Impact of Learner's Characteristics and Learning Behaviour on Learning Performance during a Fully Online Course

Minoru Nakayama[1], Kouichi Mutsuura[2] and Hiroh Yamamoto[1]
[1]Human System Science / CRADLE, Tokyo Institute of Technology, Tokyo, Japan
[2]Faculty of Economics and Graduate School of Engineering, Shinshu University, Matsumoto, Japan
nakayama@cradle.titech.ac.jp

Abstract: A fully online learning environment requires effective learning management in order to promote pro-active education. Since student's notes are a reflection of the progress of their education, analysis of notes taken can be used to track the learning process of students who participate in fully online courses. This paper presents the causal relationships between student's characteristics, note-taking behaviour, learning experience, note assessment and test scores while the relationships between these metrics is examined. A fully online course for undergraduate students in Economics was conducted. Participants were asked to study each course module and present their notes to the lecturer every week. The student's learning performance was then measured using online tests, weekly confirmation tests, and a final exam. The total number of valid participants in the courses was 53. Three factors of note-taking behaviour were extracted according to the survey, and their relationships with other metrics were calculated. A structural equation modeling technique was used to track student's learning activity as note-taking occurred, using the scores of their metrics. The results of this modeling technique suggest that key factors and their contributions to test scores can be measured. Also, the factors which contribute to note-taking behaviour were examined.

Keywords: Note taking, Fully online course, Learning assessment, Causal analysis

1. Introduction

The online learning environment is expanding throughout educational institutions around the world, including universities. In particular, this is occurring at universities which offer courses internationally. Online learning mostly consists of blended learning and fully online courses. Blended learning primarily employs face-to-face sessions, including distance learning/lecturing sessions, and online materials are also provided to students. Fully online learning has no face-to-face sessions, and most learning processes are provided through an online environment. Therefore, this type of instruction can present students with freedom from learning restrictions. Also, as the online learning environment supports student's studies, some benefits and improvements in learning activities have been reported (National Institute of Multimedia Education, 2005). They are recognised as significant learning tools.

Recently, Open Educational Resources (OERs) which are learning materials developed for online courses have come to be used widely by students and others studying using this type of technology. This trend is spreading world-wide (OECD, 2007). Currently, a new concept for online educational delivery known as Massive Open Online Courses (MOOCs) has emerged. These are available for both blended and fully online courses, and are attracting the interest of both educators and students (Hill, 2012). Though institutes of higher education recognise some potential benefits, the impact on teaching and learning is still being discussed (Gaebal, 2014).
On the other hand, it has often been suggested that a great deal of these participants have difficulty with continuing their education online, exacerbating drop-out rates (Tyler-Smith, 2006). Since the evaluation of the learning process is restricted, online tests and access logs in the case of online courses have enabled analysis up until now (Nakayama, Kanazawa, & Yamamoto, 2009). While the world-wide use of MOOCs as fully online courses has increased rapidly, the course completion rate is still one of the most serious problems impacting their success (Hill, 2012). Therefore, accessing the behaviour of participants for MOOCs has been widely analyzed (Seaton et al. 2014a, Seaton et al. 2014b). However, when instruction is provided, even in a face-to-face blended learning environment, students' evaluations of their attitudes and learning processes can be readily observed.
During a fully online course, which consists of the use of online course materials only and no face-to-face instruction, the restrictions on analysis are much tougher than in a blended learning course. It then becomes difficult to track and evaluate students enrolled in courses such as these, where the course materials are

limited to textbooks and online materials. In particular, the question of how participants learn the course content during a fully online course arises. An effective solution to this problem is therefore needed.
To track each student's learning process, we asked all participants to take notes during the course, and to present them for examination periodically. Since note-taking reflects learning activity (Kiewra, 1985, 1989; Kiewra, Benton, Kim, Risch, & Christensen, 1995; Kobayashi, 2005) and also constructivistic learning (Tynajä, 1999), this information can be used as a significant index of the learning process. Additionally it is well known that learner's attitude, literacy and learning strategies affect their learning performance (Nakayama, Yamamoto, & Santiago, 2007). Some previous studies have identified the causal relationships between these constructs and indices of learning performance, such as test scores (Nakayama, Yamamoto, & Santiago, 2011).
Note-taking behaviour in a blended learning course have been evaluated in a previous survey (Nakayama, Mutsuura, & Yamamoto, 2010). The factors of note-taking behaviour may be related to student's characteristics and test scores (Nakayama, Mutsuura, & Yamamoto, 2011b). This suggests that student's characteristics affect note-taking behaviour and test scores.
To quantitatively determine the relationships, a structural equation modeling technique was used and possible causal analysis was conducted throughout the course.
Our research questions were:

- 1. Are student's note-taking performance and note-taking behaviour related to metrics of learning progress, such as test scores, in a fully online university course?
- 2. Using causal analysis, are there any relationships between the factors of note-taking behaviour and student's personality or information literacy, and the relationships between the factors of note-taking behaviour and learning experience or test scores?
- 3. Is it possible to extract a reasonable causal model based on the extracted sub-models, and to develop a learning model using the effects of student's characteristics on test scores?
- 4. What kinds of support are significant for students who participate fully online courses?

2. Background

2.1 Obstacles to online learning

Online learning or e-Learning is a style of instruction using information technology (ICT) which includes distance learning and conventional teaching/learning activities that use the Internet. The above learning styles use various learning materials, such as web sites, and offer some freedom of study, such as the ability to learn anytime and anywhere. Currently, open educational resources such as Open Course Ware (Dinevski, 2008), which are freely available to learners not enrolled in online courses, are very popular at many universities, and are not only for registered students (National Institute of Multimedia Education, 2005). Fully online courses are becoming popular due to the proliferation of online learning. Since these course can maximise cost-benefits for all (A. W. (Tony) Bates, 2000), both universities and students have an interest in taking advantage of this.

Though most online courses have been well designed using an instructional design methodology, the failure of participants to complete courses is often discussed (Tyler-Smith, 2006). Various factors regarding online learning, such as learning styles and student's characteristics have been discussed in order to provide better courses (Park & Choi, 2009; Cercone, 2008). In particular, internal factors regarding the courses, such as course design, mental factors, such as personality and literacy, and support services, are often focused on (Park & Choi, 2009; Song, Singleton, Hill, & Koh, 2004). One approach analyses behavioural data during online learning. An online course management system can easily gather individual data about the learning process, using access logs and online test scores, as these courses are integrated with a learning management system (LMS). Using this data, the prediction of likely drop-outs (Nakayama et al., 2009), and appropriate advice providing systems have been developed (Ueno, 2004). However, data about participant's behaviour can not explain the actual problems of online learning courses or online learning systems.

2.2 Learner characteristics

Learner's characteristics can be defined as individual mental factors which may affect learning activity (Nakayama & Santiago, 2012). This factor is recognised as a major one, and a significant source of problems related to online learning. Since some characteristics affect online course completion rates and their evaluations (Park & Choi, 2009; Cercone, 2008), these influences should be examined. Of course, this has been

carefully considered in the design of traditional courses, as conventional text books provide discussion (Cronbach & Snow, 1977; Dick, Carey, & Carey, 2005). Recently, a wider range of characteristics, such as motivation, efficacy, thinking style, learning skills and socio-cultural factors, have been introduced to improve online learning (Song et al., 2004; Lim & Kim, 2003; Dabbagh, 2007; Prinsen, Volman, & Terwel, 2007). Learner's fundamental characteristics that may affect learning activity are personality, which is recognised as consisting of 5 factors, information literacy, which is related to the ability to use information technology, and the proper attitude to deal with the content of the information provided. Sometimes, attitudes towards or impressions of the learning environment can be included in the characteristics because they influence the learner's performance. As some student's characteristics, such as scores of final exams affect learning performance, in a formal course, the effectiveness of the factors is evaluated, and the causal relationships between student's characteristics and scores of tests have been analysed (Nakayama et al., 2007; Nakayama, Yamamoto, & Santiago, 2011).

2.3 Note-taking behaviour

"Note-taking" is a popular and conventional skill for all types of learning activities (Weener, 1974). The effectiveness of note-taking has been confirmed at universities and also in primary and secondary schools. The functions and effectiveness of "note-taking" have already been reviewed and discussed (Weener, 1974; Kiewra, 1989; Meter, Yokoi, & Pressley, 1994). In particular, "note-taking" requires cognitive effort because this activity is based on summarising and understanding of the context (Piolat, Olive, & Kellogg, 2005; Makany, Kemp, & Dror, 2009). This process is recognised as constructivistic learning (Tynajä, 1999) while its major effect is called the "Coding effect" (Kobayashi, 2005). The relationship between some factors of note-taking and learning performance in university courses has been established previously (Nye, Crooks, Powley, & Tripp, 1984; Kiewra et al., 1995; Kobayashi, 2005). Also, note-taking styles have been systematically classified (Makany et al., 2009). As note-taking is a common activity for students, many universities provide students with instructions about the functions of note-taking (Penn State Learning, 2009). In addition, some practical aspects have been investigated and discussed, such as the effectiveness of examining test scores and student's note-taking strategies have been discussed (Meter et al., 1994; Tran & Lawson, 2001).
Since educational technologies have introduced overhead and digital slides into lectures, note-taking behaviour has also been affected. When these slides show the critical points of the lecture, students' recording performance is equivalent to a condition using "guided notes" which are a modified version of the instructor's notes or slides (Austin, Lee, & Carr, 2004). Learning using guided notes is effective for quizzes during study class sessions and other learning activities (Austin, Lee, Thibeault, Carr, & Bailey, 2002). Therefore showing slides in classes affects students summarisation of the content to be learned.
Recently, many digital note-taking systems or digital writing systems have been developed to support flexible new methods of learning (Trafton & Trickett, 2001). Most information communication technology (ICT) applications for education promote the minimisation of the cognitive load and the transformation of course content into knowledge (Mayer, Moreno, Boire, & Vagge, 1990; Tam, 2000). These systems provide paper-less learning settings, allowing people to learn using digital files (Dinevski, 2008), which are now commonly provided. With these styles of learning, the effectiveness of note-taking was not clearly apparent (Moos, 2009). This means that many student's ability to take notes may have declined, as they prefer using online methods (Nakayama, Yamamoto, & Santiago, 2008). Some researchers bear this point in mind, noting that no evidence has been provided to prove the phenomena (Kiewra, 1985). This point should be re-evaluated in the current online learning environment.

3. Method

A formal credit course, Information Systems Network, was conducted as a fully online course. The participants were junior and senior undergraduate students in Economics at a Japanese national university. The total number of valid participants was 53. The online course consisted of modules with slides, audio files and online tests. An example of a slide is shown in Figure 1. When a student starts the slide show, he or she can join the ordinary lecture, which consists of slides and audio instruction. Of course, students can stop and replay the slide show, and rejoin repeatedly. The only printed material was a textbook, and there were no face-to-face sessions during the course.

Participants were asked to take notes freely throughout the course, without any specialised instructions. They know well that good note-taking behaviour may contribute to their own learning performance and they also have developed their own note-taking habits. All students were provided with a conventional notebook for this

survey. They were asked to present their paper-based notes for review and survey by the professor. Students were not informed of the purpose of surveying their notes. Therefore, the survey investigated their voluntary note-taking activity. They were also asked to study one module per week, and they were encouraged to take online tests to verify that they had mastered the contents of the modules. These online tests functioned as part of the learning management system (LMS). Students could evaluate test scores themselves, and take online tests repeatedly until they were satisfied with their scores. Online test scores were recorded for 13 out of 15 weeks. Also, paper-based weekly confirmation tests were conducted to monitor student's progress using online learning materials. Due to the tests, all participants had to gather in a lecture room every week for 12 out of the 15 weeks of the course. This condition simulated ordinary classes. The learning pace was set by the lecturer, and the final scores of the online tests and the weekly confirmation test scores were recorded (Nakayama et al., 2010). Students were permitted to refer to their notes during these online and reviews before the weekly test sessions.

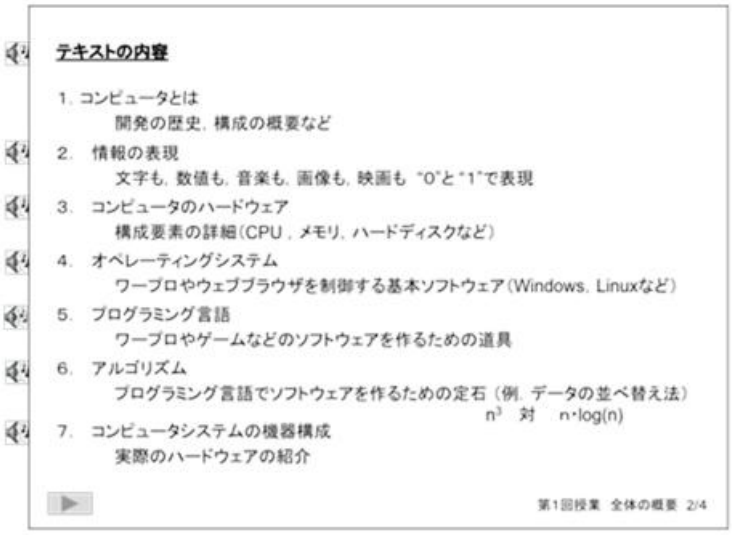

Figure 1: An example of a Slide of a Fully Online Course

3.1 Characteristics of students

Student's fundamental characteristics were measured using two constructs: personality (Goldberg, 1999; IPIP, 2004) and information literacy (Fujii, 2007; Nakayama et al., 2008). The metrics of their learning behaviour were surveyed at the beginning of the term, using questionnaires. An abstract of these constructs is as follows:

(1) Personality

The personalities of students were estimated using the International Personality Item Pool (IPIP) inventory (IPIP, 2004). This inventory consists of a five factor personality model which was proposed by Goldberg (Goldberg, 1999). The five factor components are "Extroversion", "Agreeableness", "Conscientiousness", "Neuroticism" and "Openness to Experience". These factors are explained as follows (Srivastava, 2013): Extraversion encompasses specific traits such as talkativeness, being energetic, and assertiveness. Agreeableness includes traits like sympathy, kindness, and affection. Conscientiousness includes traits like organisation, thoroughness, and planning ability. Neuroticism includes traits like tension, mood, and anxiety. Openness to Experience includes traits like having wide interests, and being imaginative and insightful. These factor scores were calculated using the results of factor analysis.

(2) Information Literacy

Fujii has developed a set of inventory for information literacy surveys which consists of 32 question items regarding 8 factors, as follows: interest and motivation, fundamental operational ability, information collecting ability, mathematical thinking (reasoning) ability, information controlling ability, applied operational ability, attitude, and knowledge and understanding (Fujii, 2007). Two secondary factors were extracted from these 8 factors: operational skills and attitudes toward information literacy (Nakayama et al., 2008).

3.2 Metrics of learning behaviour

Students acquire various study habits in school. Their habits can be measured using two metrics: note-taking behaviour (Nakayama, Mutsuura, & Yamamoto, 2011b) and learning experience (Nakayama et al., 2007).

(3) Note-taking behaviour
The note-taking behaviour of students and their behaviour may reflect not only note-taking performance but also learning achievement (Nye et al., 1984; Meter et al., 1994). Therefore, the construct for note-taking behaviour may be a key to the evaluation of the learning process. Note-taking behaviour is sometimes discussed, but has not been identified as a major technique for studying at Japanese universities, however. To observe student's note-taking abilities, attitudes and techniques, 20 original inventories were developed by the authors. The inventories were created using question items from Cornell style notes (Penn State Learning, 2009) and items from other previous studies. The inventories are displayed in Table 1 (Nakayama, Mutsuura, & Yamamoto, 2011b). Further details will be discussed in the Results section.*(4) Learning experience*
Student's learning experiences were surveyed using a set of 10 question items which had been previously developed to evaluate an online university course (Nakayama et al., 2007). This construct consisted of three factors, as follows: Factor 1 (LE-F1): "Overall evaluation of the e-learning experience", Factor 2 (LE-F2): "Learning habits", and Factor 3 (LE-F3): "Learning strategies" (Nakayama et al., 2007).

3.3 Note-taking assessment

All participants were required to present their session notes on a weekly basis. The lecturer reviewed and graded these. The contents of each session are defined using the slide presentations of the online materials. The contents of the slides are references for assessing notes. The professor who is the designer and lecturer of this course assessed all notes for 11 of its 15 weeks. The assessment was used in the final grades of participants as part of their course credit. Therefore, the assessment was evaluated as a reliable measure. Even if other professors joined in the assessments, certain aspects of their evaluations may not be consistent with those of the original professor. The contents of student's notes were evaluated using a 5-point scale (0-4), 4: Good, 3: Fair, 2: Poor, 1: Delayed, 0: Not presented (Nakayama et al., 2010). "Fair" note-taking is the thorough reproduction of information given. If any information was omitted, a "Poor" rating was given. The "Good" note-takers included those who integrated additional relevant prior knowledge with the slides and audio materials (Mayer et al., 1990). This behaviour is sometimes explained as constructivistic learning (Tynajä, 1999; Tam, 2000).

Table 1: Factor loading matrix for Note-taking behaviour (Promax rotation)

No.	Question item	1st Factor	2nd Factor	3rd Factor
1	NT during sessions to clarify the contents	**0.87**	-0.11	0.02
2	NT is for understanding the whole course not only the session topics	**0.82**	0.02	-0.01
3	NT during sessions to understand the course contents	**0.79**	0.11	-0.06
4	NT consists of what teacher presented and talked about	**0.79**	0.09	0.05
5	I understand the syllabus summary of this course	**0.63**	-0.09	0.13
6	I use a colored pen or marker to highlight important points	**0.56**	-0.04	0.17
7	I think about the meaning and importance of words during NT	**0.53**	0.29	0.21
8	NT during sessions to review the contents later	**0.52**	0.18	-0.24
9	I use NT to write some additional information in the notes taken	-0.10	**0.92**	0.04
10	I use NT to revise the notes taken after the session	-0.08	**0.89**	-0.01
11	I think about relationships between contents of the notes taken	0.18	**0.77**	0.05
12	Notes of surveyed contents are added to notes taken	-0.02	**0.71**	0.17
13	I have an original writing format for NT	-0.02	**0.62**	0.24
14	I use NT to review the notes taken after the session	0.33	**0.58**	-0.14
15	I use notes taken to review the contents of a session in advance of a test	0.20	**0.55**	-0.13
16	Notes are taken so that even non-participants can understand the contents	0.08	-0.27	**0.88**
17	My NT techniques have improved	-0.03	0.14	**0.73**
18	Notes are taken so that other participants can understand the contents	0.12	0.03	**0.72**
19	Classmates are considered when notes are taken	0.05	0.12	**0.71**
20	I have NT skills	-0.17	0.23	**0.67**
	F1: Recognizing note taking functions	1.00	Correlation	
	F2: Methodology of utilizing notes	0.47	1.00	
	F3: Presentation of notes	0.31	0.39	1.00
	Contribution ratio	0.30	0.31	0.23
	NT: Note-taking			

3.4 Causal analysis

To determine the hypothetical relationship between student's characteristics, note-taking behaviour, learning experience and test scores, a causal analysis has been used to explain the contribution of note-taking. To design a model and to evaluate the fitness of the model, the structural equation mode-ling technique (SEM) has been introduced. The actual calculations were conducted using the AMOS package (Toyoda, 2007).

The causal models were designed with consideration given to the factors of note-taking behaviour, as follows:

- 1. Impact of student's characteristics on note-taking behaviour
- Student's characteristics, in particular personality and information literacy, may be related to note-taking ability. A simple model is hypothesised that these factors affect student's note-taking behaviour.
- 2. Note-taking skills affect note-taking performance and test scores
- As note-taking behaviour may be related to overall note-taking performance and to weekly test scores (Nakayama, Mutsuura, & Yamamoto, 2011b), a causal model was designed. The contribution factor and the direction of learning experience factor should be carefully considered. As the learning experience in this paper is an online one, it is hypothesised that in a causal model note-taking behaviour affects both the learning experience and course performance, such as scores in online and weekly tests and the final exam.
- 3. An integrated model
- The two above models are merged to form a single integrated model which includes all factors mentioned above.

All paths between variables were assessed using trial and error while the path coefficients were evaluated. An optimised model was extracted by maximising the Goodness-of-Fit (GFI) and Adaptive Goodness-of-Fit (AGFI) indices.

4. Results

4.1 Note-taking behavioural factors

Valid responses from 53 participants were summarised. To extract note-taking factors for this survey, factor analysis was conducted using Promax rotation.

Table 1 shows the factor loading matrix and the correlation coefficients across three factor axes, and the contribution ratio of each factor while ignoring the other factors is also illustrated. As a result, three factors were extracted and each factor was given labels such as F1: Recognising note-taking functions, F2: Methodology of utilising notes, and F3: Presentation of notes. These factors emphasise three aspects of note-taking. According to the correlation coefficients, all factor axes correlate with each other; therefore the three factors are related to each other though they are identified separately.

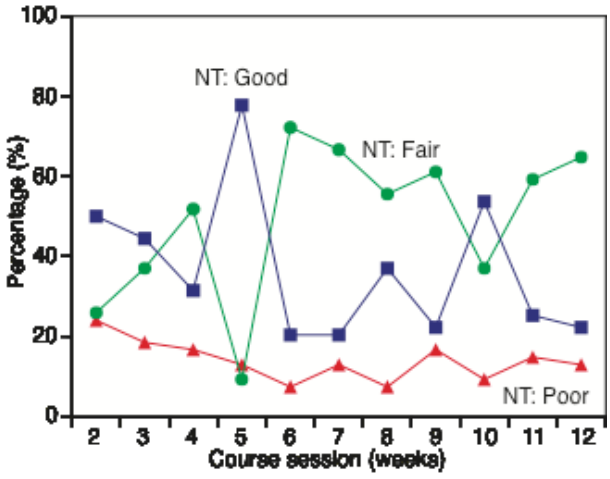

Figure 2: Grade Percentages of Note-taking Assessments

4.2 Note-taking assessment

The percentages of note assessment levels across the weeks of the course are summarised in Figure 2. According to the figure, percentages for "Fair" are almost always higher than those for the other assessment levels through the course period. The percentage rates of note-takers rated "Good" is very low. This suggests that students are unable to create "Good" notes as the course progresses. Also, the percentages of "Poor" assessment levels are almost always the lowest. This result suggests that most students have simply reproduced slide contents in their notes. All assessments are summed up as ratings for all weeks of the course, and note assessment scores are calculated for each participant. The scores indicate a kind of note-taking performance ability. For the following analysis, all participants were divided into two groups: high assessment scores and low assessment scores, using the average. The high and low groups consist of 30 and 23 students respectively.

4.3 Effectiveness of student's characteristics for note-taking assessment

Various factors of student's characteristics may affect note-taking performance. Some relationships between them have been confirmed in the results for a blended learning environment (Nakayama, Mutsuura, & Yamamoto, 2011a). In this study, the effectiveness of note-taking in a fully online learning environment is investigated.

Table 2: Comparing means of metrics between high and low levels of Note-taking score

[Mean(STD)]	Note-taking score		
Metrics	High(30)	Low(23)	*Sign.*
Personality			
Extroversion (IPIP-1)	2.70(0.70)	2.68(0.51)	*n.s.*
Agreeableness (IPIP-2)	3.43(0.53)	3.06(0.50)	$p < 0.05$
Conscientiousness (IPIP-3)	3.31(0.59)	2.83(0.64)	$p < 0.01$
Neutroticism (IPIP-4)	2.83(0.87)	2.75(0.87)	*n.s.*
Openness to experience (IPIP-5)	3.17(0.62)	3.00(0.46)	*n.s.*
Information Literacy			
Operational skills (IL-1)	3.43(0.53)	3.15(0.69)	*n.s.*
Attitude (IL-2)	3.04(0.74)	2.64(0.60)	$p < 0.05$
Learning Experience			
Overall evaluation of e-learning (LE-F1)	3.36(0.74)	3.05(0.61)	*n.s.*
Learning habits (LE-F2)	2.80(0.93)	2.13(0.79)	$p < 0.01$
Learning strategies (LE-F3)	3.43(0.80)	2.91(0.76)	$p < 0.05$
Note-taking skills			
Recognizing note-taking functions (NT-F1)	4.05(0.54)	3.31(0.83)	$p < 0.01$
Methodology of utilizing notes (NT-F2)	2.96(0.88)	2.19(0.73)	$p < 0.01$
Presentation of notes (NT-F3)	2.49(0.84)	2.41(0.82)	*n.s.*
Test scores			
Online tests (OT)	98.25(4.93)	96.40(4.44)	*n.s.*
Weekly tests (WT)	62.65(11.09)	48.73(14.22)	$p < 0.01$
Final exam (FE)	64.61(9.39)	54.58(11.01)	$p < 0.01$

First, mean factor scores of personality are compared between the high and low note-taking assessment groups. The results are summarised in Table 2. There are significant differences in these scores for "Agreeableness" and "Conscientiousness". Two of the five personality factors may affect note-taking behaviour. Next, mean second factors of information literacy are compared. The second factors are "operational skills" and "attitude" which are extracted using secondary factor analysis (Nakayama et al., 2008). There is a significant difference in the second factor between high and low note-taking assessment groups. Again, the secondary factor consists of several factors, and there are some significant differences in the original factor scores.

Mean factor scores of learning experience are also compared. Although there is no significant difference in the first factor (Overall evaluation of e-learning experience), there are significant differences in the two remaining factor scores (Learning habits and Learning strategies). Mean scores of the high group are higher than means of the low group. Students in the high group possess both good learning habits and effective learning strategies, such as the right tactics to master the academic requirements of the course.

The factor scores of note-taking behaviour between the two groups of note taking assessments are also summarised and compared in Table 2. For the first factor, "Recognising note-taking functions", the score of the high group reaches 4 out of 5 points, as they know the functions of taking notes well, while the score of the low group stays in the middle of the scale. There is a significant difference between the two groups. For the second factor, "Methodology of utilising notes", the score of the high group stays in the middle of the scale, but the score is significantly higher than the score of the low group. There is no significant difference in scores for the third factor, "Presentation of notes". Both scores remain in the lower part of the scale. The students did not object to the presentation and collective review of their notes by their classmates.
Finally, test scores, which are online test scores, weekly test scores and final exam scores, are compared between the two groups. These test scores are calculated as individual averages across the course. There are significant differences in test scores between high and low groups, except with online test scores. As mentioned above, online test scores are the final scores students record when they are satisfied with their scores after repeated trials. Therefore, there are no differences. The differences in scores of weekly tests and final exams show that note-taking behaviour contributes to learning performance.

4.4 Effectiveness of note-taking

To confirm the detailed relationship between student's learning performance and scores related to note-taking performance, a correlation analysis is conducted and the correlation coefficients are summarised in Table 3. Significant coefficients are displayed in bold font.

Table 3: Correlation coefficients between note-taking behaviour, learner characteristics and test scores

Metrics	NT-F1	NT-F2	NT-F3	Note score
IPIP-F1	-	-	-	-
IPIP-F2	**0.45**	0.29	0.33	-
IPIP-F3	**0.40**	**0.47**	**0.53**	0.28
IPIP-F4	-	-	**0.30**	-
IPIP-F5	**0.27**	**0.35**	-	-
IL-Skills	**0.55**	**0.47**	**0.47**	-
IL-Attitude	**0.46**	**0.54**	**0.55**	-
Experience-F1	0.29	0.28	**0.42**	-
Experience-F2	**0.51**	**0.55**	-	-
Experience-F3	**0.44**	**0.42**	**0.40**	-
Online test	-	**0.36**	**0.38**	0.31
Weekly test	0.33	-	-	**0.58**
Final exam	-	-	-	**0.46**
Bold: p<0.01, others: p<0.05, -:n.s.				

For personality, these three factors of note-taking behaviour strongly correlate with "Agreeableness" and "Conscientiousness", as Table 2 confirms. Additionally, "Neuroticism" correlates with the NT-F3 score, and "Openness to Experience" correlates with both NT-F1 and NT-F2. For information literacy scale scores, all three factors of note-taking behaviour strongly correlate with both secondary factors of information literacy, skills and attitude. For learning experience, both NT-F1 and NT-F2 correlate with factor scores of the learning experience.

The sum of assessment scores for note-taking correlates with mean scores of online tests (r=0.31), weekly confirmation test scores (r=0.58) and with final exam scores (r=0.46). Since note assessments originate with note-taking performance, these results suggest that student's note-taking performance affects their learning performance, while their personal characteristics are related to their note-taking behaviour. As good note-taking performance may help test scores, this suggests that the contents of the notes contribute to the test scores. Three factors of note-taking behaviour, (NT-F1) Recognising note-taking functions, (NT-F2) Methodology of utilising notes and (NT-F3) Presentation of notes are examined to determine their correlational relationships with student's characteristics.

Also, the sum of assessment scores for note-taking correlates with NT-F1 (r = 0:34; p < 0:05) and NT-F2 (r = 0:30; p < 0:05) except NT-F3 (r = 0:02).

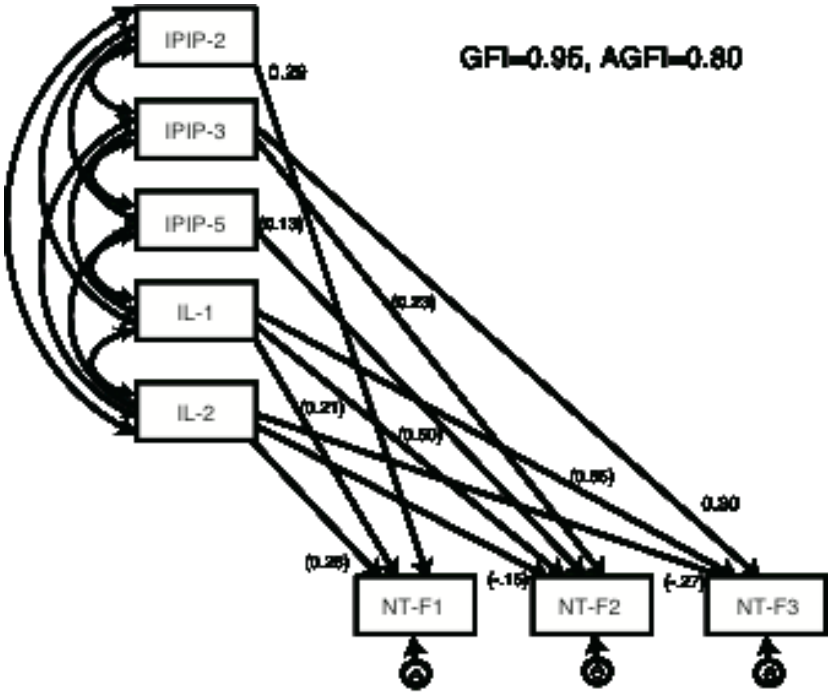

Figure 3: Paths from Student's characteristics to Note-taking behaviour (IPIP-2: Agreeableness, IPIP-3: Conscientiousness, IPIP-5: Openness to experience, IL-1: Information literacy - Operational skills, IL-2: Information literacy - Attitude, NT-F1: Recognising note-taking functions, NT-F2: Methodology of utilising notes, NT-F3: Presentation of notes, (): Path coefficient is not significant)

4.5 Impact of student's characteristics on Note-taking behaviour using causal analysis

The causal relationships between student's characteristics and note-taking behaviour are determined using a structural equation modelling technique. To build a model, results of the above correlational analysis were used. The results of correlation analysis suggest that note-taking behaviour has significant correlations with "Agreeableness", "Conscientiousness", and "Openness to Experience". Also, both secondary factors of information literacy correlate with note-taking behaviour, and are employed in the model.

A causal model with correlational paths shows the results in Figure 3. In this diagram, arches represent correlations and arrows represent directional paths. An "e" indicates an error term. The independence of personality factors is widely recognised, but sometimes there are correlations between other factors (Nakayama et al., 2007). These secondary factors of information literacy have been extracted using Promax rotation, to confirm that there are correlational relationships.

For this model, path settings are repeatedly adjusted by trial and error until the above-mentioned paths have been optimised (GFI=0.95; AGFI=0.80). The coefficients for the correlations and the paths are summarised in the top left corner of Table 4. There are correlational relationships between 5 student characteristics, and the coefficients of these varied between 0.19 and 0.94. In particular, the coefficient between the two secondary factors of information literacy is the largest. The larger coefficients appear in paths between information literacy operational skills and both NT-F2 "Methodology of utilising notes" and NT-F3 "Presentation of notes". Three personality factors affect factors of note-taking behaviour. Attitude as a factor of information literacy negatively influences NT-F2 and NT-F3, and positively influences NT-F1 "Recognising note taking functions".

4.6 Impact of Note-taking behaviour on note assessments and test scores

The causal model in Figure 4 shows the relationships between note-taking behaviour, note assessments and test score factors. Factors of note-taking behaviour shown in Table 1 were extracted using Promax rotation, and are correlated with each other. Therefore, correlational paths are established between factors of note-taking behaviour in Figure 4. According to our observations of student's learning activities, notes are used as a reference before and during online tests, weekly confirmation tests and final exams. The directional paths from factors of note-taking behaviour to test scores results may be logical. Also, the directional paths between tests

occur logically. As a result, the index of this model's Goodness-of-Fit is the highest in this paper, because it is simple and logical (GFI=0.98; AGFI=0.93). Both note-taking behaviour factors NT-F1 and NT-F2 positively affect the assessment of notes, and all test scores through NT-F3 negatively influence all of these variables except online test scores.

Table 4: Standardised path coefficients using all variables

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
(1)IPIP-2	-	0.5	(0.19)	0.4	0.3	0.3	-	-	(-.16)	-	(-.17)	-	-	-	-
(2)IPIP-3	0.5	-	(0.26)	0.6	0.5	-	(0.23)	0.30	(0.25)	-	(0.19)	-	-	-	-
(3)IPIP-5	(0.19)	(0.26)	-	0.4	0.3	-	0.1	-	-	(0.18)	0.3	-	-	-	-
(4)IL-1	0.4	0.6	0.4	-	0.9	(0.21)	(0.65)	(0.65)	1.1	0.8	(-.44)	-	-	-	-
(5)IL-2	0.3	0.5	0.3	0.9	-	(0.26)	(-.26)	(-.27)	(-.54)	(-.44)	(0.58)	-	-	-	-
(6)NT-F1	-	-	-	-	-	-	-	-	-	(0.17)	0.3	0.3	-	-	-
(7)NT-F2	-	-	-	-	-	-	-	-	(-.15)	0.2	-	0.40	-	(-.16)	-
(8)NT-F3	-	-	-	-	-	-	-	-	-	-.26	-	-.33	-	(-.16)	(-.16)
(9)LE-F1	-	-	-	-	-	-	-	-	-	-	-	(0.26)	-	(0.18)	-
(10)LE-F2	-	-	-	-	-	-	-	-	-	-	-	(0.18)	-	0.3	-
(11)LE-F3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.2
(12)NT-A	-	-	-	-	-	-	-	-	-	-	-	-	0.3	0.5	-
(13)OT	-	-	-	-	-	-	-	-	-	-	-	-	-	0.2	-
(14)WT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.60
(15)FE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

(1)IPIP-2: Agreeableness, (2)IPIP-3: Conscientiousness, (3)IPIP-5: Openness to experience, (4)IL-1: Information literacy - Operational skills, (5)IL-2: Information literacy - Attitude, (6)NT-F1: Recognizing note-taking functions, (7)NT-F2: Methodology of utilizing notes, (8)NT-F3: Presentation of notes, (9)LE-F1: Overall evaluation of e-Learning experience, (10)LE-F2: Learning habits, (11)LE-F3: Learning strategies, (12)NT-A: Note-taking assessments, (13)OT: Online tests, (14)WT: Weekly tests, (15)FE: Final exams

(): Path coefficient is not significant, - : No signicant path exists.

The path model can be used to merge factors affecting the learning experience, and this modified model is optimised. The order of the two constructs mentioned in the modelling procedure is as follows: The course is taken at a university, though student's note-taking behaviour has been developing since primary and secondary school. Therefore, note-taking behaviour also affects the learning experience. The index of Goodness-of-Fit decreased slightly from the GFI index for Figure 4 (GFI=0.94; AGFI=0.76). By comparing path coefficients for test scores with factors of note-taking behaviour or factors of learning experiences, we see that coefficients for learning experience factors are larger than coefficients for note-taking behavioural factors. By comparing path coefficients of note-taking behaviour to test scores between two previously diagrams mentioned, most coefficients decrease when learning experience factors are introduced. This suggests that the contribution of learning experience to test scores is larger than the contribution of note-taking behaviour.

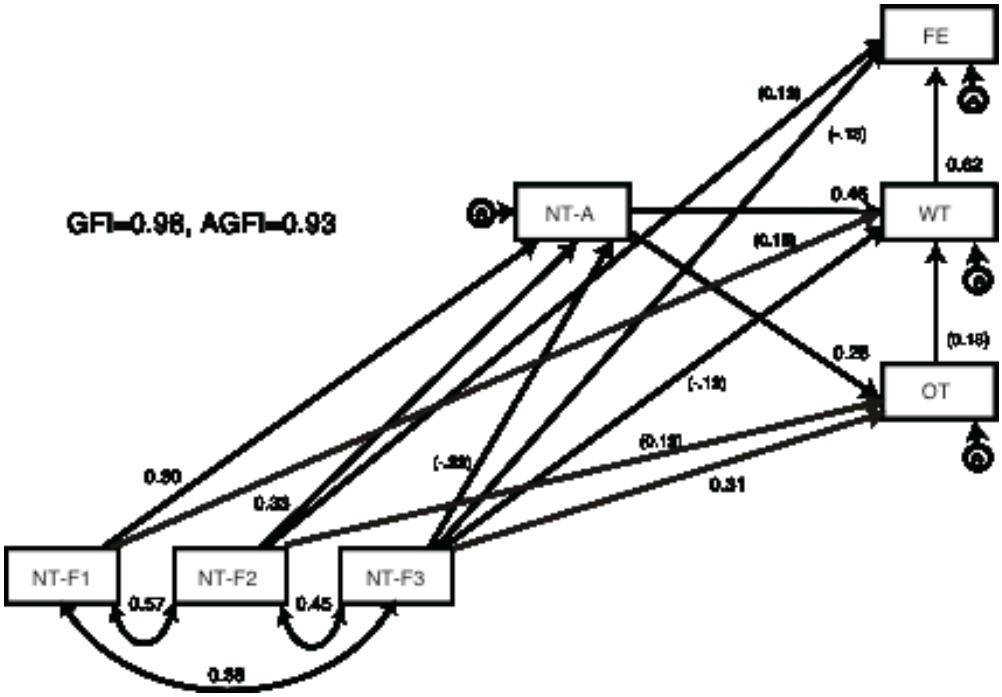

Figure 4: Paths from Note-taking behaviour to Note assessments and Test scores (NT-F1: Recognising note-taking functions, NT-F2: Methodology of utilising notes, NT-F3: Presentation of notes, NT-A: Note-taking assessments, OT: Online tests, WT: Weekly tests, FE: Final exams, (): Path coefficient is not significant)

4.7 Unified model

Some causal relationships are discussed in the above sections, though an overall model is needed to explain the causal relationship between student's characteristics of note-taking behaviour, learning experience, note assessments and test scores by merging all of the partial models together. The optimised final model is shown in Figure 5, where some paths have been removed to aid optimisation. The index of Goodness-of-Fit gets worse (GFI=0.84; AGFI=0.65), but its occurrence remains possible. Path coefficients are summarised in Table 4.

These results suggest the following: Student's characteristics affect note-taking behavioural factors and learning experience factors, but they do not affect note-taking assessments and test scores. Note-taking behavioural factors merely affect test scores while learning experience factors positively affect test scores. Note assessments are affected by both note-taking behaviour and learning experience factors, as are tests scores. Therefore, many factors positively affect test scores via note-taking assessments.

According to the results, as certain factors of student's characteristics also affect test scores, these characteristics should be considered when a study support system is developed. Also, the improvement of note-taking behaviour may positively affect the learning experience and test scores due to the assessment of student's notes. A set of instructions to enhance student's note-taking behaviour should be developed and introduced. The development of this procedure will be a subject of our further study.

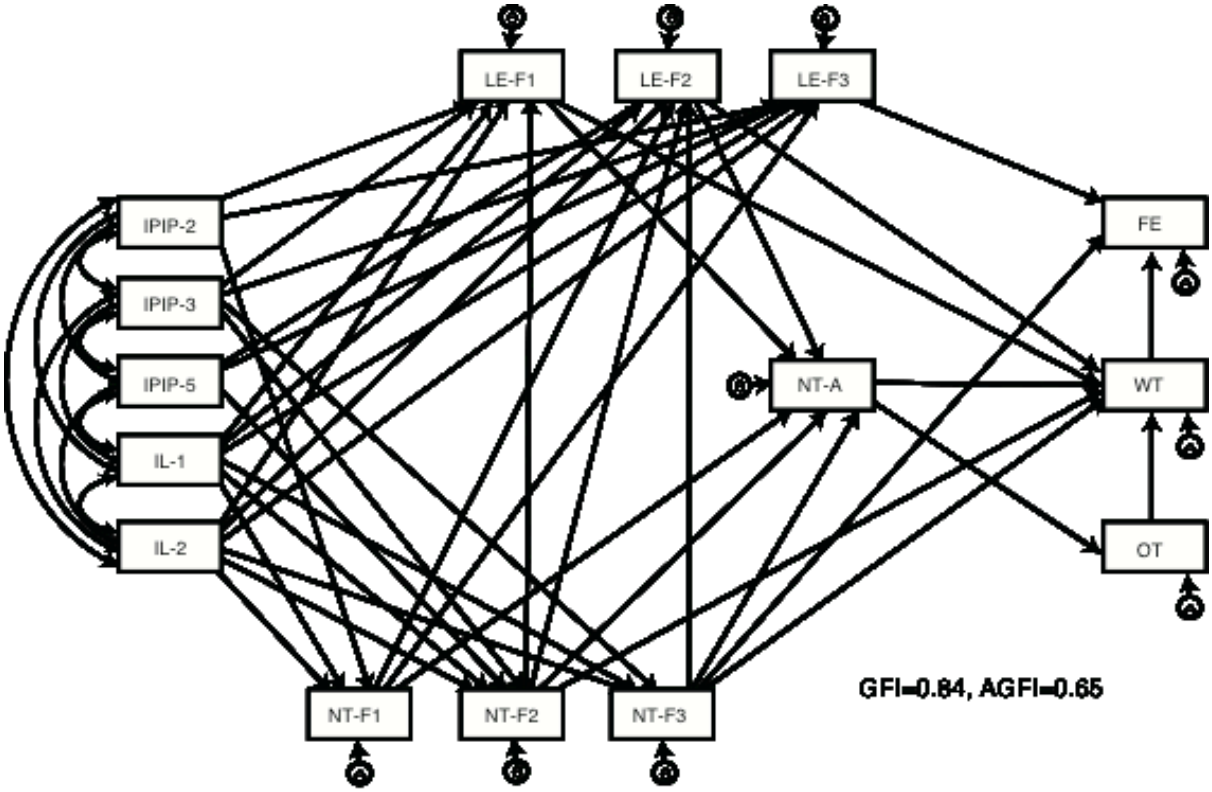

Figure 5: Path Diagram using All Variables (IPIP-2: Agreeableness, IPIP-3: Conscientiousness, IPIP-5: Openness to experience, IL-1: Information literacy - Operational skills, IL-2: Information literacy - Attitude, NT-F1: Recognising note-taking functions, NT-F2: Methodology of utilising notes, NT-F3: Presentation of notes, LE-F1: Overall evaluation of e-Learning experience, LE-F2: Learning habits, LE-F3: Learning strategies, NT-A: Note-taking assessments, OT: Online tests, WT: Weekly tests, FE: Final exams)

5. Discussion

In this study, note-taking was introduced into a fully online course to permit detailed examination of student's learning activities.

First, note-taking performance during a fully online course was insufficient and the level of note-taking that was rated as "Fair" notes was the highest. This suggests that most students simply reproduced the contents of slides in their notes. Every time students studied, they used downloaded slide files. This condition may be equivalent to one using "guided notes", which promote note-taking (Austin et al., 2004). The survey results showed that note-taking was not promoted by these materials. The possible reasons for this may be a lack of note-taking behaviour or a dependency on using digital files and not taking notes.

To measure note-taking behaviour, survey inventories were developed and three factors were extracted, as follows.

- Factor 1: NT-F1 "Recognising note-taking functions",
- Factor 2: NT-F2 "Methodology of utilising notes", and
- Factor 3: NT-F3 "Presentation of notes".

As participants' factor scores were relatively low, their consciousness of their note-taking behaviour might have been insufficient. In the causal analysis regarding note-taking, the coefficients of causal paths from these factor scores to note-taking assessments were significant, while the coefficients of causal paths from note-taking assessments to test scores of both online and weekly tests were insignificant, however.

The Goodness-of-fit index (GFI) of the causal paths in Figure 4 is high, so that the above relationship may be stable while the results agree with the previous studies regarding insisting importance of note-taking, even when an ICT environment is used. Also, the causal paths illustrate effect-spreading from note-taking behaviour

to note-taking assessment and scores of weekly tests and final exams. This suggests that learning performance such as test scores may be improved when better note-taking behaviour is developed, as a means of raising factor scores and taking "Good" notes.

Note-taking assessments did not directly affect final exam results, though coefficients of causal paths from some factors and scores of weekly test to scores of the final exam exist. Figure 5 show that scores of the final exam are directly affected by factor scores of note-taking behaviour and the learning experience. Again, these factors may be key to overall performance. Figure 3 indicates that both factors of note-taking behaviour and learning experience were affected by some factors of personality and information literacy. This causal model is also stable regarding GFI values, and the contribution of some factors to student's characteristics has been confirmed in regards to note-taking activities.

These results confirm the following points. In this study, the above mentioned possible causal paths were extracted, and the above mentioned factors need to be taken into account in order to improve learning performance in fully online courses. To maximise learning performance in a fully online learning environment, the development of better note-taking behaviour and a better learning environment for university courses are important. Characteristics of individual students also need to be considered. Other psychological factors such as learning efficacy may affect note-taking behaviour, of course. These relationships should be examined in a future survey.

The effectiveness of these programs should be confirmed, and will be a subject of our further study. According to these results, a support system and educational improvements are required to improve learning activity during a fully online course. These issues will also be subjects of our further study.

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