Analysis of Relationship Between Text Editing Process and Evaluation of Written Text in Logical Writing

Michiko Oba[1] Taku Yamaguchi[2] Shigeko Takahashi[3] Tatsuo Kobayashi[4]

Abstract: In the universities, students are required to submit reports, theses and abstracts for presentations as results of their learnings and studies. To make their texts effective, students are trained to write texts logically. Thus we have developed a text editing system which records text editing operations. To study writing process, we use the system. In this paper, we examine the results of an analysis of the relationship between the text editing process on our system and the evaluations of the written text. We will discuss the relationship between an index of the improvement of a logical text and an index of editing operations.

Keywords: writing, measurement, anaysis, logical composition

1. Introduction

In universities, logical writing ability is required to prepare reports, effectively publish learning and research results by graduation thesis and academic proceedings.

We conceived that the text editing operations record based on the matrix type text editing model is useful for the analysis of the intellectual process of writing. [1]. We aim to apply this analysis in order to improve writing instructions at schools, document reviews at companies and so on. Based on this idea, we developed a reference implementation [2].We applied the reference implementation to writing classes, collected editing operations logs and analyzed the correlation between the editing operations and the output text [3] [4].

In the writing classes, it is desirable to be able to perceive undesirable behavior throughout writing text. If one can clarify the editing operation pattern for creating a logical and easy-to-understand sentence, it helps him/her to teach writing. For this purpose, it is necessary to analyze the relation between the evaluated result of the sentence and the editing operation pattern. Since the evaluation result is a scalar data while the editing operation is a sequence of observed events (point process), it is difficult to analyze the relationship, though.

On the other hand, focusing on the relationship between programming abilities and logical writing abilities, experiments confirmed the similarity between programming ability and logical writing abilities [5] [6]. However, in the analysis of this relationship, it uses the result of writing sentence and the result of programming. In order to develop logical writing power and programming ability, it is not enough to analyze each result. It is necessary to analyze the thinking process of writing and programming and the relationship between the creation process and the result. Analysis of thought process can be searched from editing operation of sentence creation when targeting sentence creation.

In this paper, we analyze the correlations between editing operations and the evaluations for the output text. Text is evaluated whether it is logically constructed for readers and easy to understand. In our previous research, we applied a text editing tool which records text editing operations to measure writing process. We have proposed Editing Operations Indicator (EOI) to figure writing activities and analyzed correlations between EOI and the evaluations for the output text. EOI is calculated from the writing activities record [15]. In the preliminary experiment, we applied the measurement and analysis to a logical writing classes. Students wrote texts, received comments for the text and revise the text against the comments. We evaluated both the first text and the rewrote one for some points, and analyzed the evaluations and the EOI. The analysis suggested the correlations between some evaluation points and EOI. So, we have expected that observing (the value and the change of) EOI we will be able to perceive the possibility that the text is inadequately organized. By this, we can instruct students timely.

But the number of subjects were only 7 in the preliminary experiment. Output texts were evaluated from 4 points of view, each in 4 grades, but the evaluation criteria were ambiguous.

[1] Faculty of Systems Information Science, Future University Hakodate
[2] Independent Researcher
[3] Heartiness Co., Ltd.
[4] Scholex Co., Ltd.

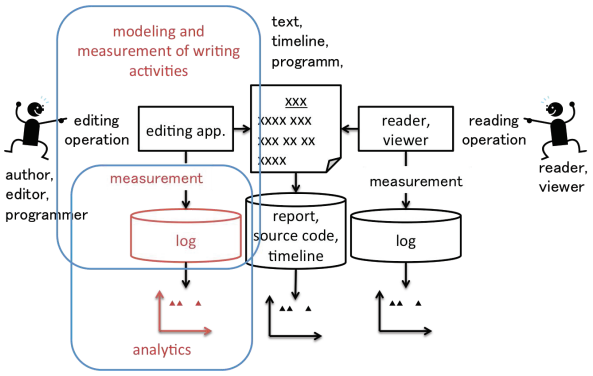

Fig. 1 Measurement and analysis of writing activity.

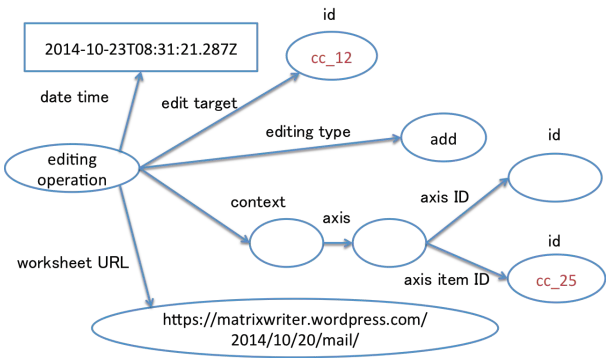

Fig. 2 Model for editing operation.

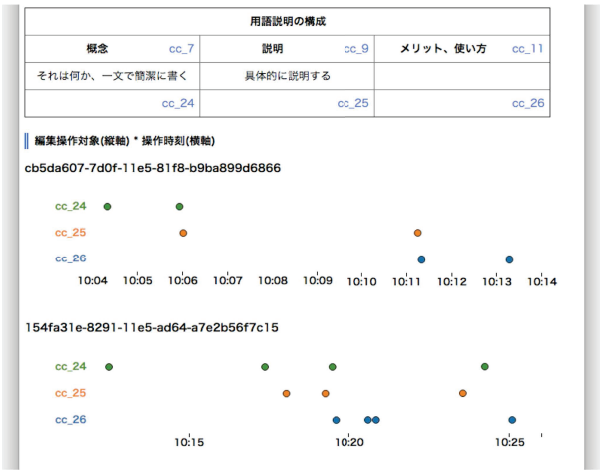

Fig. 3 Figure 3 The time-series change of editing target.

In this study, we have improved the evaluation criteria, experimented in a class which has sufficient number of students. And we have analyzed the correlations between the text editing operations and the evaluations for the output text. In this paper, we will report the result and give some considerations for it.

2. Previous Research

In this section, the measurement and the analysis for writing activities, the measurement and analysis for learning activities, and the approach of this study are explained.

2.1 Our Previous Reserch: Measurement and analysis for writing activities

The measurement and the analysis of writing activities are explained (**Fig. 1**).

We have designed Matrix Type Writing Model for measurement and analysis of writing activities (**Fig. 2**). And we have developed a reference implementation – text editing tool – which records text editing operations based on the model. We used the tool in writing classes and to write articles and proceedings. So we have collected wrting activity records. This is illustrated as ”modeling and measurement of writing” in the upper left part of Fig. 1.

In this model, writing activities are recorded as a series of text editing operations. It is recorded that what part of the text (phrases, paragraphs, etc.) is edited how (insert, move, delete, etc.), when (date and time) and in what context (a label of the field, oral instructions, etc.). Each editing operation corresponds to a writing action. A set of writing actions make up a writing activities. Further detail of the model is not explained in this article.

We have developed Topic Writer as an text editing tool and Writing Analytics as an analytics service. Topic Writer is a reference implementation for the model; it record editing operations as writing activity measurement. Students write articles according to a ”logic tree” (called worksheet) using Topic Writer. Writing activities are analyzed and visualized in Writing Analytics: when and what area in the worksheet are edited. Writing activities are separated from the output (written) text. The output text is saved in each students' own cloud storage and is hidden from the analist. Writing activity is a series of text editing events and discontinuous in time (point process). Writing Analytics show those activities in a temporal scatter plot (**Fig. 3**). ”cb5da607...d6866” and ”154fa31d-...56f7c15” are id's of the texts edited and called Document Id. ”cc_24”, ”cc_25” and ”cc_26” are id's of the fields to fill in.

And we have invented and proposed a Temporal Co-occurrence Matrices Analysis of successive text editing operations [2]. The concept of co-occurrence in a spacial-series-of-characters used in text analysis is applied to temporal-series-of-writing-actions in this analysis. In text analysis, words (or phrases) next to each other are thought to have close relationship. In writing analysis, edit targets temporally next to each other are thought to have close relationship.

Let us explain the temporal co-occurrence analysis by Writing Analytics service with a case that students wrote ”presentation evaluation” using Topic Writer tool in a writing class. The worksheet used in that case is shown in **Fig. 4**. It is a ”logic tree” to evaluate presentation. The evaluation should be constitued from three parts (typically in three paragraphs) and it is displayed to users (writers) as three fields to fill in. The temporal co-occurrence matrix is shown in **Fig. 5**

In Fig. 4 and Fig. 5, ”cc_8”, ”cc_10” and ”cc_12” are id's of the input fields as well as Fig. 3. Numbers in diagonal cells count editing operations to the same field. The next cells on the right corresponds to that editing target tran-

Fig. 4 Figure 4 Public work sheet for presentation evaluation.

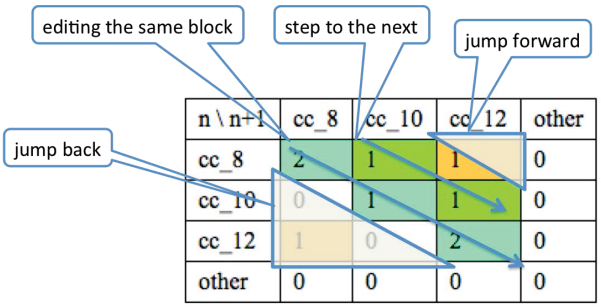

Fig. 5 Figure 5 Co-occurrence matrix of the editing operation.

sitioned to the next field on the right. Cells on these two diagonal lines corresponds to that students wrote from left to right. Positive numbers in cells outside of the two lines corresponds to jumping over to the right or going back to the left. Transitions in that way can be interpreted that the writer had an intension to do so and suggests that those two fields (paragraphs) have close relationship for the writer. Actually, the instruction above the field "cc_8" is "What is a logical presentation?" and the one above "cc_12" is "comments on your group's presentation from the points of view for planning and implementation". so those two fields seems to have close relationship.

2.2 Collecting and analyzing learning process data

In educational engineering, Learning Analysis (LA) has been extensively studied to improve study and education by collecting learning activity data and analyze them [9]. Those activities are logging into educational systems (ex. Learning Management System, ePortfolio, SNS), browsing learning materials, submitting reports, and so on [9] [10]. There are few such studies collecting and analyzing writing activity.

In the studies of reading activity, split text into paragraphs, asign those paragraphs to pages, record readers page transitions, calculate time to read paragraphs [7]. From these records, reading patterns of learners are visualized, correlation with grades are investigated, reading activity models are designed [11] [12] [13]. They evaluated comprehension level for learning materials by three-choice-questions and free-description problems. Unlike us, In those analysis temporal orders are not considered.

2.3 Issues: relationship between editing activities and the output text

We have two issues.

In our previous research, we analyzed the relation between logical writing ability and programming ability, and it turned out that each ability has similarity. However, in order to foster logical writing power and programming skill, it is not enough to analyze the relationship between the respective results. It is necessary to analyze the relationship between thought process and creation process and good or bad result (Issue 1). In this research, only the composition is subject to analysis.

On the other hand, in our previous research, we recorded writing activity as editing operations on Topic Writer tool and visualize those activity as a temporal co-occurrence matrix. For the group of students whose scores of evaluation for logical construction, the co-occurrence matrix shows that the number of editing operations was large, they tend to jump forward over or go back to edit paragraphs at the remote position [4]. But to analyze their correlation statistically that activity we need some ingenuity: editing activities are discontinuous event series (point process), and evaluation score for output text is scalar data (Issue 2).

3. Approach

For issue 1 in 2.3 For issue 1, we have tried to analyze the relationship between the writing activity and evaluation scores of the output text: use an editing tool which records editing operations in writing classes, and score the output text from several points of view whether it is logical and easy-to-understand.

For issue 2, if we have a scalar index derived from co-occurrence matrix of text editing operations, it become easier to analyze the relationship between the writing activity and the score of the text. The index should have a property that when the next editing target is near then that index value is low, and when it is far from the previous target then that index value is high. If a writer tried to make two parts coherent which are far away from each other, he/she often edit those parts successively, then this index gives high score for that editing pattern. For example, a purpose and conclusion sections are positioned far away in a text and should be coherent with each other. This property is based on our experiences as a technical writer or a magazine editor. We call it Editing Operation Indicator (EOI). EOI is a weighed sum of co-occurrence matrix and defined by formula (2.1). In (2.1) m_{ij} expresses the value of the cell in row i and column j in the matrix. w_{ij} is a weight for m_{ij} defined by formula (2.2).

In the formula (2.2), the weight w_{ij} is $2(j-(i-1)1)$ when $i < j$, 0 when $i = j, 2(i-(j-1)-1)$ when $i > j$. When editing the same field in the next operation, the weight is zero. The farther the edited field is, the heavier the weight. When editing the field back in the left side, more heavier the weight. (2.2) is expressed by a concrete numerical value in the formula (2.3).

4. Preliminary Experiment

We made a preliminary experiment in small number of students to see the relationship between the writing activ-

$$\mathrm{EOI} = \sum_{i=1,j=1}^{n} w_{ij}\, m_{ij} \tag{2.1}$$

$$w_{ij} = \begin{cases} 2(j-(i-1)-1), i<j \\ 0, i=j \\ 2(i-(j-1)-1), i>j \end{cases} \tag{2.2}$$

$$w_{ij} = \begin{pmatrix} 0 & 1 & 3 & 5 & \square & \square & \square & \square & 2(j-1)-1 \\ 2 & 0 & 1 & 3 & \square & \square & \square & \square & \square \\ 4 & 2 & 0 & 1 & \square & \square & \square & \square & \square \\ 6 & 4 & 2 & 0 & \square & \square & \square & \square & \square \\ \square & \square & \square & \square & \ddots & \square & \square & \square & \square \\ \square & \square & \square & \square & \square & \ddots & \square & \square & 5 \\ \square & \square & \square & \square & \square & \square & \ddots & \square & 3 \\ \square & \square & \square & \square & \square & \square & \square & \ddots & 1 \\ 2(i-(j-1)-1) & \square & \square & \square & \square & 6 & 4 & 2 & 0 \end{pmatrix} \tag{2.3}$$

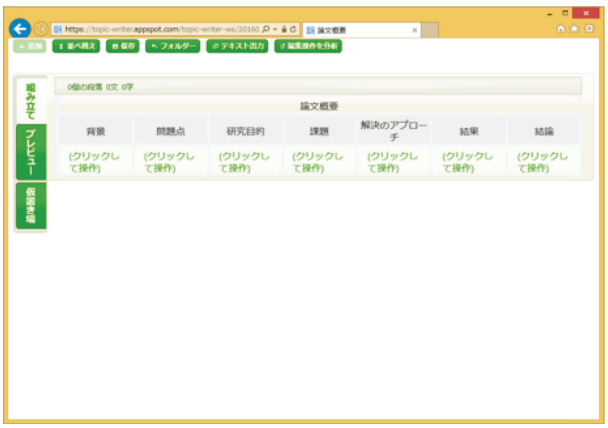

Fig. 6 Figure 6 Screenshot of worksheet for graduation thesis abstract.

ity and evaluation score. The outline of the experiment is explained in this section.

4.1 Outline of the experiment

4.1.1 Subjects and task

In the experiment, seven students in a writing classes for the 4th grade at Future University Hakodate were selected as subjects. They wrote the outline of the graduation thesis in from 400 to 600 characters.

4.1.2 Worksheet

A worksheet for graduation thesis is prepared for Topic Writer. A worksheet for graduation thesis is prepared for Topic Writer. It is consists of seven fields to fill in: background, problems, purpose, tasks, approach, result and conclusion **Fig. 6**.

4.2 Evaluation criteria for the text

The output texts are evaluated in four grades in these four points of views whether it is logical and easy-to-understand [4].

a. logically organized
b. described concretely
c. does not contain unnecessary information
d. short sentence, one thing in one sentence

Text are evaluated into 4 grades of score:

1: Bad
2: Slightly bad
4: Good
5: Excellent

This evaluation criteria is based on the ”chapter 2: write to be easy to understand” and the ”chapter 3: write not to be misunderstood” of Japanese Style Guide by Japan Technical Communicator Associationbib17.

4.3 Editing Operation Indicator (EOI)

Writing activity is expressed by EOI defined in 2.3 which is calculated by formulae from (2.1) to (2.3).

4.4 Experiment Procedure

Experiment procedure will be shown. All texts are edited by Topic Writer.

(1) Writer (subject, student) creates initial text.
(2) Teacher reviews the initial text of (1), and send the result to the writer. Teacher evaluate and set score to the text according to the criteria in section 4.2. This scores are hidden to the writers.
(3) Writers rewrote the texts based on the review results (2) from the teacher.
(4) The teacher evaluate and set scores to the revised text according to the criteria in section 4.2.
(5) EOI's are calculated for the initial and revised texts by the co-occurrence matrix from Writing Analytics.
(6) The correlationship is analyzed between the EOIs in (5) and the evaluation scores for both the initial texts in (2) and the revised one in (4). Here, it is tested using the Spearman's rank correlation coefficient (significance level 5%). The reason for using the Spearman rank correlation coefficient (hereinafter referred to as simply correlation coefficient) is that the experimental data does not follow a normal distribution, and the evaluation scores are ordinal data.

4.5 Relationship between the scores for the texts and EOI's for the writing activities

The correlation coefficient between the scores for the initial texts and the EOI at the time of creating it (hereinafter referred to as EOI1) and the P-value of the test result will be shown in **Table 1**. In Table 1 In the table, the values in the rows from 2nd to 5th are the scores of the texts and correspond to the evaluation criteria a to d. The sixth row is the evaluation value EOI1 for the editing operations for the initial text. The correlation coefficient between the evaluation scores for each evaluation criterion and the EOI1 is shown at the right end of rows in from 2nd to 5th rows.

The correlation coefficient between the scores for each evaluation criterion and EOI for the revised texts at the time of correction (hereafter referred to as EOI2) and the P-value of the test result are shown in **Table 2**.

The correlation coefficient between the improvement of the scores and EOI2 and the P-value of the test result are shown in **Table 3**. The improvement score is obtained by subtracting the scores for the initial editing from the scores for the revising.

Table 1 Table 1 Relationship between the evaluation scores of the initial texts and EOI1.

N=7	Initial Evaluation	A	B	C	D	E	F	G	Correlation Coefficient	p-Value
a	Logical Configuration	3	4	3	2	2	4	3	0.19	0.68
b	Specific Description	2	2	3	3	4	2	3	−0.23	0.62
c	No useless sentences	2	3	3	3	2	4	3	0.17	0.58
d	Simple Sentences	2	4	2	3	3	2	3	0.23	0.65
	EOI1	15	19	8	33	6	25	40		

Table 2 Table 2 Relationship between the evaluation scores of the revised texts and EOI2.

N=7	Final Evaruation	A	B	C	D	E	F	G	Correlation Coefficient	p-Value
a	Logical Configuration	2	4	3	3	3	3	4	0.00	0.00
b	Specific Description	3	4	3	4	4	4	4	0.16	0.73
c	No useless sentences	3	3	3	2	3	3	3	0.41	0.36
d	Simple Sentences	3	3	2	3	2	3	3	−0.16	0.73
	EOI2	23	5	17	11	69	25	75		

Table 3 Table 3 Relationship between the improvement scores and the EOI2.

N=7	Improbemet Degree	A	B	C	D	E	F	G	Correlation Coefficient	p-Value
a	Logical Configuration	−1	0	0	1	1	−1	1	0.48	0.28
b	Specific Description	1	2	0	1	0	2	1	−0.14	0.77
c	No useless sentences	1	0	0	−1	1	−1	0	−0.08	0.87
d	Simple Sentences	1	−1	0	0	−1	1	0	−0.19	0.68
	EOI2	23	5	17	11	69	25	75		

4.6 Analysis for the relationship between the scores for the texts and EOI's

From Table 1 the relationship between EOI1 of the initial editing operations and the evaluation scores for them is all p >0.05. As a result, no correlation can not be denied and correlation is not recognized.

From Table 2 the relationship between EOI2 of the revising operations and the evaluation scores for them is all p >0.05. As a result, no correlation can not be denied and correlation is not recognized.

From Fig. 3 the relationship between EOI2 of the revising operations and the improvement scores for them is all p >0.05. As a result, no correlation can not be denied and correlation is not recognized. However, it turns out that there is a slight correlation in the evaluation criterion a. It can be presumed that it is because it is necessary to edit remote fields to organize fields logically to improve whole text for the evaluation criterion a.

From the above, the following can be said about EOI of formula (2.2).

(1) Correlation could not be found in the relation between EOI at the time of creating the initial text and the evaluation score of them.

(2) Correlation was not found in relation between EOI after the review and the evaluation score of the revised text.

(3) The relationship between EOI after the review and the improvement score did not show a remarkable correlation. However, it seems to be able to grasp the improvement of logical organization by observing EOI. That is, when the EOI at the time of revising is observed high, there is a possibility that it can be estimated that logical organization of text is improving.

As a reason for not being able to find a remarkable relationship, it is conceivable that the number of data was extremely small.

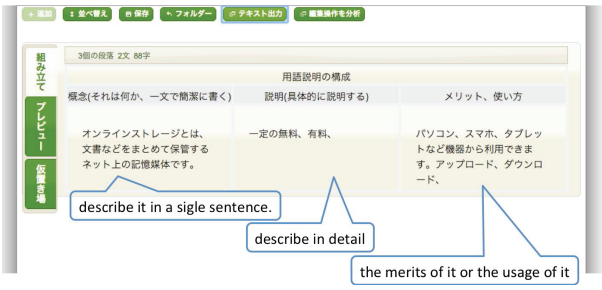

Fig. 7 Figure 7 Screenshot of worksheet for graduation thesis abstract.

For the initial document, the average of the score of each evaluation criterion was 3.0 points. For the revised text, the average score was 3.5 points. That is, by reviewing, the average score of each score improved by 0.5 (17%).

5. Experiment

The purpose of this experiment is to increase the number of data and analyze the relation between the editing operations of texts and the evaluation scores. The outline of this experiment is described below.

5.1 Subjects and ouline

5.1.1 Subjects and task

In this experiments, subjects were 38 students in business writing class in 3rd- and 4th grade in Otsuma Women's University. The theme of the writing task is "glossary" of "smartphone". Text must be written within 200 characters. The supposed reader of the text is a person in 60's who has never used smartphones but feature phones (Garakae).

The experimental procedure is basically the same as the preliminary experiment. The following two points are different.

(1) Review is performed by peer review of students. One text should be reviewed by two or more students.

(2) Evaluation of texts by teacher is based on Rubric.

5.1.2 Worksheet for the experiment

Fig. 7 illustrates the worksheet for glossary which is a public worksheet of Topic Writer. This worksheet consists of three fields: definition of the concept, explanation, merit/usage.

5.2 Evaluation criteria for text

Table 4 is the rubric for evaluating the text by teacher. Output text is evaluated from the two groups of points of views: construction (or logical organization) and expression (easy-to-understand). Each group consists of three criteria, totalling six criteria. Each criterion evaluates text in three levels.

The three levels of evaluation are scored at the following three grades.

3: Excellent
2: Standard
0: Improvement needed

This evaluation criteria improves the ambiguity of the

Table 4 Rubric. Originally written in Japanese.

Perspective		Excelent	Standard	Improvement needed
Contruction	a. Dfinition	Terminology is briefly defined in the first sentence.	There is a definition of the term, but it is not a brief sentence.	The term is not defined.
	b. Specific Discription	It is a specific discription.	Described, but the concreteity is somewhat poor.	Specific description is not written.
	c. Desctiption of Merit	The merits are written clearly.	Although the merits are written, it is hard to understand.	The merits are not written.
Expression	d. Suitable Expression	Choose a phrase suitable for the reader, and it is easy to write.	A phrase suitable for the reader has not been chosen. Or there is a few problem.	Phrases and expressions do not match for readers.
	e. Simple Setences	One sentence is short, simple and clear.	There is one sentence whose sentence is not short, simple or clear.	There are two or more sentences whose sentences are not short, simple or clear.
	f. Unification of Expression	There is no wrong word, and the expression is unified.	There is one place where there are a wrong word and parts where the expression is not unified.	Words of mistakes and places where expressions are not unified are located several places.

evaluation in the preliminary experiment [15]. And it is made taking into account the theme ”glossary” of the text.

5.3 Editing Operation Indicator (EOI)

EOI is calculated from formula from (2.1) to (2.3).

5.4 Procedure

The procedure of the experiment is the same as 4.4 The difference is that the theme of the text is ”glossary” and peer review by students. Texts were to be reviewed by two or more students.

5.5 Relationship between evaluation scores and EOI of text

The correlation coefficient between the evaluation scores and EOI for all the editing operations of all students are calculated. The initial text and the revised text after the peer review are evaluated by the six criteria from the rubric. EOI is calculated separately for the initial editing and revising **Table 5**, **Table 6**, **Table 7**.

(1) Correlation coefficient between the evaluation scores and EOI (hereafter referred as EOI1) for the initial editing.
(2) Correlation coefficient between the evaluation scores and EOI (hereafter referred as EOI2) for revising.
(3) Correlation coefficient between the improvement scores and EOI2. Here, improvement score is the score for revised text subtracted by the score for the initial text.

Table 8 shows the average points of improvement scores, EOI1 and EOI2. **Fig. 8** shows the distribution of improvement scores. **Table 9**, **Table 10** shows the distribution of EOI1 and EOI2.

Table 5 Table 5 Relationship between the evaluation points of the initial sentence and EOI1.

N=38	Initial Evaluation	Initial Evaluation - EOI1	p-Value
Contruction	a. Dfinition	0.078	0.64
	b. Specific Discription	0.060	0.73
	c. Desctiption of Merit	0.039	0.81
Expression	d. Suitable Expression	0.11	0.49
	e. Simple Setences	0.26	0.12
	f. Unification of Expression	-0.12	0.46

Table 6 Table 6 Relationship between the evaluation points of modification sentences and EOI2.

N=38	Final Evaruation	Final Evaluation - EOI2	p-Value
Contruction	a. Dfinition	0.28	0.087
	b. Specific Discription	0.22	0.19
	c. Desctiption of Merit	0.13	0.94
Expression	d. Suitable Expression	0.05	0.77
	e. Simple Setences	0.21	0.20
	f. Unification of Expression	0.010	0.55

Table 7 Table 7 Relationship between the degree of improvement and the EOI2.

N=38	Improbemet Degree	Improvement Point - EOI2	p-Value
Contruction	a. Dfinition	0.38	0.020
	b. Specific Discription	0.16	0.34
	c. Desctiption of Merit	-0.025	0.88
Expression	d. Suitable Expression	-0.27	0.10
	e. Simple Setences	-0.017	0.92
	f. Unification of Expression	0.14	0.40

Table 8 Average of Improvement and EOIs

	Improvement	EOI1	EOI2
Avarage	2.3	7.2	5.3

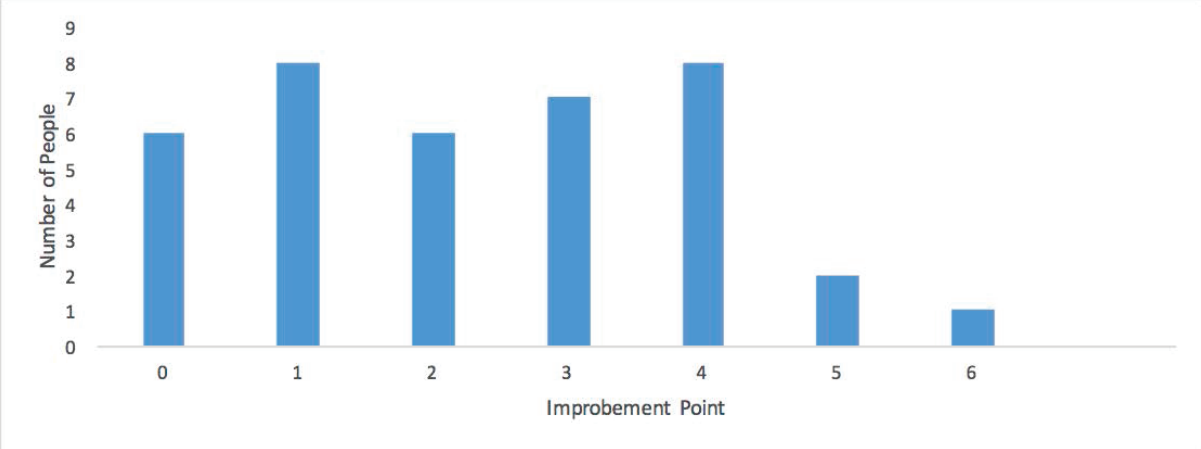

Fig. 8 Distribution of improvement scores of students

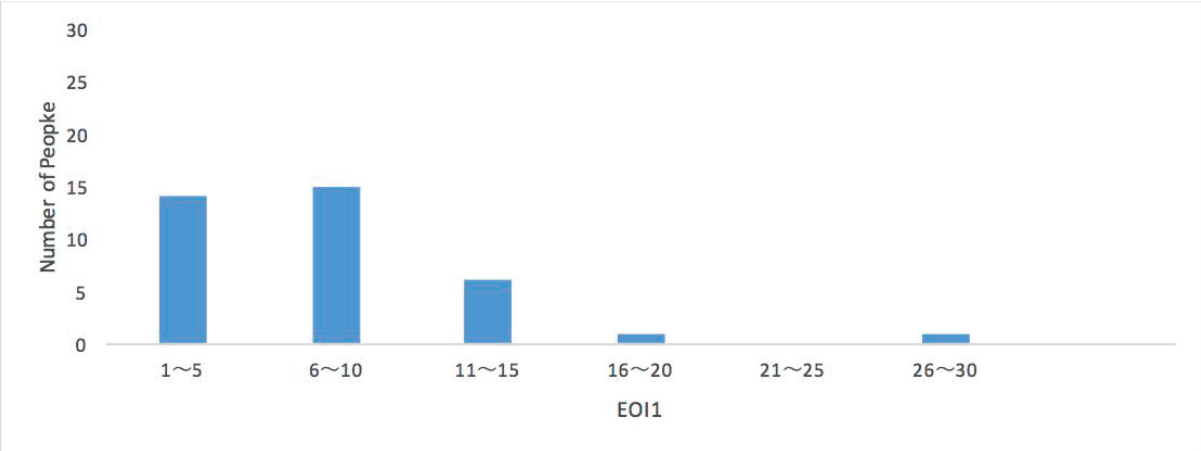

Fig. 9 Distribution of EOI1 of students

5.6 Correlation analysis for evaluation scores and EOI

From Table 5, the relationship between EOI1 and the evaluation score for the initial text is all p >0.05. From these, no correlation can not be denied and correlation is not recognized.

From Table 6, the correlation between the EOI2 and the scores for the revised text is p >0.05. From these, no correlation can not be denied and correlation is not recognized.

From Table 7, the relationship between EOI2 and the improvement scores is p >0.05 in the evaluation criterion ”a Definition”. For this criterion, the correlation is rejected at the significance level of 5% and it can be said that there is a correlation. For all others criteria, p >0.05. From these, uncorrelation can not be denied except correlation and correlation is not recognized except ”a Definition”.

From the above, the following can be said with the EOI of formula (2.2).

(1) In the relation between EOI (EOI2) and the improvement score for the revised text, correlation was found between the criterion ”a. Definition” and EOI. When improving text from the viewpoint of criterion ”a. Definition”, it seems that there are multiple related parts (fields) to be revised. Also, since the definition part is located at the beginning of the text, it can be presumed that it is because it is necessary to operate a more distant part.

(2) Correlation could not be found in the relation between EOI (EOI1) at the time of creating the initial text and the evaluation score for the initial text.

(3) Correlation could not be found in the relation between EOI (EOI2) after the peer review and the evaluation score for the revised text.

One reason that we could only find relationships for one criterion is that the number of data is still insufficient. Also, since the number of fields in the worksheet is as small as three, the possibility that EOI may be disadvantageous, because EOI increases its score when editing a remote part of the text successively.

From Table 8, the average score for the initial text is improved by 2.3 points in the revised text. The average point of EOI1 is higher than the average point of EOI2. In other words, it can be said that text is edited more wide and actively at the time of creating the initial text than at the time of revising. This detail can also be seen from the frequency distribution in Fig. 8 Fig. 9 Fig. 10. In the distribution of improvement shown in Fig. 8, 75% or more students has improved the evaluation scores. From Table 7, there is a

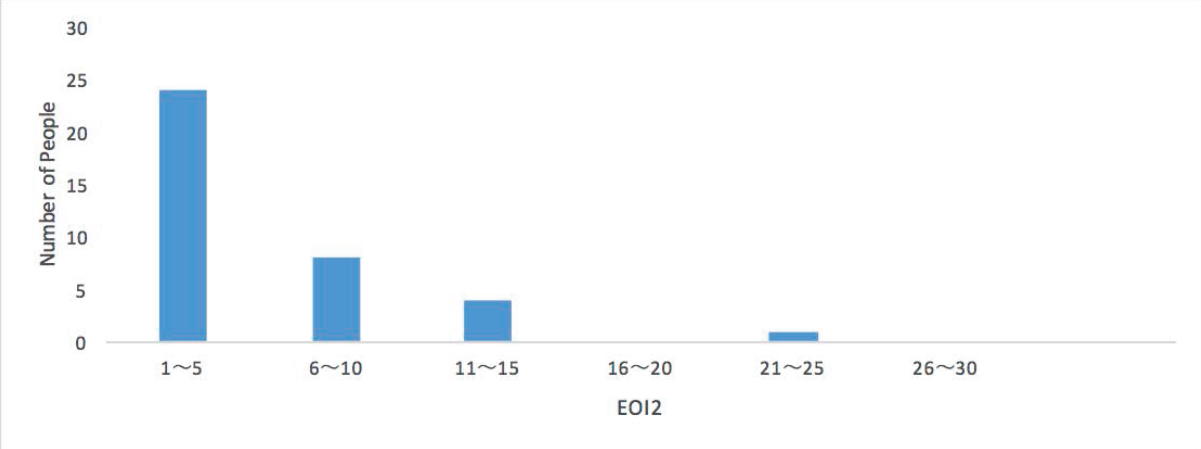

Fig. 10 Distribution of EOI2 of students

correlation between the criterion ”a. Definition” and EOI. From this it can be said that there is a tendency that the evaluation score by criterion ”a. Definition” gets higher if the value of EOI2 is high in revising. In other words, if you know EOI2 in real time at the time of revising after review, you will be able to intervene in a timely manner for students. Specifically, it is conceivable to give timely advice to students whose EOI2 value is less than 10 in Fig. 10

On the other hand, looking at each criterion, the evaluation score average in the initial text was 1.9. In the revised text, the evaluation score average was 2.3 points. In other words, by review, the average score of each criterion improved by 2.3 points (21%). It turned out that the same improvement as the teacher 's review can be seen even among the students' peer reviews. In the review from faculty members, the effect of improving due to be reviewed can be considered. However, in the case of students peer review, as a result of reviewing the texts of others, there is a possibility that improvement of their own texts could be improved.

6. Conclusion

In writing logically organized texts, we used text editing tool capable of recording editing activities. We introduced a new scalar index EOI (Editing Operation Indicator) for measuring writing activities. We proposed a method to analyze the relationship between writing activity and text evaluation score. We applied the proposed method to two types of actual writing exercises and analyzed the relationship between the evaluation scores of texts and EOI, for the initial text and revised texts based on review. We could not find a relationship in the preliminary experiment, but this can be presumed to be due to the small number of data. In experiments with increased number of data, we could not find a relationship between improvement score and revising operation (revising operation). However, it turned out that the relation with writing activity appears due to the degree of improvement score. These have made it possible to detect text improving situation observing EOI value and change. By using these, we got a prospect that timely guidance for writing will be possible.

Even by students peer review, it turns out that the texts can be improved as much as the review by teachers. It is necessary to clarify in future whether the improvement of texts by peer review is due to being reviewed by others or to do review others.

The theme of the text and the worksheet are different between the preliminary experiment and the experiment carried out this time. Especially, the problem is that there are as few as 3 fields (paragraphs) in the text. A tendency of the relation between the evaluation score of the text and the editing operation could be grasped partially by the new index called the Editing Operation Indicator EOI. We got a prospect that timely writing guidance will be possible by observing this tendency in real time. Furthermore, it is necessary to investigate with more experimental data. If you define another editing operation indicator and perform experiments, another trend may appear. It is necessary to consider the real-time analysis method using EOI, visualization, way to alert, and so on.

We will continue to experiment with writing exercises to elucidate the relationship between editing patterns and good or bad property of text. We consider the method of utilizing the knowledge obtained in the experiment in real time. We also consider variations of mechanism to use for writing instruction.

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