EXPLORING THE IMPACT OF THE INFORMATIONAL VALUE OF FEEDBACK CHOICES ON PERFORMANCE OUTCOMES IN AN ONLINE ASSESSMENT GAME

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ABSTRACT

This paper examines the impact of the informational value of feedback choices on students' performance, their choice to revise, and the time they spend designing posters and reading feedback in an assessment game. Choices to seek confirmatory or critical feedback and to revise posters in a poster design task were collected from a hundred and six Grade 8 students from a middle school in California via Posterlet, a computer-based assessment. Results show that critical uninformative feedback is associated with performance, critical informative feedback is associated with students' learning strategies (i.e., willingness to revise and feedback dwell time), while confirmatory informative feedback is negatively associated with performance and learning strategies. This research has implications for designing the informational content of feedback messages to support student performance on an open-ended design task.

KEYWORDS

Feedback, assessment, critical, informative, game, performance

1. INTRODUCTION

Feedback is an important aspect of learning performance, as it provides information about a learner's task performance (Hattie, 1999; Hattie & Timperley, 2007). However, despite a large body of feedback research, the mechanisms of feedback are still not well understood. For example, different feedback types (e.g., critical and confirmatory, immediate and delayed, etc.) have yielded mixed results for learning (Kulik & Kulik, 1988) and a meta-analysis found that feedback was even detrimental for performance in a third of the studies analyzed (Kluger & DeNisi, 1998). Feedback effectiveness is further influenced by individual differences, such as fixed versus growth mindset (Dweck & Leggett, 1988). Particularly, researchers differentiated between non-generic and generic feedback based on the informational value of feedback and they indicated that "non-generic feedback refers to a specific event and implies that performance is malleable, while generic feedback implies that task performance reflects an inherent ability" (Chiviacowsky & Drews, 2014).

The *information-processing* learning theory focuses on the individuals' cognitive ability to use the feedback information they encounter during a learning task not only to reinforce correct answers but also to correct errors (Hattie & Gan, 2011). In the *response certitude* model, instructional feedback messages include two components: verification and elaboration (Kulhavy & Stock, 1989). Verification feedback indicates whether the answer is right or wrong, while elaboration feedback aids the learner in error correction by including indications on how to correct errors or why an answer is correct (Hattie & Gan, 2011). There is a paucity of studies investigating the impact of non-generic elaboration feedback versus generic feedback on learning. Studies show that students perceive generic feedback as impersonal (Bray, 2016). Moreover, both praise and generic negative feedback were found to be detrimental to performance. In a study where 10-year old children (n = 40) kicked a soccer-ball at a target, the type of feedback (i.e., generic, such as "You are a great soccer player" versus non-generic, such as "The last kicks were great") was used to predict motor performance and learning. In their first experiment, researchers found that providing participants with generic feedback resulted in worse performance than providing non-generic feedback, after both groups received negative feedback (Chiviacowsky & Drews, 2014). In their second experiment that focused on the results of a retention task performed one day after practicing a throwing task, researchers showed that participants who

received non-generic feedback during the performance significantly outperformed participants in the generic feedback group, after receiving negative feedback.

The current study focuses on the role of the informational value of feedback when students choose between confirmatory and critical feedback. Thus, the study examines the relation between the informational value and valence of feedback choices and students' task performance, choice to revise, and time spent reading feedback and designing posters. Here, we consider two types of feedback: informative elaboration feedback (i.e., non-generic, task-specific feedback) and uninformative feedback (i.e., generic, non-task specific feedback). Particularly, the study poses the following research questions:

1) Is informative feedback associated with in-game performance?
2) Is informative feedback associated with the choice to revise posters?
3) Is informative feedback associated with feedback dwell time or with time on task?

The remainder of this paper reviews the relevant literature, it describes the Posterlet assessment game that collects students' feedback and revision choices during a poster design task, and it presents empirical evidence that the informational feedback value impacts students' performance, choice to revise, and time spent reading feedback and designing posters.

2. LITERATURE REVIEW

Choice-Based Assessments. Posterlet is a choice-based assessment game (Schwartz & Arena, 2013) that draws on constructivist assessments (Bransford & Schwartz, 1999) and that focuses on the learning processes in which students engage when designing a poster. It collects students' choices to seek critical (i.e., negative) or confirmatory (i.e., positive) feedback and it enables the exploration of the impact of students' choices on performance. Here, the informational value of students' feedback choices is explored for the first time, with a focus on its impact on performance, choice to revise, and the time students spend reading their feedback.

Performance and Feedback Value. Informative feedback is a crucial factor in developing mastery (Ericsson, Krampe, & Tesch-Römer, 1993). Moreover, feedback research reveals that praise can be harmful for performance when it is directed to the student, rather than to the task (Hattie & Timperley, 2007). Previous research showed that choosing critical feedback was associated with better learning performance in and outside of the assessment environment (Cutumisu, Blair, Chin, & Schwartz, 2015; Cutumisu, Blair, Chin, & Schwartz, 2016). This research takes a step further and hypothesizes that students perform better when they encounter critical informative feedback.

Revision and Feedback Value. Although feedback from an expert is one of the most important factors in deliberate practice, feedback is most effective when learners apply it to revise and improve their performance (Ericsson et al., 1993; Kulik & Kulik, 1988). Despite research showing that feedback information is rarely used in revision of work (Carless, 2006), revision was strongly associated with willingness to choose critical feedback across many studies (Cutumisu et al., 2015; Cutumisu et al., 2016). In this paper, the relation between the informational value of feedback and students' choice to revise is explored for the first time.

Feedback Dwell Time, Value, and Time on Task. Previous research shows that the more the students choose to seek critical feedback, the more they dwell on feedback (Cutumisu et al., 2015). The current study aims to discern between the impact of informative and uninformative critical feedback on the time students take to read their feedback and design their posters.

The Posterlet Assessment Game. The Posterlet game tracks two learning choices students make while creating posters: the choice to seek confirmatory (positive) and critical (negative) feedback about their posters and the choice to revise their posters. On every game round, students choose either confirmatory or critical feedback from three virtual characters and choose whether to revise their poster. The feedback messages generated by the game were designed to alternate between informative (confirmatory: "Your poster helps people know where to go." or critical: "Where is the Fall Fair going to be?") and uninformative (confirmatory: "I like fairs" or critical "I don't like fairs."). This study investigates which type of feedback is associated with learning outcomes, depending on the learner's choices between confirmatory and critical feedback. For instance, if the student makes two same-valence choices on a poster, the first choice is always informative and the second is always uninformative. The game also produces a poster score as the number of tickets sold by each poster booth. An overall poster performance score is computed by adding the poster scores on each game round. More details about Posterlet are provided in prior work (Cutumisu et al., 2016).

3. METHODS

3.1 Participants and Procedures

Participants were n=106 Grade 8 students (60 female, 46 male), ranging in age from 13 to 14 years, from a public middle school in California. All students had the same science teacher and they played the Posterlet game in May 2015 designing three posters (M=14.76 minutes, SD=4.07) individually, as one of the assessments administered that day. Students who did not provide consent (n=9) or did not complete all posters (n=8) were excluded from analyses. Thus, the analyses included n=89 students (50 females).

3.2 Measures

Choices. *Critical Feedback* measures students' willingness to make "I don't like…" choices, ranging from 0 (no critical feedback chosen) to 9 (only critical feedback chosen). Feedback is divided into two orthogonal categories: valence (Confirmatory or Critical) by informational value (Informative or Uninformative). *Revision* measures students' willingness to revise their posters, ranging from 0 (no poster revised) to 3 (all posters revised). *Critical Informative Feedback* measures the number of informative critical feedback messages read by each participant (e.g., "You need to tell them what day the fair is."), while *Critical Uninformative Feedback* measures the number of uninformative critical feedback messages read by each participant (e.g., "I don't really like fairs"). Students chose the feedback valence (confirmatory or critical), not the feedback value (informative or uninformative). Critical Feedback is the sum of the Critical Informative and Critical Uninformative Feedback. *Confirmatory Feedback* is a complementary measure to Critical Feedback (i.e., 9 - Critical Feedback). Thus, *Confirmatory Informative Feedback* measures the number of informative confirmatory feedback messages (e.g., "It's good you told them what day the fair is."), while *Confirmatory Uninformative Feedback* measures the number of uninformative confirmatory feedback messages encountered (e.g., "I like fairs"). Confirmatory Feedback is the sum of Confirmatory Informative and Confirmatory Uninformative Feedback. Choices were measured by round and across the game.

In-game Poster Performance. Posterlet generates a *Poster Quality* score based on 21 design principles reflecting a student's poster performance across all rounds of the game. The quality of each poster is the sum of the scores for each of the 21 features: 1 if a feature is always used correctly on a poster, 0 if a feature is not included on the poster, and -1 if a feature is used incorrectly on a poster. Poster Quality measures the sum of the quality of students' posters by game round: *Poster Quality 1*, *Poster Quality 2*, and *Poster Quality 3*.

Feedback Dwell Time. *Feedback Dwell Time* measures the amount of time students spent reading feedback across the game. The amount of time students spent reading feedback on each game round was also computed as *Feedback Dwell Time 1, Feedback Dwell Time 2, and Feedback Dwell Time 3*, respectively.

Time on Task. *Design Duration* measures the time students take to design posters. It sums the time spent designing posters on each game round: *Design Duration 1*, *Design Duration 2*, and *Design Duration 3*.

4. RESULTS

4.1 Is Informative Feedback Associated with In-Game Performance?

Spearman correlation analyses were conducted to explore the association of the informative and uninformative feedback with poster performance by feedback valence (confirmatory or critical), as these variables were not normally distributed. Results showed that Poster Quality was positively associated with Critical Uninformative Feedback but not with Critical Informative Feedback, and negatively associated with both informative and uninformative confirmatory feedback, as shown in Table 1. Thus, the more the students engage with critical uninformative feedback, the better their posters are. More importantly, the more they engage with confirmatory feedback (informative or uninformative), the worse they perform on their posters.

Table 1. Correlations between performance and feedback information overall and by round ($^{***}p < .001$, $^{**}p < .01$)

Measure (n=89)	Critical Informative Feedback	Critical Uninformative Feedback	Confirmatory Informative Feedback	Confirmatory Uninformative Feedback
Poster Quality	.09	**.52*****	**-.36*****	**-.32****
Poster Quality Round 1	.20	.16	-.20	-.16
Poster Quality Round 2	.08	**.38*****	**-.29****	-.17
Poster Quality Round 3	-.09	**.50*****	**-.27****	**-.34****

Analyses by game round revealed that, on each of the second and third game rounds, poster performance (Poster Quality 2 and Poster Quality 3) correlated with Critical Uninformative Feedback and inversely with Confirmatory Informative Feedback, as shown in Table 1, consistent with the findings across the game. No correlations were found on the first round, perhaps because students were engaging in exploration and had not yet discovered a strategy. These results indicate that better poster performance is associated positively with both types of critical feedback (significantly only with critical uninformative feedback) and negatively with both types of confirmatory feedback (significantly only with confirmatory informative feedback).

A standard linear regression analysis was conducted to determine if informative and uninformative feedback messages were individual predictors of Poster Quality for each feedback valence. A model composed of critical informative and critical uninformative feedback predicted Poster Quality [$F(2,86) = 15.92$, $p < .001$, $R^2 = .27$, Adj. $R^2 = .25$], but only critical uninformative feedback ($\beta = .54$, $B = 4.82$, $p < .001$, $r = .52$, partial = .50, part = .50) was an individual predictor on Poster Quality, while critical informative feedback ($\beta = -.06$, $B = -.62$, $p = .52$, $r = .15$, partial = -.07, part = -.06) was not. In contrast, a model composed of confirmatory informative and uninformative feedback significantly predicted Poster Quality [$F(2,86) = 8.6$, $p < .001$, $R^2 = .17$, Adj. $R^2 = .15$], but confirmatory informative feedback ($\beta = -.24$, $B = -2.1$, $p = .07$, $r = -.38$, partial = -.19, part = -.18) and confirmatory uninformative feedback ($\beta = -.20$, $B = -2.55$, $p = .13$, $r = -.37$, partial = -.16, part = -.15) were not individual predictors. Thus, out of all types of feedback examined, critical uninformative feedback is the best predictor of Poster Quality.

4.2 Is Informative Feedback Associated with the Choice to Revise Posters?

Next, the study aimed to discern between the impact of the informative and uninformative value of critical and confirmatory feedback on students' choice to revise. Table 2 shows the average critical feedback, critical informative feedback, and critical uninformative feedback for the students who did not revise any of the three posters and for the students who revised at least one of the three posters, respectively.

Table 2. Average and standard deviation of critical feedback by informational value and revision

Choice (n=89)	Critical Feedback	Critical Informative Feedback	Critical Uninformative Feedback
No Revision (n=11)	4.27 (2.76)	2.55 (1.75)	1.73 (1.62)
Revision (n=78)	6.01 (1.86)	3.45 (1.04)	2.56 (1.21)

Results show that students who choose more critical feedback also revise their posters more. Students who encounter more critical informative feedback tend to revise more, as do students who encounter more critical uninformative feedback. Table 3 shows the equivalent information for confirmatory feedback. Conversely, students who encounter more confirmatory feedback tend to revise less. This low revising trend persisted for students who encountered more confirmatory informative and uninformative feedback. Table 4 shows the average critical and confirmatory feedback broken down by informational value. Results show that, on average, students chose more critical than confirmatory feedback across the game.

Table 3. Average and standard deviation of confirmatory feedback by informational value and revision

Choice (n=89)	Confirmatory Feedback	Confirmatory Informative Feedback	Confirmatory Uninformative Feedback
No Revision (n=11)	4.73 (2.76)	3.18 (1.83)	1.55 (1.13)
Revision (n=78)	2.99 (1.86)	2.18 (1.21)	.81 (.84)

Table 4. Average and standard deviation of critical and confirmatory feedback overall and by informational value

Choice (n=89)	All Feedback	Informative Feedback	Uninformative Feedback
Critical Feedback	5.80 (2.06)	3.34 (1.18)	2.46 (1.29)
Confirmatory Feedback	3.20 (2.06)	2.30 (1.33)	.90 (.90)

Spearman correlation analyses investigated which type of feedback (informative or uninformative) was associated with Revision for each feedback valence (confirmatory or critical). Across the game, Revision was positively associated with Critical Informative Feedback and with Critical Uninformative Feedback, but negatively associated with Confirmatory Informative Feedback and Confirmatory Uninformative Feedback, as shown in Table 5. Moreover, on each game round, Revision was positively associated with Critical Informative Feedback and negatively associated with Confirmatory Informative Feedback.

Table 5. Correlations between revision and feedback value overall and by round ($^{***}p<.001$, $^{**}p<.01$, $^{*}p<.05$)

Choice (n=89)	Critical Informative Feedback	Critical Uninformative Feedback	Confirmatory Informative Feedback	Confirmatory Uninformative Feedback
Revision	**.32****	**.39*****	**-.32****	**-.42*****
Revision 1	**.24***	**.29****	**-.24***	**-.29****
Revision 2	**.24***	-.03	-.18	-.04
Revision 3	**.32****	**.41*****	**-.34****	**-.51*****

A standard linear regression analysis was conducted to determine whether informative and uninformative feedback messages were individual predictors of revision, for each of the two feedback valences, critical and confirmatory. A model composed of critical informative and critical uninformative feedback significantly predicted Revision [$F(2,86) = 8.84$, $p < .001$, $R^2 = .17$, Adjusted $R^2 = .15$] and both critical informative ($\beta = .24$, B = .21, $p = .02$, $r = .34$, partial = .24, part = .23) and uninformative ($\beta = .25$, B = .20, $p = .02$, $r = .35$, partial = .24, part = .23) feedback were individual and medium predictors of Revision. In contrast, a model composed of confirmatory informative and confirmatory uninformative feedback significantly predicted Revision [$F(2,86) = 10.01$, $p < .001$, $R^2 = .19$, Adjusted $R^2 = .17$], but only confirmatory uninformative feedback ($\beta = -.35$, B = -.40, $p < .01$, $r = -.43$, partial = -.28, part = -.26) significantly and negatively predicted Revision, while confirmatory informative feedback was not a significant negative predictor ($\beta = -.11$, B = -.08, $p = .42$, $r = -.35$, partial = -.09, part = -.08).

4.3 Is Informative Feedback Associated with Dwell Time or Time on Task?

Finally, Spearman correlation analyses were conducted to investigate whether informative and uninformative feedback messages were differentially associated with the time students spent reading feedback, as well as with the time students spent designing their posters (i.e., time on task). We examined closely the last round of the game, when students presumably had found a stable learning strategy, judging by the significant differences from the first to the second round of the game in poster performance but a non-significant difference between the last two rounds of the game.

On round 3, the amount of time students took to read feedback was associated positively with Critical Informative Feedback and negatively with Confirmatory Uninformative Feedback, as shown in Table 6. This indicates that the more the students encounter critical informative feedback, the more time they spend reading feedback on the last round of the game. Conversely, the more time the students encounter confirmatory uninformative feedback, the less time they spend reading feedback on the last game round.

Table 6. Correlations between feedback dwell time and feedback value overall and by round ($^{*}p<.05$)

Choice (n=89)	Critical Informative Feedback	Critical Uninformative Feedback	Confirmatory Informative Feedback	Confirmatory Uninformative Feedback
Feedback Dwell Time	-.16	-.18	.14	**.24***
Feedback Dwell Time 1	-.11	**-.24***	.11	**.24***
Feedback Dwell Time 2	-.14	-.11	.14	.13
Feedback Dwell Time 3	**.22***	.11	-.13	**-.22***

The association between students' time on task (i.e., the amount of time students took to design each poster) and the informational value of critical and confirmatory feedback was also examined. Results shown in Table 7 revealed that, although significant only for the second round of the game, students' time on task was positively associated with critical feedback (both informative and uninformative) and negatively with confirmatory feedback (both informative and uninformative).

Table 7. Correlations between poster design duration and feedback value overall and by round ($^{*}p<.05$)

Choice (n=89)	Critical Informative Feedback	Critical Uninformative Feedback	Confirmatory Informative Feedback	Confirmatory Uninformative Feedback
Design Duration	.02	.05	-.10	.005
Design Duration 1	.15	-.002	-.15	.002
Design Duration 2	**.23***	**.21***	**-.27***	**-.22***
Design Duration 3	.08	.12	-.11	-.12

5. DISCUSSION, LIMITATIONS, AND FUTURE WORK

Performance and Feedback Value. The game did not provide a tutorial, thus, the first round of the game was an opportunity for students to explore the digital environment. Results revealed that the more the students encountered critical uninformative feedback, the better they performed on the poster design tasks. Although the association between poster performance and critical informative feedback was positive, it did not reach significance. When the individual contributions of the informative and uninformative feedback for each feedback valence in predicting poster performance were examined, critical uninformative feedback emerged as the only significant predictor. It is surprising that uninformative critical feedback proved to be more helpful for performance than informative critical feedback. One possible explanation is that students strive to identify the shortcomings of their poster when they encounter critical uninformative feedback, thus they work harder on subsequent posters. Results also showed that the less confirmatory informative feedback students encountered, the better they performed on the poster design tasks. This result supports previous findings that confirmatory feedback, and especially praise or confirmatory uninformative feedback, may be harmful for performance (Hattie & Timperley, 2007). This result also suggests that students already know the information provided by the confirmatory informative feedback, thus they may only improve their poster designs when they read critical informative feedback that fills a gap in their poster design knowledge. This hypothesis is supported by the findings related to revision and the informative value of feedback showing that the more the students encounter critical (informative and uninformative) feedback and the less they encounter confirmatory (informative and uninformative) feedback, the more they revise their posters. However, it could be that students who usually revise their work are more drawn to seeking critical rather than confirmatory feedback. Taken together, these results warrant further investigation, because when examining the associations over each of the last two rounds of the game between the different types of feedback and feedback dwell time, as well as time on task, we found that when students encountered more critical informative rather than uninformative feedback, they tended to spend more time reading the feedback and designing posters. This suggests that critical informative feedback may be more important than both critical uninformative feedback and confirmatory feedback, which was our initial hypothesis. A follow-up study will collect more data and will include a learning post-test, which was not possible for this study due to

the limited time allotted for this assessment among a battery of assessments administered that day, to further clarify the relation between critical informative feedback and performance.

Revision and Feedback Value. Findings showed that the more the students encountered critical feedback (both informative and uninformative) and the less they encountered confirmatory feedback (both informative and uninformative), the more they chose to revise. Overall, students chose more than the average amount of critical feedback and less than the average amount of confirmatory feedback across the game. Due to the design of the informational value of feedback, students encountered a higher amount of informative than uninformative feedback for each feedback valence. The results broken down by students who revised at least once and students who never revised showed that students who more frequently chose critical than confirmatory feedback also revised more, supporting prior research (Cutumisu et al., 2015; Cutumisu et al., 2016). Conversely, students who more frequently chose confirmatory feedback also revised less. This result indicates that, for revision, the valence of feedback may be more important than the informational value of feedback, especially as critical and confirmatory informative feedback messages were designed to be equivalent in informational value and length in Posterlet. Moreover, this result was consistent on each game round as well. Thus, within the same feedback valence, the informative and uninformative feedback messages seem to be equally important. When examining the individual contributions of the informative and uninformative feedback for each feedback valence in predicting revision, informative and uninformative feedback messages were equivalent, significant, and unique predictors of revision for both critical and confirmatory feedback, respectively. These results show that the choice to revise is impacted by the valence of the feedback choice more than by its informational value. Critical feedback seems to determine students to try harder and revise their work (e.g., fix mistakes pointed out by the feedback), regardless of its specificity.

Feedback Dwell Time, Time on Task, and Feedback Value. On the last game round, findings indicate that the more the students encountered critical informative feedback and the less they encountered confirmatory uninformative feedback, the more time they spent reading feedback. Overall, this result is consistent with previous research showing that the more the students choose to seek critical feedback, the more they dwell on feedback (Cutumisu et al., 2015). This result suggests that, yet again, it is the critical informative feedback that is associated with better outcomes. The finding also suggests that the more the students encounter confirmatory uninformative feedback, the less attention they pay to this type of feedback. Results also showed that students' time on task was positively associated with critical feedback (both informative and uninformative) and negatively with confirmatory feedback (both informative and uninformative), although significantly only on the second round of the game. Taken together, these results support the findings regarding performance and revision and highlight the importance of critical over confirmatory feedback.

Limitations and Future Work. In Posterlet, students are given a choice regarding the valence of their feedback, but not regarding the informational value of feedback. The feedback system embedded in the Posterlet game is designed to alternate between informative and uninformative feedback of the same valence. For example, when choosing three pieces of critical feedback on a poster, the student may encounter two critical informative feedback messages and one critical uninformative. Moreover, if the student makes no design mistakes and chooses critical feedback, uninformative critical feedback is presented instead of critical informative feedback. Thus, a future experimental study will control both the valence and the informative value of the feedback students choose. In that case, would students choose more informative or more uninformative feedback and would their prefer critical over confirmatory feedback? Consequently, what would the students' performance be in each of these cases? Lastly, a follow-up study will explore the relation between feedback value and other factors, such as academic achievement and mindset.

6. CONCLUSIONS

The paper examined the impact of the informational value of feedback on students' performance, willingness to revise, and time spent reading feedback and designing posters. Findings showed that students' performance was positively associated with the critical uninformative feedback that they encountered and negatively associated with the confirmatory informative feedback that they encountered. Moreover, students' choice to revise was positively associated with the critical informative and uninformative feedback that they encountered and negatively associated with the confirmatory uninformative that they encountered. On the

last round of the game, findings indicate that the more time the students spent reading feedback, the more critical informative feedback and the less confirmatory uninformative feedback they encountered on that round. The data provide evidence that critical uninformative feedback is helpful for performance, critical informative feedback is helpful for revision and time on task, and confirmatory informative feedback may be detrimental for performance, for students' willingness to revise their work, and for the time they spend reading feedback in a poster design task. These findings constitute a first step in gaining an insight into the value of feedback and its impact on performance and learning choices. This research has implications for the design of assessments and instructional materials that may help students engage more closely with feedback and revision, and, consequently, apply good learning choices to improve their performance.

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