The Impact of Writing on Academic Performance for Medical Students

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Research article

Keywords: Academic Performance, Effects of Writing, Writing to Learn, Medical Education

Posted Date: August 31st, 2020

DOI: https://doi.org/10.21203/rs.3.rs-25591/v2

Version of Record: A version of this preprint was published on January 19th, 2021. See the published version at https://doi.org/10.1186/s12909-021-02485-2.

Abstract

Background Since the 1970s, writing has been widely used in classroom settings. Writing enhances learning, but there are limited studies that prove its effectiveness, especially in the medical education setting. The purpose of this study, therefore, is to investigate the effect of writing on medical students' academic performance. Methods An experiment was conducted with 139 medical students from Seoul National University College of Medicine. They were randomly assigned to three study conditions: self-study (SS), expository writing (EW), and argumentative writing (AW). Each group studied the given material by the method they were assigned, and they were tested on their understanding and transfer of knowledge. Results The results showed that the two writing groups displayed better performance than the SS group in transfer type items, while there was no difference in scores between the EW and AW group. However, the three groups showed no significant difference in their scores for rote-memory type items . Also, there was a positive correlation between writing score and transfer type items in the AW group. Conclusions This study provides empirical evidence for writing to be adopted in medical education for greater educational benefits. Our findings indicate that writing can enhance learning and higher-order thinking, which are critical for medical students.

Background

"Writing organizes and clarifies our thoughts. Writing is how we think our way into a subject and make it our own. Writing enables us to find out what we know—and what we don't know—about whatever we're trying to learn."[1] As Zinsser once stated, we can clarify what we know and what we do not know through writing. The process of writing requires writers to have a clear understanding of the subject matter[2] and makes use of cognitive abilities. For these advantages, since the 1970s, writing has been widely used in classroom settings.[3] By adopting writing assignments in the classroom, learning could be promoted. Writing helps students to develop thinking and enhance academic performance; it promotes metacognitive skills[4] and critical thinking.[5] However, many teachers avoid teaching using writing because they argue that the amount of time allotted to writing assignments will only decrease the amount of time available to address the learning content they need to cover.[6, 7] They also question whether teaching students by writing could enhance academic performance, having claimed writing has a limited effect on students' achievement.[8]

While researchers in fields of education and psychology have found evidence that writing does enhance learning,[9, 10] there is limited research regarding writing in medical education. However, if there is empirical evidence that writing enhances academic performance more than when students self-study, it becomes a strong reason to adopt writing in classrooms along with its additional educational benefits.[11] One of the most important educational benefits is that writing helps students develop higher-order thinking skills. Higher-order thinking skills involve three cognitive processes; analysis, evaluation and creation. [12] Writing specifically fosters the first two processes of higher-order thinking in relation to metacognitive skills and critical thinking abilities that are utilized during writing.[4,5] Metacognitive skills involve cognition about the process of writing, which is facilitated when writers plan what to write and self-evaluate what has been written. Critical thinking, a part of higher-order thinking skills, is promoted through analyzing whether conclusions have been logically drawn and evaluating the arguments to improve one's writing. Medical professions use higher-order thinking skills when diagnosing patients.[13] Doctors need to define the problem of a patient, mentally represent the situation, plan how to proceed with the patient, and evaluate the whole process to check against other possibilities.[14] While it is important for medical students to practice higher-order thinking skills,[15] modern classrooms have not fully embraced educational methods such as writing due to constraints in classroom settings.[16] Not only is teaching through writing still unfamiliar to professors in medical schools,[17] but medical students are also not aware of the importance of writing.[18] If writing can replace the traditional methods of learning, future medical professionals can learn what they need to learn and develop the skills needed to become better practitioners. For these reasons, the need for writing education in medical schools should be emphasized.

More specifically expository and argumentative writing tasks have been frequently dealt in educational settings. That is because these two types of require comprehension and evaluation of general concepts.[19, 20] However, each writing task focuses on different skills leading to varying educational effects. Expository writing requires reasoning skills like classification, comparison, definition, and illustration; it requires a structured interpretation of the texts and thus can be more effective in improving comprehension.[21] On the other hand, argumentative writing deploys more reasoning skills than expository writing.[22] Writers need to establish contested claims while formulating an explanation, generating counterarguments and assessing them to support their own opinions.[23] While both types of writing can help students to develop thinking skills, writing an argumentative essay involves much more reasoning practice.

In this study, we tried to prove the effects of writing in a medical education setting. We measured students' achievement through a final test that assessed rote-memory and transfer of knowledge on the materials they learned through writing. Transfer of knowledge is defined as the students' ability to apply what they learned to new and/or novel situations and corresponds to the use of critical thinking in a wide variety of contexts.[24, 25] Considering that the ultimate goal of education is to improve thinking and transfer of learning, the implications of this study would be meaningful if participants who learned through writing show better performance on transfer type items. We also expected that the effects of the two types of writing would be different. While participants with higher writing scores would also show better academic performance, those who study by writing an argumentative essay would achieve higher scores in transfer type items than those who study by writing an expository essay. We assumed argumentative writing would enhance higher-order thinking more than expository writing because it involves more reasoning activities that promote critical thinking, like analyzing and synthesizing an argument.[26]

To summarize, we divided the participants into three groups: those who study by themselves (self-study; SS), those who study by writing a summary text (expository writing: EW), and those who study by writing an argumentative essay (argumentative writing: AW). We tested each group's academic performance and tried to better differentiate the effect of two separate types of writing on learning.

Methods

Participants

Participants were recruited at the Seoul National University College of Medicine. Among 139 individuals, 48 were female. Twenty-three participants who failed to follow the directions were excluded from the study. Therefore, only the data from the remaining 116 participants were analyzed (= 19.22, = 0.79).

Material

The participants were instructed to study a 4-page-long written material. The study methods varied depending on their assigned groups. The subject matter dealt with the relationship between youth's cognitive development and musical skills. This subject was chosen because it is less likely to be affected by background knowledge since related courses are not provided to the medical school students. In addition, it was convenient to devise final test questions and the writing tasks based on the topic as the material covered diverse concepts and theories. We were also able to refer to an already existing set of test questions on this topic, verified and used in the National Teacher Certification Examination in Korea.

Experiment Procedure

According to our experimental design, participants were randomly assigned to either of the three groups: the SS group, the EW group, and the AW group. For the SS group, participants were instructed to study the written material by themselves for 25 minutes. For the writing groups, participants were instructed to write a half-page long essay on the given material for 25 minutes. Specifically, the EW group was instructed to summarize the given text, while the AW group was instructed to make their arguments based on what they learned. The EW group was told to write more than three paragraphs, the total length of over a half-page. The group had to summarize various stages in youth's cognitive development, which was mainly handled in the learning material. The AW group was instructed to write an argumentative essay. The length of the writing required was identical to the EW group. The participants were ordered to pretend that they were an elementary school music teacher, and must propose a music class based on the cognitive development theories introduced in the given material. There were four theories they could choose from, and they had to explain why the theory they chose was better than the others. Following the study session, participants were asked to solve the Remote Associates Test, which also served as a filler task, for 15 minutes. Finally, they were given 20 minutes to complete a final test on the learning materials.

Remote Associates Test (RAT)

Remote Associates Test (RAT) is a test commonly used to assesses creativity.[27,28] This goes in context with the last cognitive process of higher-order thinking, creation.[12] To see how the creation process of higher-order thinking is related to writing and final performance, fifteen questions were selected from the question pool published by Mednick.[29,30] The student being tested has to think of a fourth word that is somehow related to three words given and all questions have one definite answer.

Measurement of Academic Performance

Final test questions were comprised of rote-memory type and transfer type items. Although most of the questions required the participants to write a short or narrative answer, these items had definite answers and guidelines to evaluating students' performance. Furthermore to rule out any subjective evaluation by the experimenters, the raters' agreement for transfer items was measured by Intraclass correlation. The coefficient value showed high agreement among the three raters (ICC(3, *k*) = .930). The ten rote-memory type items asked direct factual information on the given material and were worth 13 points. There were four transfer type items, which required the students to think a step further and apply what they learned to new situations. These items required not only an overall comprehension of the given material but also application of it to different situations, which were worth 16 points. Thus, the maximum score students could achieve was 29 points.

Writing Scores

To analyze the effect of writing, we scored their essays based on the writing performance criteria proposed by Lumley[31]. Specifically, we rated students' writing based on three criteria. First, we rated whether the writing is cohesive and clearly organized (3 points). Second, whether the writing is appropriate to the task and materials given (2 points), and is easily comprehendible (2 points). Third, whether all aspects of presentation conventions including spelling, punctuation, layout are handled skillfully (3 points). The maximum writing score was 10 points in total.

Statistical Analysis

To examine the effect of different study conditions on academic performance, analysis of covariance (ANCOVA), linear regression analysis, and correlation analysis were performed. All statistical analyses were performed using SPSS 23 software (SPSS, Chicago, L, USA) and R (3.6.2. version; R Foundation, Vienna, Austria). The statistical significance for all tests was set as $\alpha < 0.05$.

Results

To begin with, ANCOVA was conducted to compare the academic performance of students in the three groups. As shown in **Table 1**, there was a significant difference in total test scores between the three groups ($P = 0.002$, $\eta_p^2 = 0.102$). The difference in scores for transfer type items was also significant ($P < 0.001$, $\eta_p^2 = 0.249$). However, no difference was found in scores for rote-memory type items ($P = 0.899$, $\eta_p^2 = 0.002$).

Looking at each of the groups in detail, the two writing groups showed significantly higher total test scores than the SS group ($P = 0.007$, $\eta_p^2 = 0.064$). The SS group scored significantly lower than the EW group (13.34 vs. 17.11, $P = 0.003$, $\eta_p^2 = 0.077$); however, no significant difference was found between the SS group and the AW group (13.34 vs. 16.54, $P = 0.109$, $\eta_p^2 = 0.023$). The average total score of the AW group was not significantly different from that of the EW group (16.54 vs. 17.11, $P = 0.197$, $\eta_p^2 = 0.015$).

For rote-memory type items, there were no significant differences between the three groups. The performance of the writing groups was not significantly different from that of the SS group ($P = 0.937$, $\eta_p^2 = 0.000$). In addition, the score of the SS group for rote-memory type items was not significantly different from those of the EW group or the AW group (9.26 vs. 9.14, $P = 0.858$, $\eta_p^2 = 0.000$; 9.26 vs. 9.57, $P = 0.756$, $\eta_p^2 = 0.001$). The performance of the AW group was not significantly different from that of the EW group (9.14 vs. 9.57, $P = 0.648$, $\eta_p^2 = 0.002$).

In terms of transfer type items, the writing groups performed significantly better than the SS group ($P < 0.001$, $\eta_p^2 = 0.155$). The SS group scored significantly lower than the EW group (4.09 vs. 7.97, $P < 0.001$, $\eta_p^2 = 0.171$), and the AW group (4.09 vs. 6.97, $P = 0.006$, $\eta_p^2 = 0.067$). However, the scores of the AW group and the EW group were not significantly different (6. 97 vs. 7.97, $P = 0.077$, $\eta_p^2 = 0.028$) (**Table 2**).

Data from the RAT task and the writing scores from participants in the writing groups were further analyzed to identify how writing enhances performance. We expected participants' responses to RAT will be positively correlated with their academic performance. Overall, correlation analysis including all three groups did show that RAT scores have a weak positive correlation with performance in rote-memory items ($r(114) = 0.18$, $P = 0.045$). However, for participants in the writing groups, RAT scores did not show any significant correlation with the main study variables as demonstrated in **Table 3**.

We also predicted participants' writing score to show a positive correlation with their final performance, assuming the quality of writing reflects the level of participation in learning. As a result, the writing scores of participants for all writing conditions combined showed a weak positive correlation with both performances in rote-memory ($r(68) = 0.34$, $P = 0.003$) and transfer type items ($r(68) = 0.27$, $P = 0.022$) (**Table 3**). However, a significant linear relationship between the quality of writing and performance in transfer type items were discovered only in the AW condition. Linear regression analyses controlled for age and gender variables indicated that the writing scores significantly predicted performance on transfer type items for participants in the AW group ($R^2 = 0.26$, $F(3, 31) = 5.123$, $P = 0.001$) (**Table 4**).

Discussion

Writing promotes higher-order thinking as writers analyze what has to be written, evaluate the arguments that had been written, and finally creating original perspectives on the task at hand. Despite its importance in facilitating students to become critical thinkers, writing has not been actively used in medical education settings because the importance of process of learning had been frequently overlooked. However, recent changes have shifted the education paradigm to focus on learning processes in the form of summative evaluation. Rather than testing students' on their rote-memorization skills, evaluating their learning process through writing could be meaningful in recruiting and training better doctors. By way of illustration, students of Maastricht College of Medicine are required to submit a portfolio that includes reflection papers on the roles and abilities of medical professionals, scientists, and health care providers, respectively.[32] Since these essays are written multiple times over many semesters or years, students have the opportunity to reflect upon their whole learning process and look back on what they have learned. In this way, there are many opportunities for writing to be used as a way to evaluate students' learning process and promote higher-order thinking in medical education. Thus, the focus of our study has been to validate the effect of learning through writing by providing empirical evidence that writing can not only help medical students learn but also become critical thinkers.

We first hypothesized that participants who learned through writing will show significantly higher performance in transfer type items. As a result, the SS group scored significantly lower in transfer type items than the AW and the EW group. Compared to students who just read the given material to comprehend and memorize the information, students involved in the writing task had to analyze what they had read and present what they had learned in their own words. Therefore, it can be expected that a writing task which requires higher-order thinking skills, such as analysis and evaluation, better prepares students for transfer type items that test more than a basic level of comprehension.[33]

Overall, writing scores of the EW and the AW group showed a weak positive correlation with performance in rote-memory and transfer type items (**Table 3**). However, there were some different patterns between the two writing groups (**Fig 1**). While participants in the EW Group achieved similar scores on transfer type items regardless of their writing scores, test performance of the participants in the AW Group increased according to their writing scores. The reason why there was no difference in performance between the two writing groups could be inferred from the results of further linear regression analysis (**Table 4**). Since writing scores show a weak positive correlation with performance in transfer type items only in the AW condition, participants with poor writing skills in this group may not have benefited enough from the writing task. On the other hand, we can assume there was no individual variance in the learning effect of expository writing because no significant correlation was found for the participants in the EW group. Such different dynamics between the two different types of writing could have lowered the final test performance of participants in the AW group, or have raised the scores in the EW group, bringing academic performance within the writing groups to a similar level.

In addition, we checked for any positive correlations between RAT scores and the main study variables to see whether the creation process of higher-order thinking is related to writing and final performance. According to our results, RAT scores were only positively correlated with scores for rote-memory type items. This may be attributed to that fact that RAT measures convergent thinking abilities, not divergent thinking abilities.[34] Creativity is mainly consisted of convergent thinking and divergent thinking; however, these two concepts are different. While convergent thinking skills involve production of a single predetermined solution to given problem like RAT, divergent thinking skills require exploration of multiple possible solutions in order to generate creative ideas. In this sense, transfer type items which require application of knowledge in various contexts seem closely related to divergent thinking more than convergent thinking. The different focus of each assessment tool could have been the reason why RAT did not show any significant correlations with the writing scores or performance in transfer type items.

All in all, we were able to find empirical evidence that writing can be a useful learning tool for medical students. The two writing groups showed higher performance in transfer type items that require application of the given information. This study, however, still has some limitations. First, the instructions in the writing task were not clear enough to differentiate the effect of learning depending on the type of writing. While, some verbs in the instruction for the AW group, such as “suppose,” did follow the definitions of higher-order thinking in Bloom’s taxonomy, the writing task did not clearly require the students to have an opinion and argue about it.[33] Considering we intended for the writing task to be argumentative, a more direct instruction that required the students to take a stance and support his or her perspective was needed. Second, overall performance scores showed a floor effect. Specifically for transfer type items, the mean score of the three groups ranged from 4 to 7 points, much below the maximum 16 points. This could have been due to the low validity of test items. However, considering the questions came from a certified source, such a problem could have derived from the hard difficulty level. Not only were the question pool from a teacher certification examination, but the subject matter dealt with an unfamiliar topic to medical students. Regardless of the floor effect, the writing groups did score significantly higher in transfer type items compared to the SS group. Thus, for future studies it would be meaningful to replicate our results with a larger sample size and materials more closely related to medical education. Last but not least, a more relevant measure of cognitive processes involved in higher-order thinking must be considered. The task used in our study was RAT which assess creativity, specifically convergent thinking skills. With almost no significant correlation found between RAT scores and the main study variables, implementing other tasks that could accurately measure participants’ related higher-order thinking skills will help us better understand cognitive processes behind the effect of writing on learning.

Conclusion

Writing could be used as an useful learning tool that promotes higher order thinking. As students have to analyze the given information and evaluate it to express their ideas in a compact piece of writing, higher-order thinking is promoted throughout the process. Therefore, our findings provide empirical evidence for writing to be adopted in medical classrooms settings for greater educational benefits. Especially, writing enhances students’ academic performance in transfer type items that require students to apply the knowledge they learned to novel situations. We also suggested ways to incorporate writing in medical education to maximize their performance and evaluate their learning process at the same time. By actively using writing assignments in class, we expect medical students to enhance not only knowledge but also higher-order thinking skills.

Abbreviations

Self-Study group (SS); Expository Writing group (EW); Argumentative Writing group (AW); Remote Associates Test (RAT)

Declarations

Ethics Approval and Consent to Participate

The study was reviewed and approved by the Institutional Review Board (IRB) of Seoul National University School of Dentistry (approval No. S-D20190016). All participants were aware that they were taking part in this research and gave informed consent in addition to confirming that they would allow us to use their collected data anonymously for publication. All the data were anonymously collected and analyzed.

Consent for Publication

Not Applicable

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing Interests

All authors have no potential conflicts of interest.

Funding

Not Applicable

Authors' contributions

All authors have read and approved the manuscript. Conceptualization: Kim SE; Methodology: Kim SE, Park JY; Formal analysis: Yang JW, Lim JS; Data curation: Yang JW, Lim JS; Investigation: Kim SE, Yang JW, Lim JS; Writing - original draft preparation: Kim SE; Writing - review and editing: Lee SH, Ihm JJ, Park JY

Acknowledgements

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Tables

Table 1. Academic Performance by group and type of final test items

Group	SS (*n* = 46)	EW (*n* = 35)	AW (*n* = 35)
Total score (29 points)	13.34 (4.54)	17.11 (5.51)	16.54 (4.80)
Rote-Memory items (13 points)	9.26 (1.97)	9.14 (2.40)	9.57 (1.70)
Transfer type items (16 points)	4.09 (2.03)	7.97 (3.73)	6.97 (3.00)
Type of items	*F*	*P*	η_p^2
Total score (29 points)	6.351	.002	.102
Rote-Memory items (13 points)	0.106	.899	.002
Transfer type items (16 points)	18.616	<.001	.249

F (also known as value of F-distribution) describe the probability distribution, notably in the analysis of variance. *P* (also known as p-value) means statistical significance in the probability. η_p^2 (partial eta-score) is an effect size that is measure of the magnitude of a phenomenon in statistics. Data are shown as mean (standard deviation). SS: Self-study, EW: Expository writing, AW: Argumentative writing. For each group, total scores, rote-memory item scores and transfer type item scores are given. Gender and age were adjusted.

Table 2. Comparison between groups for total score, rote-memory items, and transfer type items

Contrast	df	SS	*F*	*P*	η_p^2
Total Score					
Writing vs. SS	1	181.849	7.592	.007	.064
SS vs. EW	1	221.086	9.230	.003	.077
EW vs. AW	1	40.402	1.687	.197	.015
AW vs. SS	1	62.599	2.613	.109	.023
Rote-Memory items					
Writing vs. SS	1	.025	.006	.937	<.001
SS vs. EW	1	.129	.032	.858	<.001
EW vs. AW	1	.835	.209	.648	.002
AW vs. SS	1	.386	.097	.756	.001
Transfer type items					
Writing vs. SS	1	262.310	20.342	<.001	.155
SS vs. EW	1	295.550	22.919	<.001	.171
EW vs. AW	1	40.972	3.177	.077	.028
AW vs. SS	1	103.261	8.008	.006	.067

F (also known as value of F-distribution) describe the probability distribution, notably in the analysis of variance. *P* (also known as p-value) means statistical significance in the probability. η_p^2 (partial eta-score) is an effect size that is measure of the magnitude of a phenomenon in statistics. df is an abbreviation of degree of freedom. SS: Self-Study, EW: Expository writing, AW: Argumentative writing. For each group, total scores, rote-memory item scores and transfer type item scores are given. Gender and age were adjusted.

Table 3. Correlations between main study variables

Variables	1 Writing scores	2 RAT scores	3 Total test scores	4 Transfer type item scores	5 Rote-Memory type item scores
1. Writing scores	-	-	-	-	-
2. RAT scores	0.14	-	-	-	-
3. Total test scores	0.35^{**}	0.16	-	-	-
4. Transfer type item scores	0.27^{*}	0.10	0.91^{***}	-	-
5. Rote-Memory type item scores	0.34^{**}	0.20	0.74^{***}	0.41^{***}	-

$^{*}P < 0.05$, $^{**}P < 0.01$, $^{***}P < 0.001$

Table 4. Multiple regression analysis of writing scores and performance of transfer type items

Independent Variables	Expository Writing (EW) group					
	β	SE	t	P	95% CI	
					Upper	Lower
Age	-1.82	0.63	-2.92	0.007**	-3.099	-0.548
Gender	1.16	1.26	0.92	0.363	-1.40	3.719
Writing Scores	0.29	0.35	0.91	0.372	-0.357	0.927
Constant	39.41	12.46	3.16	0.003**	14.0	64.826
Independent Variables	**Argumentative Writing (AW) group**					
	β	SE	t	P	95% CI	
					Upper	Lower
Age	1.52	1.31	1.16	0.256	-1.153	4.184
Gender	1.06	1.04	1.02	0.316	-1.065	3.19
Writing Scores	1.15	0.31	3.72	0.001***	0.521	1.787
Constant	-32.65	25.6	-1.28	0.211	-84.856	19.554

β is a dimensional parameter vector that is known as effects or regression coefficient. SE is an abbreviation of standard error. t (also known as t-statistic) is abbreviated from hypothesis test statistic. P (also known as p-value) means statistical significance in the probability. $^{*}P < 0.05$, $^{**}P < 0.01$, $^{***}P < 0.001$

Figures

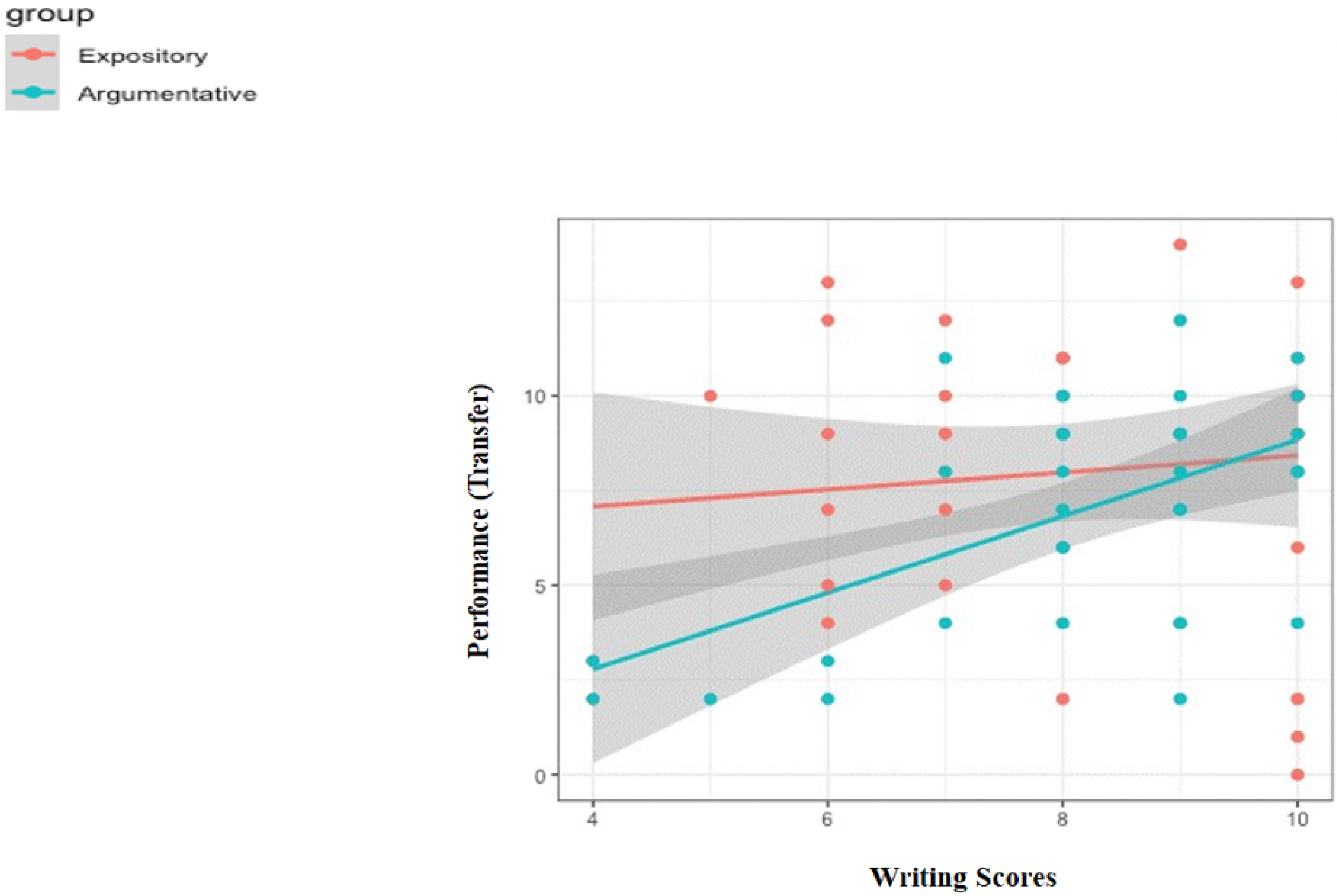

Figure 1

Linear Regression between writing scores and academic performance. Regression results representing how writing scores(0-10) affect students' academic performance on transfer type items(0-16) for two writing groups. Red points indicating Expository writing group; blue points indicating Argumentative writing group.