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Note Taking Activity and its assessment in a Blended Learning Environment

Minoru Nakayama1, Kouich Mutsuura2 and Hiroh Yamamoto3

1 Human System Science, Tokyo Institute of Technology, Tokyo, Japan

2 Faculty of Economics, Shinshu University, Matsumoto, Japan

3 Shinshu University, Matsumoto, Japan
nakayama@cradle.titech.ac.jp

"Note-taking" is a popular skill for all types of learning activities. In recent years, the online educational environment has began spreading rapidly at institutes of higher educational, obviating the need for printed materials or written notes. This means that students' ability to take notes may decline and this may influence the success of their learning. In order to examine this phenomenon, students' notes were surveyed during a blended learning course in a bachelor level program at a Japanese university. The course consisted of an online test system and face-to-face lectures using ICT equipment. Participant's learning performance was measured using online tests, written essays and a final exam, in addition to the assessment of their notes. The contributions of note-taking activities were measured using statistical tests. As individual note-taking performance may be based on student's characteristics, these contributions were also examined. In the analysis, metrics of participant's characteristics such as personality, information literacy and learning experience were surveyed. Additionally, lexical features of notes taken were extracted using a text analysis technique, and these features were compared with the grades given. Conceptual mapping of the contents of notes was conducted, and the behaviour of good note-takers is discussed using the extracted results.

Keywords: note-taking, blended learning, learning assessment, learner characteristics, Text analytics

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Introduction

The current learning environment offers various types of learning experiences, such as distance education and asynchronous learning, for university level education and for informal methods of learning [Nakayama & Santiago:2004]. In particular, information communication technologies (ICT) offer many possibilities, therefore this equipment is in high demand for use in conventional education, such as in combinations with black board writing and PC slides or movie presentations. Flexible teaching and learning are possible using these methods. Also, e-learning systems which are supported by ICT and include a learning management system that can provide options such as additional learning materials, including lecture movies and online tests. Learning opportunities can also be extended outside of the lecture room. The online learning environment is a requirement for leading universities world wide, for many kinds of organisations, and for consortia that promote online learning.

Though most learning environments are easy for students to access and use, their learning processes are not simple, and at times are complicated sometimes. For example, frequent slide changes prevent notes from being taken, and online materials sometimes decrease the passion for students to become involved in face-to-face sessions. Conventionally, the lecturer can observe every student's level of motivation and learning situation, since face-to-face conditions exist. There are many methods available for monitoring the learning situation. In some online learning environments, student's access logs are analysed; these analytical approaches are sometimes effective [Ueno:2007] and sometimes not [Nakayama et al.:2009]. The authors have introduced conventional note-taking monitoring into a blended learning environment that is a combination of conventional face-to-face sessions and an online learning system [Nakayama et al.:2010], in order to measure student's learning progress.

Note-taking is a time-honoured and commonly used and skill, and useful even in higher education [Weener:1974]. The functions and effectiveness of note-taking have already been reviewed [Kiewra:1989, Piolt:2005, Trafton:2001], since this activity promotes constructivistic learning [Tynajä:1999]. The Learning performance of note takers has been previously confirmed at the university level [Nye et al.:1984, Kiewra:1985, Kiewra et al.:1995, Nakayama et al.:2010], however, most Japanese university students have little experience about how to take good notes and how to learn using online learning materials. Learning performance may depend on their note-taking ability. In particular, information and language processing skills are directly related to learning activity. Also, self-learning may affect the ability to manage the level of their academic success. This

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topic has conventionally been discussed as aptitude treatment interaction [Cronbach & Snow:1977]. This term means the student's characteristics contribute to their learning behaviour. Those relationships are keys to revealing students' learning processes and to improving the overall educational environment.

This article discusses the following topics regarding the above mentioned problems.
- Student's characteristics in a blended learning environment were measured and the relationships between the scores that were compared and note-taking activities were analysed.
- The relationships between the lexical features of the contents of students' notes and the lecturer's notes provided during classes were analysed to discover what student's learning activities were.
- The relationships between features of student's notes and the final exam scores as a measure of learning performance.

2 Method

2.1 Blended learning courses

The surveyed course was a credit course called "Information Networking System", a blended distance education course. Students on two campuses could participate in the lectures, in rooms connected using a two-way audio-visual distance lecturing system.

All participants were bachelor students and all already had some experience studying in a blended learning environment. However, they were not taught any systematic note-taking skills and techniques for this at university. This point will be discussed later.

In this blended learning course, face-to-face sessions with students were conducted for 15 weeks. Students were encouraged to take an online test for each session of study outside of the class room, as a function of the learning management system (LMS). The participants were informed that these online test scores were taken into consideration when final grades were given. Also, students could take these tests repeatedly, until they were satisfied with their results, since online test practice was a part of the reviewing activity of their course. At the end of course, the lecturer took into consideration the final scores recorded by the LMS during marking. Additionally, this course required participants to submit three essay reports

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which summarised knowledge acquired on their own, and to complete additional studies for their final exams.

The number of participants differed. For all survey items, there were 60 participants, and for note content analysis there were 20 participants, due to the limitation of the capacity to manually analyse written notes.

2.2 Note-taking assessment

All participants were distinctly asked to take their own notes during the course and to present their notes every week, as notes were measured for this survey. All notes were scanned and stored as images on a PC. The lecturer quickly reviewed and assessed each set of notes, then immediately returned the notebooks to students. However, students did not obtain any feedback about the evaluation points used regarding their notes. The assessments may reflect the student's note-taking ability.

Of course, the contents of student's notes depends on the information presented during the course sessions. The content presented was created by the lecturer in advance, when the course content was developed. Therefore, these notes can be used as the criterion for the evaluation of student's lecture notes. The content of student's notes was evaluated as "Good", "Fair" or "Poor".

The course was organised with face-to-face sessions, when the lecturer could talk freely about the course topic, and students could take notes freely from the information they received. When students wrote down additional details from the lecture, as mentioned above, the note was rated as "Good" since information was recorded thoroughly. The "Good" also included note-takers who integrated this knowledge with relevant prior knowledge [Mayer et al.:1990], as some pieces of knowledge are related to each other, and some pieces of knowledge are related to relevant prior knowledge. This suggests that several kinds of constructivistic learning activities were used by students.

If a student reproduced the same information in his or her notebook as in the lecturer's presentation, the note taking was rated as "Fair". If any information was omitted, the rating given was "Poor". In a sense, "Poor" note-takers ignored or failed to reproduce the information transmitted in the lecture.

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2.3 Characteristics of students

According to our experience, note-taking activity may be affected by the student's characteristics. Personality traits may also affect this. To test this hypothesis, student's characteristics were measured using three constructs. These constructs were: Personality [Goldberg:1999, IPIP], Information Literacy [Fujii:2007, Nakayama et al.:2008] and Learning Experience [Nakayama et al.:2007]. These last two surveys were conducted after the other two immediately above mentioned studies were published, as the tendencies have been confirmed using additional data from our study.

1. Personality: The International Personality Item Pool (IPIP) inventory [IPIP] was used to measure personality. Goldberg [Goldberg:1999] lists five personality factors which are called the "Big 5" and for the construct of this study, there are five component scores: "Extroversion", "Agreeableness", "Conscientiousness", "Neuroticism" and "Openness to Experience".

2. Information Literacy: Fujii [Fujii:2007] defined and developed inventories for measuring information literacy. The survey used had 32 question items, and 8 factors were extracted: interest and motivation, fundamental operation ability, information collecting ability, mathematical thinking ability, information control ability, applied operation ability, attitude, and knowledge and understanding. This inventory was originally developed to measure information literacy among high school students in many countries. It can also be used to measure the information literacy level of university students [Fujii:2007].

3. Learning Experience: Students' learning experience in a blended learning environment was measured using a 10-item Likert-type questionnaire. This construct measures students' attitudes to blended learning environments. As in previous studies, three factors were extracted: Factor 1 (F1): overall evaluation of the e-learning experience, Factor 2 (F2): learning habits, and, Factor 3 (F3): learning strategies [Nakayama et al.:2007].

3 Result

3.1 Note-taking assessment

The assessment scores of notes are summarised in Figure 1. Note assessments were conducted for 13 of the 15 weeks of the course. According

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to Figure 1, both percentages for "Good" and "Fair" are comparable during the first several weeks, and they enter a "trade-off" situation throughout the rest of the sessions. This suggests that the percentage of note takers rated "Fair" is relatively high because participants voluntarily took notes. In comparing the percentage of "Good" and "Fair" notes with the rates in a fully online course, a blended learning environment encourages note taking during course sessions. Non-verbal communication of the lecturer and the atmosphere of the session may promote students to take notes.

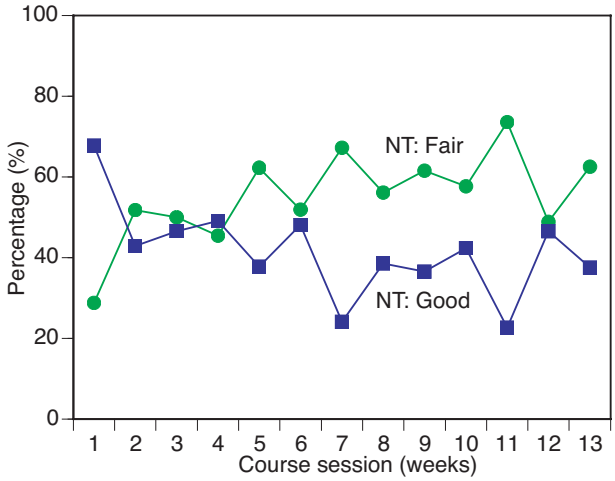

Figure 1. Comparison of percentages for note grades across course sessions.

3.2 student characteristics

The sums of assessment scores for note-taking during the course were calculated using a grading scale, to evaluate each individual student's note-taking ability. To emphasise the differences in note-taking abilities, the students are then divided into two groups, consisting of high and low scores. The scores of the two groups are compared, to measure the contribution of student's attributes and characteristics to note-taking activities. First, students' learning performance from essay report scores, online test scores and final exam scores was summarised by group, in Table 1.

Table 1. Comparison scores of learning performance between two note-taking groups (N=60)

	Note assessment score	
	High(n=31)	Low(n=29)
Report score	0.70(0.19)	0.68(0.13)
On-line test score	98.9(2.1)*	94.7(8.3)
Final exam score	44.8(8.6)	42.4(5.8)
() indicates SD.		
significance level *: p<0.05		

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Although there are no significant differences between the two groups, the scores of on-line tests and final exams for the group of note takers with high scores are higher than those for the group with low scores, the report scores for the low score group are higher than those for the high score group. As a result, note-taking scores did not contribute to learning performance in this course. These tendencies remained the same even when the amount of data increased.

The relationship between a student's personality and note-taking performance was measured. The note-taking scores are summarised across 5 personality factors, in Table 2 using the same format as in Table 1. As shown in the table, there are significant differences in "conscientiousness" between the two groups. This result suggests that some aspects of students' personalities positively affect note-taking activity. To improve student's note-taking performance, this factor should be considered in detail.

Table 2. Comparison scores of personality between two note-taking groups (N=60)

	Note assessment score	
Factors of Learning Experience	High(n=31)	Low(n=29)
Overall evaluation of the e-Learning experience	3.07(0.54)	3.03(0.56)
Learning habits	2.35(0.81)	2.38(0.72)
Learning strategies	3.06(0.67)	3.31(0.80)
5-point scale, () indicates SD.		

The contribution of information literacy was also measured, using the same format. In Table 3, the scores of note-takers are displayed across 8 factors of information literacy. Additionally, the scores are calculated as a summation of information literacy. There are significant differences in note-taking scores for "Mathematical thinking ability" and "Knowledge and understanding" at a 5% level of significance. The effectiveness of these factors was on both note-taking performance groups, and a general tendency cannot be stated using information literacy.

Table 3. Comparison scores of information literacy between two note-taking groups (N=60)

	Note assessment score	
Personality Factors	High(n=31)	Low(n=29)
Extroversion	2.90(0.62)	2.64(0.61)
Agreeableness	3.38(0.45)	3.25(0.48)
Conscientiousness	3.27(0.47)*	2.86(0.47)
Neuroticism	2.79(0.68)	2.73(0.67)
Openness to Experience	3.70(0.59)	3.23(0.45)

5-point scale, () indicates SD.
Significance level *:p<0.05, **:p<0.01

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Table 4. Comparison scores of learning experiences between two note-taking groups (N=60)

	Note assessment score	
Information Literacy Factors	High(n=31)	Low(n=29)
Interest and motivation	3.90(0.74)	3.95(0.74)
Fundamental operation ability	4.21(0.64)	3.96(0.62)
Information collecting ability	3.24(0.80)	2.94(0.74)
Mathematical thinking ability	2.55(0.70)	3.27(0.78)*
Information control ability	3.10(0.73)	2.65(0.76)
Applied operation ability	2.93(0.84)	2.77(0.66)
Attitude	2.89(0.66)	2.71(0.56)
Knowledge and understanding	3.48(0.65)*	2.91(0.59)
Grand total	3.29(0.48)	3.14(0.42)
5-point scale, () indicates SD.		
significance level *: p<0.05		

The contribution of learning experiences such as subjective evaluation was examined, and three factor scores are summarised in Table 4. However, there are no significant differences between the two groups.

Regarding the above analysis, student's characteristics affected note-taking activities in various ways. Since these characteristics also contributed to learning performance, some causal analysis was conducted across their measures [Nakayama et al.:2011]. As the amount of data in the metrics is small, the actual relationship cannot be extracted. Therefore, the overall relationship can be speculated using the detailed results of alternative data sets of which have already been reported in other references [Nakayama et al.:2013a].

4. Note content analysis

4.1 Text analysis of the notes taken

For this section, the number of valid subjects selected randomly was 20, as the data collection process was cumbersome.

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All images of notes taken which had been scanned and stored were manually converted into digital text files. The work consisted of reading hand-written characters and typing the notes or words, excluding figures. Since character reading systems could not be used for this work, the data was transcribed manually. The lecturer's notes were also scanned and transcribed. Using this process, text files for each individual and each session were created.

Using natural language processing techniques, nouns and adjective terms were extracted from every file using a Japanese morphological term analysis tool [MeCab]. The text files of students and the lecturer were merged together. As a result, a term-document matrix (X) and term frequency vectors were created for each class session (13 sessions). To extract the features of terms, the latent semantic indexing (LSI) technique was used. The features of the terms and the course sessions were extracted from the term-document matrix of the notes taken in each class using SVD (singular value decomposition analysis) [Deerwester et al.: 1990] as follows: X = TSD. The term feature matrix (T) contains feature vectors of each term. The feature vectors of note documents (N) for each class session (i) were calculated for the lecturer and for each student using a summation of term feature vectors (T) which was weighted according to term frequency (Fi) in a class (i), therefore, Ni = TFi. Regarding the above process, the vectors of features of notes were calculated, and can be used in a quantitative comparison of notes taken.

4.2 Features of notes

The contents of notes taken by students are related to, the content of the lecturer's presentations, and the relationship between the number of terms of the students and the lecturer is summarized in Figure 2.

In Figure 2, the horizontal axis shows the number of terms the lecturer presented in each course session, and the vertical axis shows the means of terms students recorded. The means for "Good" and "Fair" note takers are respectively calculated. The error bar shows the standard error of the means. Regarding the relationship, the diagonal line in the figure shows a kind of transmission performance, using the same number of terms which the lecturer presented and students wrote down.

Both the numbers and means of terms for "Good" note takers are always higher than the numbers and means for "Fair" note takers, while the number of terms for "Fair" note takers is almost always the same as the number of terms given by the lecturer, because these plots are distributed along a diagonal line. In particular, the number of terms for "Good" note takers

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stays high even when the number of terms in the lecturer's notes is low. For example, students in the high group constantly write down 150-200 terms even when the lecturer presents less than 100 terms.

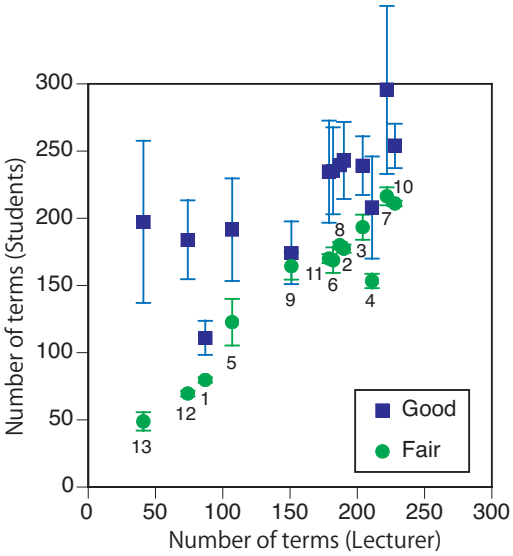

Figure 2. Comparison of the number of terms presented by the lecturer and taken by the student

According to Figure 2, the "Good" note takers record more terms. The number of terms these students record is almost always higher than the number of terms provided by the lecturer. To examine the relationship between the terms the lecturer presented and the terms students recorded, two indices are introduced, as follows.

- Word ratio: the ratio of written terms in comparison with the number of lecturer's terms (the number of terms students recorded / the number of terms the lecturer presented)
- Coverage: coverage ratio was calculated as a percentage of the number of terms recorded by students.

Both indices were calculated for each student, and mean and standard errors for each session are summarised in Figure 3. The horizontal axis shows word ratio, the vertical axis shows coverage. Both mean and standard errors are compared between "Good" and "Fair" note takers. As Figure 3 shows, the coverage increases with the word ratios around where the word ratio is 1.0, and the coverage for "Good" notes is usually higher than the coverage for "Fair" notes. Also, for some sessions "Good" note takers show the prominence of word ratios while they maintain high coverage. Therefore, "Good" note takers repeatedly record some of the same words

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in their notes. As noted above, good note takers wrote down many more terms than the lecturer presented. In the blended course learning the word ratios deviated widely. Additionally, "Fair" note-takers did not completely reproduce all of the terms, thus the coverage was distributed between 0.7 and 0.8:1.

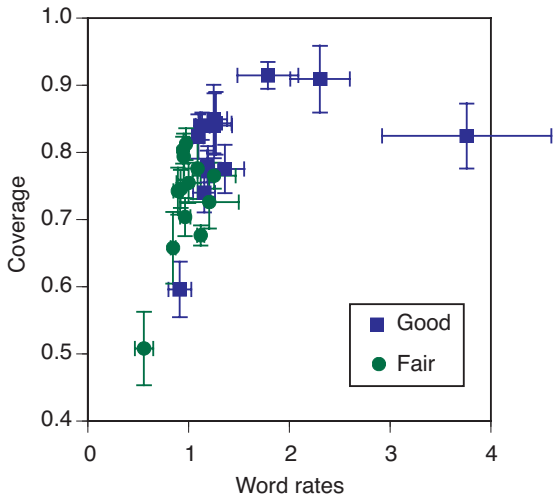

Figure 3. Relationship between word ratios and coverage (N=20)

Regarding note-taking statistics, most students successfully reproduced the conceptual contents presented by the lecturer. To determine the relationship between the conceptual presentation of contents of student's notes and the contents presented by the lecturer, the features of the contents were compared. These features were calculated using the term frequency and the term features which were extracted from the LSI model mentioned above. Every feature of student's notes and the lecturer's presentation is given across each of the 13 sessions is given. A two dimensional graph of the feature vectors is illustrated in Figure 4. The horizontal axis shows the first component, and the vertical axis shows the second component. The features of notes for "Good" and "Fair" note takers and for the lecturer are displayed separately. Also, the number of the session is indicated. As the geographical distance shows a degree of dissimilarity of the notes, most sessions form clusters. In some sessions, features of notes for students and features of the lecturer's notes are concentrated in one area, although the features were calculated using the both grades of note assessments.

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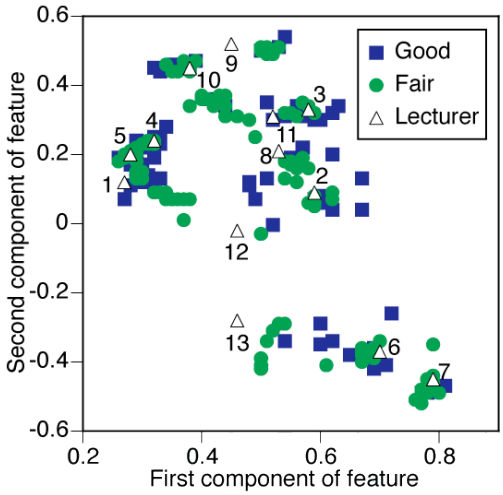

Figure 4. Conceptual map for students' and lecturer's notes (N=20+1)

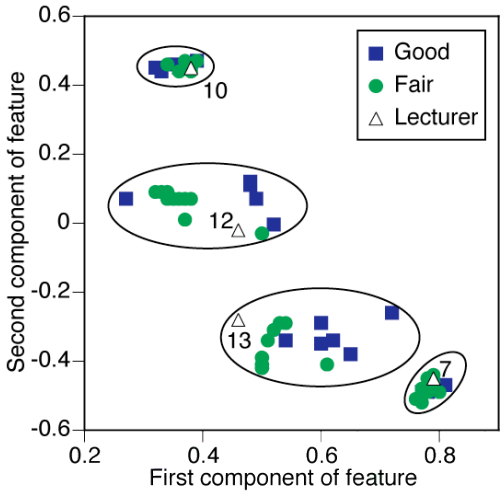

Figure 5. Conceptual map for typical sessions (N=20+1)

Four typical sessions are focused on in Figure 5. As the plots for sessions 7 and 10 produce small clusters, they are similar to each other and also similar to the lecturer's notes, while there is little difference between the two groups of grades. Contrary to this tendency, the plots for sessions 12 and 13 are distributed. The plots for "Fair" notes are located near the plots for the lecturer's notes, while the plots for "Good" notes are more widely distributed. The "Good" note-takers created original concepts from the lecturer's presentations. These tendencies depend on the number of terms which appear in the session, since the features converge into one value when the number of terms is large. The number of terms for sessions

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12 and 13 is relatively small in Figure 2, and the deviations of plots are relatively large in Figure 5.

4.3 The relationship between features of note-taking and scores of final exams

The impact of note-taking behaviour, such as word ratios and coverage of notes for test scores, needs to be measured since student's note-taking activity may contribute to their learning performance. For this analysis, overall individual means across sessions were calculated as features of notes, sums of note grade scores, and means of online tests.

A correlation analysis was conducted using the above indices. The coefficients are summarised in Table 5. All coefficients for scores of final exams are positive and significant ($p<0.05$) while all coefficients for online tests are not significant. Note-taking activity, including word ratios and coverage values contributed to the scores of final exams as a measure of overall performance.

Table 5. Correlation coefficients between note indices and test scores.

	Word ratio	Coverage	Note assessment
Final Exam	**0.56**	**0.43**	**0.46**
Online test	(0.23)	(0.18)	(0.07)

Bold : $p<0.05$, (): not significant

4.4 The contributions of note-taking assessment

For a detailed analysis on the relationship between final exams and features of note-taking, the relationships between the two note-taking assessment groups were compared. The relationships between word ratios and final exams for high and low note-taking groups are illustrated in Figure 6. The word ratios are distributed around 1.0, and there are positive correlational relationships. Further analysis reveals that the correlational relationship for the low group is significant ($r=0.72$, $p<0.05$) while the relationship for high group is not significant ($r=0.55$, $p=0.08$). As shown in Figure 6, most word ratios are around 1.0 when the scores of final exams are less than 50%. Some word ratios of the high group deviate widely when the scores of final exams are higher than 50%. In particular, the scores of final exams are high when the participants recorded higher word ratios during

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lectures which presented fewer terms. Therefore, note-taking skills may affect the scores of final exams.

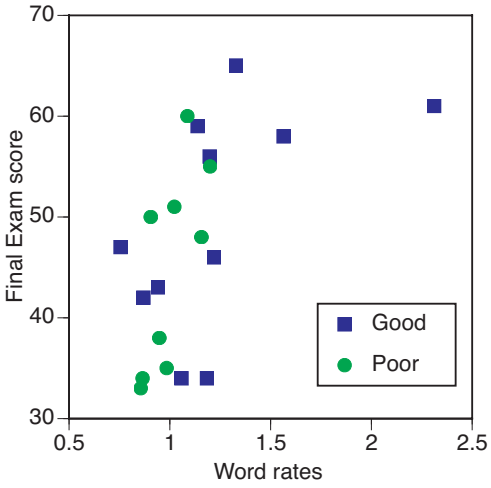

Figure 6. Relationship between word ratios and final exam scores

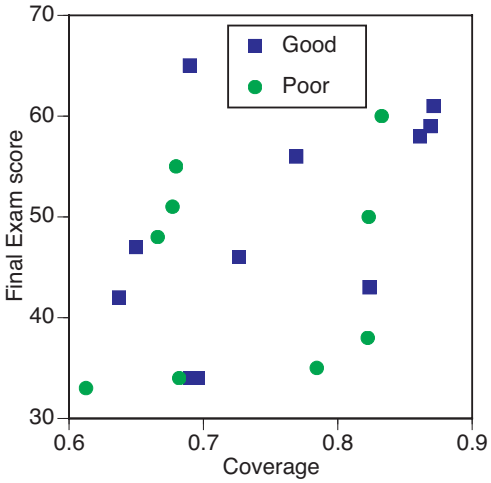

Figure 7. Relationship between coverage and final exam scores

The relationships between coverage and final exams for high and low note-taking groups are illustrated in Figure 7. As the figure shows, there is a positive correlational relationship. However, every correlational coefficient is not significant for the high group ($r=0.53$, $p=0.09$), nor for the low group ($r=0.26$, $p=0.50$). Therefore, the contribution of coverage for final exams may not be significant but word ratios are. This suggests that any increase in the number of terms students record, including terms related to

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the lecture, does not occur, inspire students to record additional terms, or affect the scores of final exams.

5. Conclusion

In order to examine the learning progress and improve learning activity in a blended learning course, an assessment of note-taking ability was conducted. This assessment examined student's characteristics and lexical features of notes they took during a blended learning course.

The relationships between note-taking assessment and metrics of students characteristics were analyzed, and some contributing factors were extracted. Notes taken by twenty student's during the course and features of lexical information extracted from these and comparable to the lecturer's notes were analysed. The relationships between the number of terms and coverage of notes given by lecturers and recorded by students was examined. The resulting features of "Good" notes were high-lighted. The relationships between final exam scores and features of notes were analysed, and the contributions of note taking features were measured.

6. Practical conclusion for future academics

As mentioned in the introduction, note-taking is a very popular learning activity in our daily lives. The effectiveness of note-taking activity should be recognized and the benefits of note-taking extended to various other learning activities. The authors have also confirmed the additional effectiveness of note-taking activity in the following ways.

First, student's characteristics, which have been discussed in this chapter, quantitatively affect their learning activities, and the relationship can be evaluated using causal analysis, such as a structural equation modelling (SEM) technique [Nakayama et al.: 2012b]. Student's additional characteristics, such as note-taking skills, are defined using student's responses to designated questionnaires and the factor structures of note-taking skills. These consist of three factors: NT-F1: Recognising note taking functions, NT-F2: Methodology of utilising notes, NT-F3: Presentation of notes [Nakayama et al.: 2013b, 2013c]. The assessment of note-taking activities also facilitates measurement of learning activity even in fully online courses, which do not have face-to-face sessions [Nakayama et al.: 2013b, 2013c]. These results suggest that writing activities such as taking notes contribute to various types of learning, as previous conventional studies about note-

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taking have reported [Kiewra: 1989, Nye et al.: 1984, Trafton & Trickett: 2001].

Second, a detailed lexical analysis of the contents of notes taken can create indices of note-taking activity, as they provide further opportunities for evaluation [Nakayama et al.: 2016]. Since this information may reflect student's actual learning behaviour, university course final exam scores can be estimated using these indices [Nakayama et al.: 2015].

The above results suggest that students should be encouraged to merely taking notes and to sharpen their note-taking skills in order to improve their study habits. The effectiveness of introducing note-taking activity has been discussed above, and that the activity is based on a constructivistic learning theorem. Therefore, note-taking may promote self-directed learning methods, such as active learning. The authors are currently investigating the impact of note-taking activity on students' emotional condition.

Again, note-taking is a basic learning skill. Even in team or group learning, this skill as well as other generic skills are key [Nakayama et al.: 2012c]. The skill of note-taking is often used in project based, and informal learning, since project management requires appropriate lexical record-taking and communication using notes.

Though creative design or creating works of art are often recognized as non-verbal activities, the “design thinking” process and its learning opportunities [Lugmayr et al. 2014] have been studied. By analysing the design thinking process, conventional behavioural learning and human information processing [Rowe, 1987], which are based on project management, can be enhanced [Lugmayr: 2012]. If verbal information plays a major role, even in non-verbal activity, the observation of both note-taking activity and note-taking skills may facilitate students' creative output beyond academia.

An example of an instruction set for promoting note-taking has been discussed [Nakayama et al.: 2016], and various types of additional approaches should be considered in order to enhance learning activity so that the overall body of knowledge in individual disciplines can be further developed.

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IJNCAA [Nakayama et al.: 2011] and as a JSET short letter [Nakayama et al.: 2012a].

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