6331.350                | 52 | 121.757     |        |      |
| Total             | 181789.300              | 55 |             |        |      |
| Corrected Total   | 12852.514               | 54 |             |        |      |

\(^a\) R Squared = .507 (Adjusted R Squared = .488)

Furthermore, the significance level for the mathematical connection ability of auditory learning style of 0.001 was higher than other learning styles of 0.000 (Table 3). It means that there was an influence on the mathematical connection ability of the learning given by the teacher in accordance with the learning style of the students. This indicated that the learning, which was in accordance with the students’ learning style, affected the development of students’ mathematical connection ability. The learning that was not in accordance with the learning style of students did not result in the better mathematical connection ability compared to the learning which was in accordance with the students’ learning style.

### Table 3. Parameter Estimation for Advanced Test

| Parameter       | B       | Std. Error | T      | Sig.   | 95% Confidence Interval |
|-----------------|---------|------------|--------|--------|-------------------------|
| Intercept       | 21.083  | 5.120      | 4.118  | .000   | 10.810 - 31.356          |
| [GB=1.00]       | 10.128  | 3.000      | 3.376  | .001   | 4.107 - 16.148           |
| [GB=2.00]       | 0\(^a\) | .         |        | .      | .                       |
| X               | .710    | .118       | 6.016  | .000   | .473 - .946             |

\(^a\) This parameter is set to zero because it is redundant.

4. Conclusion
The mathematics learning with auditory learning style facilities for students who had an auditory learning style contributed well to students' mathematical connection ability. The good mathematical connection ability of students who have an auditory learning style was determined based on the initial mathematical connection ability which was in sufficient level. Based on the pretest and posttest results of students with auditory learning style, there was an increase in the mathematical connection ability.
Based on the initial findings, students had medium level of qualification of mathematical connection ability. However, after the learning with auditory learning style, the average mathematical connection ability of students with auditory learning style increased in high, very low and low level of qualification.

Based on the results of data analysis, it was found that the learning style contributed 50.7% to the students' mathematical connection ability. The results showed that learning, which was adjusted to the learning style of students, made good contribution to the ability of students' mathematical connection. Therefore, to improve the mathematical connection ability of students who have an auditory learning style, it is necessary to provide learning that match the learning style of the students as an effort to realize effective learning and optimal results. The main conclusion obtained from this research is that the learning activities carried out by the teacher, which are in accordance with students’ learning style, affect the development of students' mathematical connection ability.

Acknowledgments
Hopefully, this article can encourage school teachers to implement mathematics learning which takes into account learning conditions in which can provide suitable learning facilities and learning targets to develop mathematical components (mathematical connections) of students. Thus, the effectiveness of learning can be achieved, and the results of mathematics learning will be not only about how to solve math problems but also able to achieve students’ math power as well. Therefore, I would like to thank you for the trust in me to submit this article.

References
[1] DePorter, B. & Hernacki, M. (2011). *Quantum Learning*. Bandung: KAIFA
[2] DePorter, B., Reardon, M., & Nourie, S.S. (2010). *Quantum Teaching*. Bandung: KAIFA
[3] Halim, A. (2012). Pengaruh Strategi pembelajaran dan Gaya Belajar terhadap hasil Belajar Belajar Fisika Siswa SMPN 2 Secanggang kabupaten Langkat. *Jurnal Tabularasa PPS UNIMED*, 9(2), hlm.142-158.
[4] May, T.C. (2005). *Teaching Maths to Pupils with Different Learning Styles*. London: Paul Chapman Publishing.
[5] National Council of Teachers of Mathematics (NCTM). (2000). *Principles and Standards for School Mathematics*. Reston, Va.
[6] Purwanto. (2014). *Evaluasi Hasil Belajar*. PUSTAKA PELAJAR: Yogyakarta
[7] Sagitasari, D.A. (2010). *Hubungan antara Kreativitas dan gaya Belajar dengan Prestasi Belajar Matematika Siswa SMP*. (Skripsi). Universitas Negeri Yogyakarta.
[8] Slameto. (2010). *Belajar dan Faktor-faktor yang Mempengaruhinya*. Jakarta: Rineka Cipta.
[9] Sugiyono. (2015). *Metode Penelitian Kombinasi (Mixed Methods)*. Bandung: Alfabeta