

How learners use feedback information: Effects of social comparative information and achievement goals

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Abstract

The present study investigated how learners use feedback information on their test results. We also examined the effects of the type of feedback and learners' achievement goals on the manner in which feedback information was reviewed. In an experimental study ($N = 42$ undergraduate and graduate students), we tracked eye movements of the participants while they took a critical thinking test and received their test results. The results showed that most participants checked feedback for incorrectly-answered questions but not for correctly-answered questions. This suggests that learners do not use feedback information to judge the adequacy of the process of solving. In addition, these tendencies were not different between feedback conditions. Furthermore, participants' achievement goals predicted learners' review activities. Specifically, learners with higher mastery goals tended to check feedback for correctly-answered questions. Therefore, fostering the pursuit of mastery goals may prompt learners to use feedback information to enhance their comprehension.

Keywords: achievement test; feedback; eye movements; achievement goals

Introduction

The information provided in feedback is a critical component of learning because it enables learners to correct errors and judge the adequacy of the process of solving problems (Butler, Godbole, & Marsh, 2013). Previous studies have shown the efficacy of feedback (e.g., Hattie & Timperley, 2007; Kluger & DeNisi, 1996). For example, Nakano (1986) showed that students who corrected and elaborated upon their responses after receiving feedback information achieved higher performance levels. In addition, learners can monitor the effectiveness of their learning strategies and react to feedback by altering strategies employed during studying (Zimmerman, 1990). Therefore, learners are encouraged to use feedback information to enhance their comprehension and monitor the effectiveness of their learning strategies after they receive feedback on their performance (Dansereau et al., 1979).

However, do learners spontaneously use feedback information to enhance their performance? Some studies (e.g., Maclellan, 2001) posit that many learners do not regard feedback as useful or as an opportunity to review and improve their learning. If learners do not use feedback information effectively, ample information in the feedback message is rendered useless. Unfortunately, previous studies have not examined learners' spontaneous use of feedback

information. Thus, the present study investigates how learners use feedback information while they are checking feedback information through the analysis of their eye movements. The eye tracking method has been used to study cognitive processes during information processing (Lai et al., 2013; Rayner, 1998). This method is capable of recording online cognitive activities, and therefore it is a promising tool for investigating cognitive process.

In addition, it is important to identify factors that affect learners' review activities such as correcting errors or judging the adequacy of the process of solving in order to obtain implications for educational practice. Consequently, our intent was to investigate what external and internal factors affect learners' use of feedback information. Specifically, we focused on the type of feedback received as external factors and on learners' achievement goals as internal factors.

The type of feedback

A primary objective of a feedback study is to determine what information should be provided to learners for the feedback to be effective (Butler et al., 2013). On the basis of past studies, Butler et al. (2013) indicate that feedback must contain correct answers and information on the accuracy of learners' responses. In contrast, previous studies have shown that social comparative information undermines subsequent performance and interest compared to self-referenced feedback and written verbal comment (Butler, 1987; Shih & Alexander, 2000). Particularly notable is Butler's (1988) finding that learners who received task-involving comments continued to express high interest and performance, whereas learners who received numerical grades or both grades and comments exhibited decreased interest and performance. Butler (1988) interpreted that grades were perceived primarily as salient extrinsic incentives. If social comparative information is salient and draws learners' attention, then learners' review activities such as checking correct answers may be impaired. Therefore, we focused on social comparative information and investigated its effects on review activities.

Achievement goals

Achievement goals are defined as specific orientations that represent the desire to pursue an achievement task and are important factors that relate to intrinsic motivation and the

use of learning strategies (e.g., Ames, 1992; Elliot, 1999). Traditionally, two types of achievement goals have been distinguished: mastery goals and performance goals. They differ with respect to the reason why students are pursuing an achievement task. Mastery goals orient learners toward self-improvement and task mastery, whereas performance goals orient learners toward the demonstration of competence relative to others. Recent studies (e.g., Elliot & McGregor, 2001; Elliot & Murayama, 2008) suggest a 2×2 achievement goal framework in which an approach-avoidance dimension that contrasts the desire of approaching positive outcomes to that of avoiding negative outcomes is integrated (for further extension of this framework, see Elliot, Murayama, & Pekrun, 2011). However, there are few studies that utilize a 2×2 achievement goal framework. Thus, we focused on a trichotomous goal model that included the goals most commonly endorsed by learners, namely mastery goals, performance-approach goals, and performance-avoidance goals (Elliot & Church, 1997).

Mastery goals are positively related to deep-processing strategies that involve semantic understanding of study materials or solutions, persistence, and effort during studying (Elliot, McGregor, & Gable, 1999). It is predicted that learners with higher mastery goals will devote attention to information about self-improvement. Performance-approach goals, which focus on the attainment of competence relative to others, are viewed as similar to mastery goals in that they focus on potential positive outcomes (Elliot et al., 1999). However, performance-approach goals differ from mastery goals in that they focus on an extrinsic achievement outcome. In fact, performance-approach goals are not linked with deep-processing strategies. Therefore, it is predicted that learners with higher performance-approach goals tend to devote attention to information on performance rather than self-improvement. Performance-avoidance goals, which focus on the avoidance of incompetence relative to others, are negatively correlated with deep-processing strategies and task enjoyment (Elliot & Harackiewicz, 1996; Elliot et al., 1999). So, it is predicted that learners with higher performance-avoidance goals will avoid checking the feedback information.

Method

Participants and design

Forty-two Japanese undergraduate and graduate students (18 males and 24 females) participated in return for payment. The participants were randomly assigned to the control condition ($n = 21$) or the normative feedback condition ($n = 21$). In both groups, participants received post-test information on their correct and incorrect responses on an item by item basis, a total score, and a description of the skill measured by the test. In the normative feedback condition, participants were additionally provided with an average undergraduate score and a relative ranking. Relative ranking information indicates the rank of a participant with

respect to the others: it signifies if the total score of the participants was among the highest 5%, 20%, 35% or 50%, or the lowest 35%, 20% or 5%.

Figure 1 presents the example of feedback in the normative feedback condition: (a) the participant's own total score; (b) average score of undergraduate students; (c) relative ranking; (d) description of the skill measured by the test; (e) the participant's own correct and incorrect response on an item by item basis ("o" denotes a correct response and "x" denotes an incorrect response). Additionally, correct answers and explanations of how to solve questions were hyperlinked corresponding to the number for each item; and (f) a quit button. Note that, in the control condition, (b) average score of undergraduate students and (c) relative ranking were not provided.

Apparatus

Eye movements were recorded using a Tobii TX300 (screen size: 23"; screen resolution: 1920×1080). Participants sat 60 cm from the screen and their head movements were minimized via use of a chin rest.

Two eye tracking indicators were employed on the basis of two areas of interest (AOIs), each of which corresponded to information on performance and correctness (see Figure 1). The type and size of the chosen AOIs were the same for the two conditions. We used two types of data in analysis: total fixation duration and fixation count. The Tobii I-VT Fixation Filter's default values (Tobii Technology, 2012) were used to filter fixation.

Materials

The critical thinking test used in this study was developed by Kusumi et al. (2010). Critical thinking is defined as "reasonable reflection about what we believe and do" (Ennis, 1987), and central in most definitions of 21st century skills. It seems to be increasingly important for undergraduates to acquire critical thinking ability as the Organization for Economic Co-operation and Development (OECD) began the Assessment of Higher Education Learning Outcomes (AHELO) in 2010. We employed a critical thinking test because participants seem to not seriously check feedback information if they did not consider their test performance as important. Our thinking was that many participants should value their critical thinking skills more than their knowledge of subject material in a domain they are not invested in.

The test was originally developed by referring to the theoretical frameworks of previous studies on critical thinking (e.g., Ennis, 1987). The test comprised 23 items measuring three major skills: (1) five items for understanding of structure (e.g., identifying opinion and conclusions, stipulating meaning, and clarifying reasons), (2) 13 items for reasoning based on passages (e.g., analyzing implicit assumptions and analogies, as well as strengthening/weakening the argument), and (3) five items for scientific argument (e.g., analyzing and evaluating the design of experiment/study, and 2×2 contingency tables).

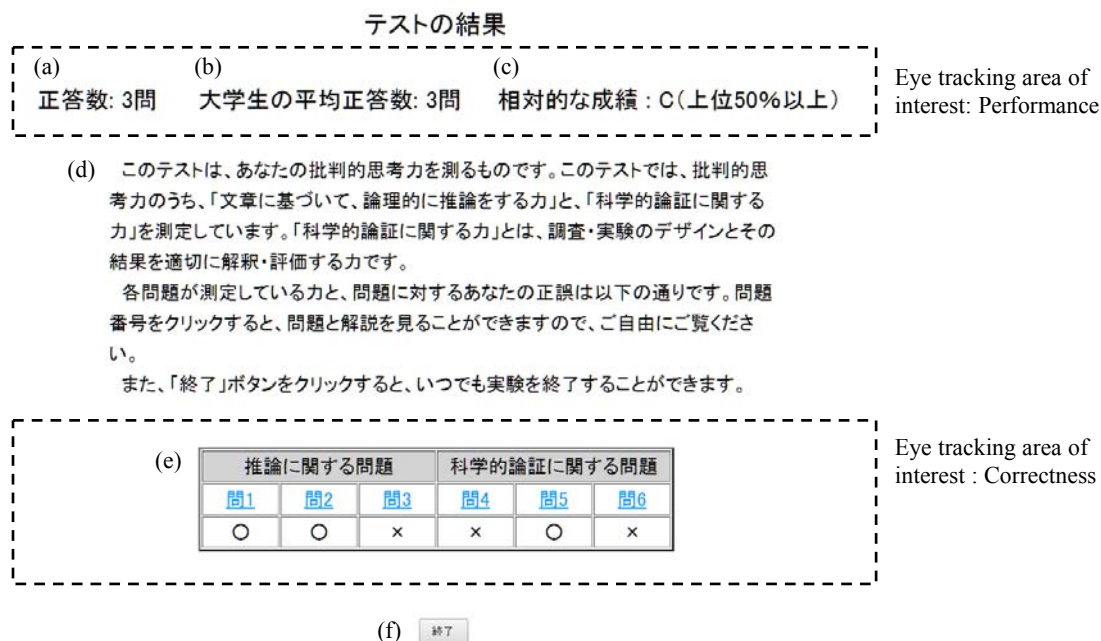


Figure 1: An example of feedback in the normative feedback condition: (a) the participant's own total score; (b) average score of undergraduate students; (c) relative ranking; (d) description of the skill measured by the test; (e) the participant's own correct and incorrect response on an item by item basis. Correct answers and explanations of how to solve questions were hyperlinked corresponding to the number for each item; and (f) a quit button.

In order to select the items for this study, we used the data obtained by Kusumi et al. (2010). The data consisted of 301 undergraduate students (135 males and 166 females, mean age 19.9 years) from 81 different universities in a metropolitan area in Japan. In this study, three items for reasoning based on passages and three items for scientific argument were selected such that the average correct response rate across all items in the set was about 50% (i.e., average score of six items was about 3.0). Average correct response rates of each item ranged from 18% (difficult item) to 89% (easy item) (from Kusumi et al., 2000). The items had a mean length of 456 characters ($SD = 90$, range: 297–565). All items were multiple-choice with five choices.

Procedure

The experiment was conducted on an individual basis with participants seated at the computer. Participants were instructed to take the critical thinking test. To motivate the participants to take the test and check the feedback information, the experimenter explained the importance of acquiring critical thinking ability. The experimenters informed participants that they would receive feedback on their performance; however, they did not explain specific details of the information. In addition, participants were informed that they could quit checking the feedback information at any time by clicking a quit button at the bottom of the screen.

Participants completed a nine-item questionnaire on achievement goals before taking the test. Then, eye fixations

and saccades were calibrated for each participant using the device's calibration tool. No time limit was placed on taking the test. The participants were asked to take a short break each time they completed two questions. Eye fixations and saccades were re-calibrated after the break. Feedback information on his or her test result was provided on the screen after each participant completed the sixth question.

Questionnaire

Participants' achievement goals were assessed using adapted versions of the items developed by Tanaka and Yamauchi (2000). To assess participants' goals related to the upcoming test, a reference to the test was added to the items: mastery goals (comprised of three items including statements such as "I want to understand the content of this test as thoroughly as possible"; $\alpha = .57$), performance-approach goals (comprised of three items including statements such as "I want to perform well on this test relative to other students"; $\alpha = .80$), performance-avoidance goals (comprised of three items including statements such as "I want to avoid doing worse in this test than other students"; $\alpha = .85$). The participants responded to each item on a scale from 1 (disagree) to 5 (agree).

Results

Descriptive statistics and correlations

Table 1 presents the mean values and standard deviations of

the achievement goals and test score. The means of test score in both conditions were higher than the average score (i.e., 3.0) obtained by Kusumi et al. (2010). Independent sample *t*-tests revealed that no significant differences existed in achievement goals and test score between the two conditions.

Table 2 presents the correlations between achievement goals and test score. Achievement goals were not related to test score. Mastery goals did not correlate with performance goals, whereas correlation between performance-approach goals and performance-avoidance goals was highly positive.

Table 3 presents the frequency distribution of the rate of checking of correct answers. Most participants checked all correct answers on incorrectly-answered questions (17 in the control and 16 in the normative feedback condition), whereas half of the participants never checked correct answer on correctly-answered questions (10 in the control and 12 in the normative feedback condition). In addition, Table 4 presents the number of participants who checked correct answers and the correct way to solve the question, and the time spent checking them.

The effects of the type of feedback and achievement goals

We used a generalized linear model to examine the effects of the type of feedback and achievement goals on the rate of checking of correct answers. To assess the effects of the feedback condition, a dummy variable was included; the normative feedback condition was coded 1 and the control feedback condition was coded 0. The analysis for incorrectly-answered questions showed that none of the factors affected the rate of checking of correct answers. The

Table 1: Achievement goals and test score in the control and normative feedback conditions: means, standard deviations, and *t*-test.

	Control		Normative feedback		<i>t</i> (40)	<i>d</i>
	Mean	SD	Mean	SD		
Mastery goals	4.07	0.68	4.05	0.70	0.83	0.26
Performance-approach goals	2.51	1.07	2.76	0.79	0.09	0.03
Performance-avoidance goals	2.87	1.12	3.16	1.09	-0.87	-0.28
Test score	3.95	1.12	3.67	1.11	-0.84	-0.27

Table 2: Correlations between achievement goals and test score.

	1	2	3
1. Mastery goals			
2. Performance-approach goals	.15		
3. Performance-avoidance goals	.04	.79**	
4. Test score	-.01	.12	-.02

Note. ** $p < .01$

analysis for correctly-answered questions showed that mastery goals affected the frequency of checking of correct answers ($b = 1.49$, odds ratio = 4.44, $p < .01$); however, other factors had no effect.

Furthermore, we used a generalized linear model to examine the effects of the type of feedback and achievement goals on eye movements. Table 5 presents the means and standard deviations of total fixation duration and the fixation count. To reduce complexity, only fixation count was used as dependent variables. The analysis for fixation count on performance (Table 6) revealed that the feedback condition had a positive effect. Thus, the fixation count was greater in the normative feedback condition than in the control condition. In addition, performance-approach goals had a positive effect and performance-avoidance goals had a negative effect. The analysis for fixation count on correctness revealed that test score had a negative effect and mastery goals had a positive effect.

Discussion

This study examined how learners use feedback information. Results showed that most learners checked correct answers and explanations regarding the right way to solve questions

Table 3: Frequency distribution of the rate of checking of correct answers.

Rate of checking (%)	Control		Normative feedback	
	Correct	Incorrect	Correct	Incorrect
0	10	3	12	3
20	1	0	0	0
33	1	0	0	0
50	1	0	0	1
67	1	0	0	1
80	1	0	0	0
100	6	17	9	16

Note. Total number of participants in the control condition for incorrectly-answered was 20 because one participant provided correct responses for all questions

Table 4: Number of participants and amount of time spent checking the correct answers and explanations regarding the ideal way to solve questions.

	<i>n</i>	Control		Normative feedback		
		Mean (sec)	SD	Mean (sec)	SD	
Question 1	12	27.92	19.69	12	49.03	51.89
Question 2	15	37.65	20.80	17	63.96	82.41
Question 3	12	19.34	19.43	11	27.68	37.65
Question 4	12	13.61	23.68	10	19.53	14.47
Question 5	8	25.66	27.30	12	34.00	26.13
Question 6	9	20.72	29.62	12	25.76	16.75

Table 5: The mean values and standard deviations of total fixation duration and fixation count in the control and normative feedback conditions.

AOIs	Control		Normative feedback	
	Mean	SD	Mean	SD
Duration (sec)				
Performance	1.22	1.68	4.41	3.29
Correctness	9.84	4.71	10.63	5.93
Count				
Performance	5.00	6.27	20.38	14.67
Correctness	33.15	15.45	35.95	18.86

Table 6: Parameter estimates of the feedback condition, test score, and achievement goals on fixation count.

	Performance		Correctness	
	Estimate	SE	Estimate	SE
Feedback condition	1.33 **	0.11	0.10	0.06
Test score	-0.07	0.04	-0.07 **	0.02
Mastery goals	-0.06	0.07	0.23 **	0.04
Performance-approach goals	0.40 **	0.10	-0.05	0.05
Performance-avoidance goals	-0.20 **	0.07	-0.07	0.04

Note. ** $p < .01$

they answered incorrectly, whereas about half did not check them for questions they answered correctly. These findings suggest that learners tend to correct errors, but they do not judge the adequacy of the process of solving these problems, nor do they think of better solutions.

With regard to the influence of the type of feedback, fixation count on performance was greater in the normative feedback condition than in the control condition. Because the amount of information on performance in the normative feedback condition is more than in the control condition, these results do not necessarily mean that social comparative feedback draws learners' attention. In addition, the type of feedback had no effect on checking of correct answers and being fixated on correctness. These findings imply that social comparative feedback does not necessarily impair learners' review activities.

One possible explanation for the null effect of social comparative information could be the high achievements of participants on the test. Butler (1988) found that low achievers who received numerical grades notably exhibited reduced interest and performance. Therefore, we speculate that the effect of social comparative information is not found because most participants in the present study received a higher than average score. In addition, the effects of feedback may be mediated by other factors. For example, recent studies have investigated learners' perspectives of tests and feedback and showed that the effects of tests and

feedback depend on the students' perceptions of them (e.g., Rakoczy et al., 2013; Suzuki, 2011). Rakoczy et al. (2013) showed that there were no significant direct effects of feedback on interest and achievement development, but there were significant indirect effects on interest and achievement via perceived competence support and usefulness. This shows that further study is necessary to clarify the effects of providing social comparative information.

With regard to the effects of achievement goals, the hypotheses received some support. Performance-approach goals, which orient learners toward the demonstration of competence relative to others, had a positive effect on fixation count on performance. In contrast, performance-avoidance goals, which orient learners toward the avoidance of negative outcomes, had a negative effect on fixation count on performance. In addition, mastery goals, which orient learners toward task mastery, had a positive effect on checking of sample answers and a fixation on correctness. The fixation count increases with checking of correct answers and ways to solve questions. Thus, learners with higher mastery goals tend to review and understand the feedback content as thoroughly as possible so that they may enhance their comprehension. These findings imply that increasing learners' mastery goals may contribute to review activities such as correcting mistakes or judging adequacy of the process of solving after taking tests. For example, the anticipation of temporal evaluation enhances the adoption of mastery goals (e.g., Butler, 2006; Pekrun et al., 2014).

Our study has several limitations. First, this study was conducted in a laboratory context rather than in an ecologically valid setting. Thus, further experiments need to be conducted in an ecologically valid setting such as an actual classroom. Second, the study did not consider the influence of feedback information on subsequent performance. Achievement feedback is known as one of the most powerful influences on learning (Hattie, 2009). Future studies would examine the relation between eye movements during the checking of feedback information and subsequent learners' performance. Finally, our findings pertain to undergraduates and graduates. We should examine the generalizability of this study to different age groups and cultures. In addition, other types of feedback such as feedback using absolute standards or self-referenced feedback could be employed.

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