Paths from Formative Assessment to Learning Outcomes: A Between-Course Approach Study of Undergraduate Freshmen in Two Japanese Universities

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This study considers the relationship between formative assessment and learning outcomes by comparing students' responses on courses with and without formative assessment. Path analysis of 220 courses reveals that (1) the relevance of formative assessment to course objectives has a larger effect on learning outcomes than experience or feedback of the assessment; (2) time distribution has a greater impact on learning outcomes than the length of independent learning; and (3) the type of formative assessment causes a variation in terms of the paths to the length and distribution of learning time.

BACKGROUND

Effectiveness of Formative Assessment

The purpose of this study is to examine the effect of formative assessment[1] on student learning using an evidence-based approach. As readers may be aware, previous research, such as by Black and Williams (1998), Yorke (2003), and MacMillan, Venable, and Varier (2013), has discussed the effects of formative assessment, and newer findings on university education have continued to be added. Those previous research can be separated into three categories according to the unit of analysis: in-course, between-course, and between-program.

Most in-course studies try to examine the effectiveness of specific formative assessment techniques. These are generally based on the response of students took a same course, module, or subject but experienced different instructions. The majority of the research regarding formative assessment falls into this category. In fact, in *Assessment & Evaluation in Higher Education* from 2000 to 2013, 15 out of the 17 studies with titles including the term 'formative assessment' adopted an in-course approach. This approach is popular even in other journals. For example, Lipnevich, McCallen, Milles, and Smith (2014) analyzed data on 100 students enrolled in child development courses at a large, urban northeastern university in the United States and found that the writing of students who received detailed rubrics for their formative evaluation improved more compared to students who did not.

Between-course approach attempts to see the differences in learning experiences resulting from the use of formative assessments in university courses. A 'course', which normally lasts one semester (15 weeks in Japan), is a unit of study with corresponding awarded credit[2]. Although between-course approach is not as common as in-course approach, Nishigaki and Yabe (2008) give an example of the

former. They studied 300 students at a Japanese national university and concluded that there were no significant differences in self-reported outcomes for courses with different formative assessment conditions. In contrast, McDowell, Wakelin, Montgomery, and King (2011) developed the Assessment for Learning Questionnaire and collected 698 responses at an institution in the United Kingdom. They showed that students who took part in 'assessment for learning' modules were more likely to report having deeper learning approach and greater engagement with the subject matter.

Most macro perspectives use between-program approach, in which formative assessment is a part of or a characteristic of an whole degree program, and not specific to individual courses. Based on audits of 23 degree programs in 8 universities and 1,220 responses from the Assessment Experience Questionnaire, Jessop, Hakim, and Gibbs (2014, p. 84) asserted there was no significant correlation 'between volume of formative assessment and quantity of effort ($r=.109$, $p>.05$)'. Conversely, Morozumi (2009) used the results of a nationwide student survey in Japan, and found that mid-semester assessments significantly increased learning times in engineering faculties ($\beta=.243$, $p<.001$).

Although each of the three categories of analysis can be used for discussing the effects of formative assessment, the interest of this study is in between-course comparison. This is because in-course studies in Japan have little relevance for English-speaking countries as the discrepancy in teaching language makes it difficult to share the nuances of tangible practices in the classroom. Also, between-program research seems not to attract much attention because of certain particularities in Japanese undergraduate curriculum, which will be explained in the next subsection. In view of these circumstances, this study will not use in-course or between-program approaches but between-course approach.

Students' Recognition As an Indicator of Learning Outcomes

The Particularities arise in undergraduate curriculum of Japanese universities because of two components of it: major study and common study. Students generally take common study courses until the middle or end of their sophomore year, and then proceed to their major study[3]. Courses included in the common study curriculum are foreign languages, interdisciplinary thematic programs, and introductory courses outside of one's major subject of study.

The required courses for common study generally vary depending on universities. Accordingly, it is not relevant to compare the learning outcomes of the courses for lower class level students by looking at academic grades or grade point averages. Rather, students' own recognition of learning outcomes is more suitable for relative comparison, regardless of course or university attributes.

Learning outcomes in this paper are measured by three dimensions: satisfaction, achievement, and motivation. All of these are essential for the retention of students, especially freshman students, however they are usually treated separately as learning outcomes. Horstmanshof and Brownie (2013) cited several previous studies asserting that formative assessments positively affect student satisfaction. Hodgson and Pang (2012) found that for the dimension of achievement, 90.2% of research participants agreed or strongly agreed that in-depth understanding could be achieved through formative assessment. Additionally, Weurlander, Soderberg, Scheja, Hult, and Wernerson (2012) concluded in their qualitative research of medical students at a Swedish university, that formative assessment motives students to study in several ways.

While the aforementioned findings are derived from in-course studies, this study tries to validate the relationship between formative assessment and students' recognition of learning outcomes through a between-course approach.

Research Questions

In light of previous research findings and the particularities of Japanese undergraduate curriculum, this article sets three main research questions.

1) What aspects of formative assessment relate to learning outcomes? Despite a basic consensus that formative assessment has effects on learning outcomes, there are some contradictory findings. One possible reason is that the focused aspect of formative assessment differs among studies (MacMillan et al., 2013). This article distinguishes between experience and quality of formative assessment, and

compares their effectiveness on learning outcomes. In this way, it will be clear whether the experience of formative assessment or the quality of it is more important for student learning.

2) How does learning time intermediate the relationship? In addition to the direct effects of formative assessment on learning outcomes, there are presumed to be indirect effects through the length and distribution of learning time. Formative assessment forces students to prepare for tasks (Hodgson & Pang 2012), and learning outcomes might depend partially on learning time. The relation between formative assessment, learning time, and learning outcomes will be examined using path analysis.

3) Does the relationship expressed by the path diagram differ with the type of formative assessment? For independent learning, whether a formative assessment task is done in classrooms or outside classrooms should have a bearing on the path diagram. It is reasonable to predict that formative assessment tasks done outside classroom will have a larger influence on learning time, and possibly on learning outcomes.

METHOD

Survey Procedure

Participants in this study were from two Japanese universities located in different area of Japan, national university A and public university B, both with around 10,000 undergraduates studying a wide range of fields. The number of freshmen who volunteered to respond to the online questionnaire in August 2014 was 69: 25 from university A and 44 from university B.

Respondents were asked to answer questions about the courses they took on a certain day of the week. The chosen day was predetermined by the authors of this article in order to randomize the answers. This was necessary because freshman students in Japan register for 15.5 courses per semester on average (National Federation of University Co-operative Associations 2016), and course categories tend to be fixed on a certain day of the week or period of a day. It can therefore be difficult for students to answer questions about all of their courses, and course categories could be biased if the day was not randomly appointed. Each respondent answered questions on around 1–4 courses, depending on their registration, and information on a total of 220 courses was collected.

The online questionnaire was developed in 2012 and has been revised several times with reference to the results of semi-annual surveys. The version used in August 2014 consisted of four sections. Students gave information on their personal details in section 1, an outline of the course in section 2, their learning experiences in section 3, and their perception of assessment tasks in section 4. For sections 2–4, students answered the questions for each course they took. Learning outcomes and learning times were gauged in section 3, and questions regarding their experience and the quality of formative assessments were asked in section 4.

The procedure for this study focuses on students' perceptions of assessment and learning. Studies such as Gilles, Detroz, and Blais (2001) that focus on teachers' perspectives of assessment are indispensable to see the actual practice of formative assessment. However, to understand the relationship between formative assessment and student learning, it is reasonable to ask students about how they experienced formative assessment, and to judge the quality of the assessment (Struyven, Dochy, & Janssens 2005).

Data Description

In this paper, formative assessment is divided into two types: 'in-class' and 'hand-in' assessments. In-class formative assessments (ICFAs) require students to demonstrate their knowledge and abilities through tasks such as mid-term exams, quizzes, and presentations. In contrast, hand-in formative assessments (HIFAs) require students to write reports or complete assignments out of class and submit them to the instructor.

For both types, respondents were asked about assessment 'experience' (Was there assessment in the course? Yes=1, No=0), 'relevance' (Was the assessment task relevant to the objectives of the course? Definitely yes=5 to Definitely no=1), and 'feedback' (Did the feedback about the task help you to

understand the reasons for the mark you got? No feedback=0, No=1, Yes=2). Table 1 shows the number of respondents (N), and the means, standard deviations (SD), and minimum and maximum (Min. and Max.) values for the variables. The percentage of students experiencing ICFAs (39%) is slightly less than for HIFAs. The mean scores for 'relevance' and 'feedback' are higher for ICFAs than for HIFAs.

The survey also asked questions concerning the length of independent study (How long did you learn outside classroom hours for the course during this semester?) and the distribution of learning times (Did you consistently spend time learning outside classroom hours? Definitely yes=5 to Definitely no=1). Since one semester consists of 15 weeks in both universities, the mean score on Table 1 indicates that the respondents spent less than 30 minutes per week per course on learning outside classroom hours. Additionally, the mean score of 'time distribution' implies that learning was concentrated near the end of the semester, possibly due to preparation for summative assessments, such as final examinations and reports.

The learning outcomes are considered from the three dimensions described above: satisfaction (Were you satisfied with the learning in this course?), achievement (Did you learn a lot in this course?), and motivation (Did this course motivate you to learn more about the theme or subject of the course?) All questions were answered using a 5-point scale ranging from 'definitely yes'=5 to 'definitely no'=1. The results are also shown in Table 1. Comparison of the three mean scores reveals that it is more difficult to motivate students toward further learning than it is to make them feel satisfied or have a sense of achievement from the course.

TABLE 1
DESCRIPTIVE RESULTS OF VARIABLES

	N	Mean	SD	Min.	Max.
In-class formative assessments					
Experience	220	0.39	0.49	0	1
Relevance	81	4.17	0.86	1	5
Feedback	81	1.27	0.77	0	2
Hand-in formative assessments					
Experience	220	0.45	0.50	0	1
Relevance	93	4.02	0.83	2	5
Feedback	93	1.17	0.70	0	2
Length and distribution of learning time					
Length of learning time	220	6.78	10.42	0	90
Time distribution	220	2.37	1.23	1	5
Recognition of learning outcomes					
Satisfaction	220	3.67	1.01	1	5
Achievement	220	3.76	1.00	1	5
Motivation	220	3.34	1.21	1	5

PATH ANALYSIS

Analysis Model

The relation between formative assessment and learning outcomes can be examined by path analysis with consideration of the indirect effect of learning time. Figures 1 and 2 illustrate the basic model for the analysis. Experience and quality (relevance and feedback) of formative assessment are analyzed separately because of the difference in sample size—only respondents who answered 'yes' for experience are included in the quality analyses.

Figure 1 is based on the hypothesis that experience of formative assessment directly influences the

three learning outcomes, and indirectly influences them through the length and distribution of independent learning time. Error variables for learning time and learning outcomes are correlated accordingly. The influence of formative assessment quality—the relevance of assessments to course objectives and feedback on the assessments—is presumed in a similar way, which can be expressed as in Figure 2.

FIGURE 1
MODEL FOR EXPERIENCE ANALYSIS

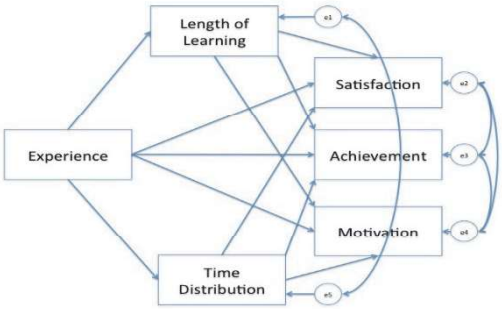
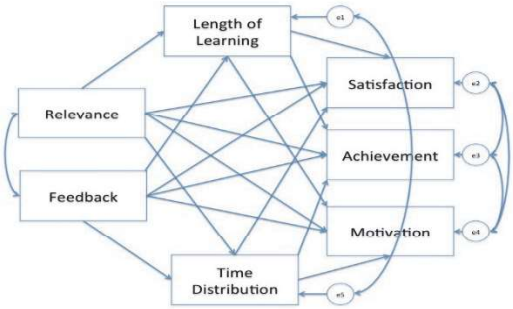


FIGURE 2
MODEL FOR QUALITY ANALYSIS



Each of these two analyses is run on in-class and hand-in formative assessments in the next subsection using SPSS 21.0 and Amos 22.0. The path analysis begins with the basic models, i.e., Figures 1 and 2, then paths are removed based on statistical significance until all remaining paths are $p<0.1$. The resulting models are shown in Figures 3 and 4 with fit indices (acceptable standards are $p>.05$, GFI/AGFI>.90, and RMSEA<.05). Subscripts for the paths are the standardized regression coefficients (***$p<0.001$, **$p<0.01$, *$p<0.5$), and those for the variables are R^2 values. Error variables and the correlations between them are not included in Figures 3 and 4.

Results

Figure 3a indicates that experience of ICFAs has no direct effect on length of learning or learning outcomes. However, students tend to learn more evenly outside classroom hours in courses with ICFAs, and the distribution of the learning time slightly elevates the outcomes (the degrees of variance explained are 2%–5%).

The effect of the quality of ICFAs is stronger than that of experience of ICFAs (Figure 3b). If ICFAs are relevant to course objectives, students are more likely to be satisfied, learn a lot, and feel motivated. Although the degree of feedback is not related to learning outcomes, it can affect length and distribution of independent learning time.

FIGURE 3a
EXPERIENCE OF IN-CLASS FORMATIVE ASSESSMENTS

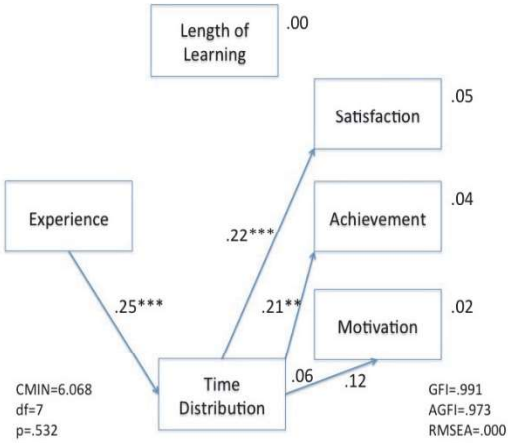
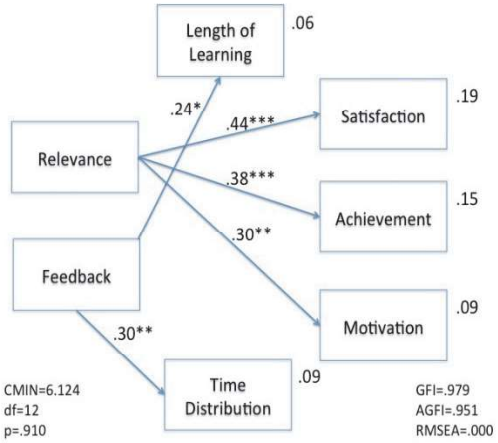


FIGURE 3b
QUALITY OF IN-CLASS FORMATIVE ASSESSMENTS



The results for HIFAs are depicted in Figure 4. The diagram for HIFAs experience is almost the same as that for ICFAs, except for the path to length of learning, which does not lead to the learning outcomes. This difference is reasonable because HIFAs are usually in the form of homework assignments.

The relevance of HIFAs directly influences the three learning outcomes (Figure 4b). The relevance of HIFAs relates to all three learning outcomes, although the relationship is weaker than for ICFAs. Additionally, feedback has an effect on satisfaction and achievement, but the statistical significance is $p<.10$. Learning time can increase through HIFAs, but it does not change the recognition of learning outcomes in the same manner as the experience of HIFAs.

FIGURE 4a
EXPERIENCE OF HAND-IN FORMATIVE ASSESSMENTS

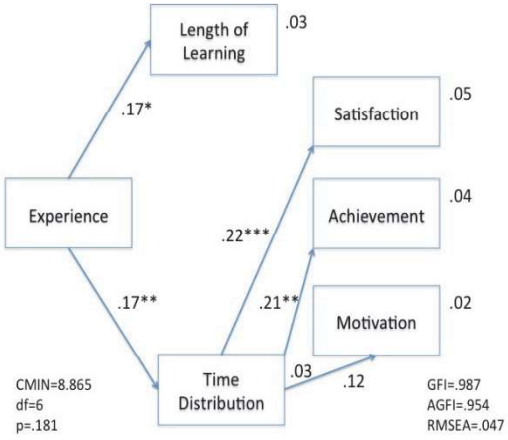
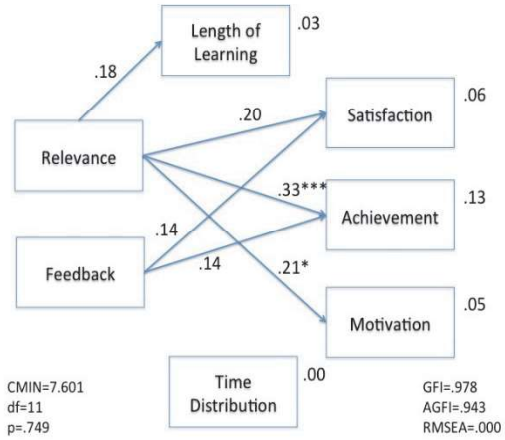


FIGURE 4b
QUALITY OF HAND-IN FORMATIVE ASSESSMENTS



CONCLUSION

Discussion

The findings can be summarized in response to the research questions as follows. First, the relevance of formative assessment has a larger effect on learning outcomes than experience or feedback of the assessment. Experience itself does not affect the learning outcomes directly, but it does have an indirect effect via learning time distribution. Compatible with Biggs and Tang (2011) and McConnell and Doolittle (2012), it is ascertained that the alignment between expected outcomes and assessments is important for learning outcomes. Furthermore, despite the amount of previous 'in-course approach' studies that emphasize the importance of feedback (for example, Drew, 2001; Nicol & Mafarlane-Dick, 2006; Hounsell, 2007), feedback was not found to be significant in this between-course approach. This implies that feedback on formative assessment does relate to learning outcomes for individual courses, but is not a decisive factor for students' relative recognition of learning outcomes when comparing course to course. Alternatively, this contradiction between previous research and this study may be owing to the selection of learning outcomes. While feedback improves objective outcomes such as marks on final examinations or academic grades, it is probable that subjective outcomes of student learning do not change significantly through feedback on formative assessment.

Secondly, it is suggested that the time distribution has a greater impact on learning outcomes than the length of independent learning. The length and distribution of outside classroom learning time did not intermediate between quality of formative assessment and learning outcomes, but time distribution did between experience and outcomes. This is an interesting result because it is intuitively reasonable that time spent on tasks should positively relate to learning outcomes, and empirical research indeed has generally supported this relation (see a review by Gog, 2013). In Japan, since the Central Council of Education (2012) questioned the sufficiency of students' learning time[4], universities have been pushed to make students learn more specifically outside classroom hour to improve the quality of graduates. However, this study has indicated that simply increasing learning time through formative assessment is not enough, at least for Japanese students, to result in greater satisfaction, achievement, and motivation.

Finally, the type of formative assessment causes a variation in terms of the paths to length and distribution of learning time as well as in terms of the most sensitive learning outcome. For the paths to learning time, it is evident that feedback on formative assessment can motivate students to learn longer and more evenly only when the tasks are done in the classroom. The experience and relevance of formative assessment affects the length of independent learning only when the tasks are completed outside the classroom. The most sensitive learning outcome varies, as seen in Table 2. Using classroom hours for formative assessment is supposed to make students feel satisfied because they can feel that the teacher cares about their learning progress. It is assumed that HIFAs do not relate strongly to satisfaction because HIFAs force students to spend their spare time on tasks outside classroom hour. However, students do realize that they learn a lot in courses with HIFAs. Table 2 also suggests that it is not easy for teachers to motivate students through formative assessment. Although assessments can be an incentive for learning (Walvoord & Anderson, 2010; Sambell, McDowell, & Montgomery, 2013), they seem not to be able to incite students to learn more about the theme or subject after a course ends. These discrepancies let us know the different, notable points of formative assessment for better recognition of the learning outcomes by students.

Table 2
DECOMPOSITION OF TOTAL (T), DIRECT (D), AND INDIRECT (I) EFFECTS

	In-class formative assessments	Hand-in formative assessments
Satisfaction	T=.50 (D=.44, I=.06)	T=.38 (D=.34, I=.04)
Achievement	T=.43 (D=.38, I=.05)	T=.51 (D=.47, I=.04)
Motivation	T=.33 (D=.30, I=.03)	T=.23 (D=.21, I=.02)

Limitations

One of the most notable limits of this study is the sample design. Even though the number of respondents and their answers regarding course details are acceptable as a case study, they are not enough for generalization of the findings. A large sample would allow analysis of the differences in the relation between formative assessment and learning outcomes in accordance with the traits of students (Sambell & McDowell, 1998). The relation may differ depending on a student's stage of study, their faculty, or learning orientation. In view of this, the sample of freshmen at two Japanese universities used in this study is only a starting point for research on the effect of formative assessment using a between-course approach. Moreover, if it is possible to compare the results of analyses internationally, the findings will have greater relevance for undergraduate curriculum development.

Another conceivable improvement of the research framework is to widen the indicators of the learning outcomes. In addition to students' recognition of satisfaction, achievement, and motivation, academic grades should be considered. This is especially so for international comparison because some evidence of relationships between formative assessment and marks or degree classifications have been reported in the context of higher education in the United Kingdom (Gibbs & Simpson, 2004). On the other hand, long-term outcomes should not be ignored. In this study, questions regarding the recognition of learning outcomes were asked just after the courses had ended. More time might be required to precisely judge the value of courses, and panel research could be used to gauge the long-term effects.

ACKNOWLEDGEMENTS

We would like to thank Yuji Hayashi (Tokyo Metropolitan University), and Shinji Tateishi (National Institute for Educational Policy Research) for their contribution to this work as research collaborators.

ENDNOTES

1. In this article, formative assessment refers to the tasks assigned by an instructor during a course of study, not at the end of the course, regardless of their purpose and weight for academic grading. Generally, as can be seen in Irons (2008), Brookhart (2011), and others, it is supposed by definition that the results of formative assessments are always used to improve students' learning and teachers' instruction. Nevertheless, the definition here places emphasis on the timing of assessments because the feedback is treated as a variable of, but not a given condition of, formative assessments.
2. The credit system established by the Japanese government requires that a student earn at least 124 credits in 4 years to graduate. The minimum requirement is altered to 188 credits in medical and dental programmes, 186 credits in pharmacy programmes, and 182 credits in veterinary science programmes. The duration of these programmes is 6 years.
3. The curriculum structure of Japanese universities and liberal arts programmes in American higher education have a lot in common. The big difference is in the admission systems. Japanese college students are forced to complete 'common study', even though their major is decided before admission and they have entered a specific department.
4. One credit equals approximately 45 hours of study in the Japanese credit system. The required contact (in-class activity) hours vary depending on the instructional style: 15–30 hours in lectures and seminars, and 30–45 hours in experiments and practicals. This system is similar to the European Credit Transfer and Accumulation System

(ECTS) with a standardized number of credits to complete a degree course (Gonzalez and Wagenaar 2008), and to the American in-and-out of class time distribution approach (United States Department of Education Office of Postsecondary Education 2011).

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