

The impact of brief reflective responses on student performance

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Abstract

One-minute papers allow students to process what they learned during class and improve student performance. However, this activity can become monotonous and takes significantly longer than the name implies. The research described here tests the effectiveness of a briefer, more flexible version of this technique to increase the perceived relevance of the material and, in turn, performance. Students were randomly assigned to either self-generate a reflective response or answer a content-specific question generated by the instructor at the end of class. Students positively evaluated the brief reflective response activity. Moreover, answering the self-generated reflective responses was associated with greater perceived relevancy of course material to students' daily lives compared to answering the content-specific questions. Perceived relevancy, in turn, was associated with higher examination grades. Thus, brief reflective responses are a useful tool to increase meaningful connections to course material which enhances examination performance.

Keywords

active learning, assessment, brief class activity, reflection, student performance

Active learning techniques

Many active-learning techniques require students to reflect on their own learning and understanding in the classroom. Such techniques increase student engagement by addressing many of Zepke and Leach's (2010) proposals for action. Especially useful in large lecture-based courses, the one-minute paper technique allows students to consider the material covered in class (Cross and Angelo, 1988; Stead, 2005), thereby increasing examination scores (Almer et al., 1998; Chizmar and Ostrosky, 1998). Other more intensive writing and journal tasks also improve student performance (Butler et al., 2001; Connor-Greene, 2000; Conrad, 2013; Dietz-Uhler and Lanter, 2009). One-minute

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papers are generally viewed positively by students (Stead, 2005) and provide valuable feedback for course instructors (Nicol and Macfarlane-Dick, 2006; Steadman, 1998). It is important for instructors to employ assessment techniques that provide feedback about the effectiveness of their teaching so that they know how to proceed with the rest of the course (Hattie and Timperley, 2007). Similarly, formative assessment feedback is useful for students (Jonsson, 2012; McCarthy, 2017).

Although one-minute papers are a beneficial learning technique, they take around 5–10 minutes of instructional time as students struggle to quickly comprehend and formulate responses (Cross and Angelo, 1988). In addition, the activity can become monotonous (Stead, 2005). Thus, researchers have tested a variety of adaptations of this technique. In its original form, the one-minute paper requires instructors to stop class up to 10 minutes early and to ask students to write their response to one or two questions. Typically, the questions ask students to identify the most important thing they learned in that day's class and the one question that they still have about the material covered (Stead, 2005). Variations of the one-minute paper have altered whether responses are signed or anonymous, and completed in pencil and paper form or electronically; whether the instructor responds individually or to a few questions at the beginning of the next class; when in the lecture the questions are posed; and even whether responses are completed individually or in small groups (Chizmar and Ostrosky, 1998; Stead, 2005). In all cases, compared to a no-activity control, a one-minute paper improves student performance.

Such improvements in student performance appear for similar engaged learning techniques. For example, the four-questions technique (Dietz-Uhler and Lanter, 2009) asks students to identify an important concept that they have learned, explain why it is important, apply it to their own life, and ask a question about the concept. Using this four-questions method to guide reflection on course information before a quiz helps students receive higher grades compared to those who complete it after a quiz. Similarly, the think–pair–share activity requires students to respond to specific questions based on the lecture material and then discuss their responses in pairs or in small groups (Butler et al., 2001). The first part of the activity lasts about 5 minutes. After discussion, the instructor facilitates a classroom dialogue to share class-generated answers or to provide the correct answer to the question. The discussion may expand to take as much time as the instructor wishes. The think–pair–share activity was well received and led to a modest improvement in students' examination grades. In general, students learn better when they reflect on concepts in written assignments (Conrad, 2013) and when they apply concepts to examples from current events or to their own lives (Connor-Greene, 2000).

Mechanisms for improving student performance

One way that active-learning techniques may improve student performance is by increasing the amount of thought about, and engagement with, course material. Students perform well in classes when they engage in critical thinking, spend time studying, or are interested in course material (Crede and Kuncel, 2008; Schneider and Preckel, 2017; Zhang, 2000). Compared to simply memorizing information for later recall, actively writing about a topic encourages students to critically evaluate the material (Prosser and Trigwell, 2014) and facilitates recall of the information (Gingerich et al., 2014). Autonomous learning is positively related to self-efficacy (Garcia and Pintrich, 1996), which can increase achievement via the desire to master skills and understand class ideas (Greene et al., 2004). In fact, more intelligent students perform well in academic environments in part because they engage in these deep approaches to learning (Chamorro-Premuzic and Furnham, 2008). All students experience the most benefit from active learning on higher level questions (e.g. applying concepts to new situations) as opposed to lower level questions (e.g. matching terms to definitions; Richmond and Hagan, 2011).

A second way that active learning may improve student performance is by increasing the perceived relevance of course material to students' daily lives (Schneider and Preckel, 2017). Students are more likely to integrate new information with previous knowledge, thus remembering it better, when instructors point out how course material relates to students' lives, experiences, and aims in life. This process relies, in part, on the self-reference effect to improve students' memory by relating course material to their self-concept (see Rogers et al., 1977; Symons and Johnson, 1997). However, it may be difficult for instructors to make such connections between course material and students' lives clear, particularly when students come from diverse backgrounds and have a variety of experiences and aims. A brief, reflective, learning activity may facilitate just this type of connection for students.

Clearly, active-learning techniques that involve reflecting on one's own understanding of course material improve student performance. Reflective learning is positively related to cognitive outcomes following meetings with instructors (McGrath, 2014), in traditional classes (Connor-Greene, 2000; Conrad, 2013), in service learning settings (Dunlap, 1998), and at the end of the first year of college (Nelson Laird et al., 2014). Following Schneider and Preckel's (2017) call to compare variations of effective teaching techniques, we test how a brief reflective response improves student performance. Specifically, we test whether providing students with instructor-generated questions versus allowing students to generate their own questions for reflection differentially affects exam performance. We also test which mechanism (i.e. increased thought and engagement or perceived relevance and self-reference) explains the association between reflection and performance. The study described here answers the following questions about brief reflective responses:

1. Does student enjoyment differ between self-generated and instructor-generated prompts?
2. Do examination scores differ between self-generated and instructor-generated prompts?
3. Do increased thought or engagement with course material explain the effects of daily questions on student performance?
4. Do self-generated prompts improve student examination grades by increasing the perceived relevance of course material?

Method

Participants

We tested students in two sections of an intermediate undergraduate level Social Psychology class at a private Midwestern university. These two sections (48 students each) were taught in the same semester by the same instructor. All students completed a daily reflection activity as part of the class. The instructor was not present when consent was obtained and there was no penalty for declining participation; 73 students (78% of all students enrolled, 85% women, 43% sophomore) provided consent to analyze their data. Of those who agreed to participate, 63 (86%) completed all study materials.

Class activity

Brief reflective responses differ from one-minute paper activities in two ways. First, they are *brief*; they take very little class time. Students may complete the activity at any point during class and are given only 2 minutes at the end of class to finish their reflection. Although brief, this activity increases student-instructor communication, stimulates meaningful learning, and assesses class

progress. Second, brief reflective responses are *flexible*. Rather than requiring students to complete the same task each time (e.g. identify something they learned or something they are unclear about), students may write about any aspect of the material that stood out to them that day. Allowing students the flexibility to determine both the topic and nature (i.e. question or comment) of their reflective response lets the activity adapt to student needs and allows them to make meaningful connections with the material. Students may also consider connections between the material and their daily lives without disclosing personal information in their responses.

Within each section, students were randomly assigned to either complete self-generated ($n=36$) or instructor-generated ($n=37$) prompts. In the *self-generated prompt condition*, students were encouraged to write a question about the material that they would like the instructor to answer or a comment about how the course material was interesting or related to their own lives. In the *instructor-generated prompt condition*, students received specific questions to answer during each class session. To create a more stringent comparison than a no-activity control condition, these instructor-generated questions encouraged some level of engagement with the course material beyond simply copying down factual information.

Procedure

At the beginning of the semester, students received a handout that described the daily class activity and included instructions for either the *self-generated prompt* or the *instructor-generated prompts*. All but one student followed the instructions in their handout throughout the semester. Students in the self-generated and instructor-generated prompt conditions did not differ based on class section, gender, or year in school ($t_s < 0.45$, $p_s > 0.66$).

The instructor ended class 2 minutes early to allow students to finish this activity using index cards. Students could complete up to 24 responses, which counted for 10% of their course grade. Again, their grade was independent of participation in this study. At the beginning of each class, the instructor announced the correct response to the instructor-generated question from the previous class and responded to two questions from the self-generated prompt condition.

At the end of the semester, students completed a survey about the activity. They used a 5-point scale that ranged from 1 (*strongly disagree*) to 5 (*strongly agree*) to report the extent to which they thought the activity was enjoyable, and it encouraged them to think deeply about lecture material. Students also indicated whether they felt engaged with the class material and whether the material was relevant to their daily lives.

We collected student examination grades from the four multiple-choice examinations administered throughout the semester and calculated an average of the four examination scores (out of 100%).

Results

Across both conditions, students completed the majority of the possible responses (about 92%). Students in the instructor-generated prompt condition answered the question correctly 96% of the time. In the self-generated prompt condition, 74% of responses posed a question and 18% included a self-reference (e.g. “The Jim Jones compliance will forever be a confounding and tragic influence of obedience. It makes me second guess and think deeper about what authority figures are saying”; “sometimes I feel like I am perpetuating gender norms because I love sparkles + pink + wearing dresses. I’m not trying to, it’s just what I like. I don’t know if I should try to change this or not?”).

Question 1: student enjoyment of self-generated versus instructor-generated prompts

Independent-samples *t*-tests showed that students in the self-generated prompt condition did not differ from students in the instructor-generated prompt condition regarding how much they reported enjoying the activity (see Table 1).

Table 1. Ratings of the brief reflective response activity and exam grades for instructor- and self-generated prompts.

	Type of reflection prompt		<i>df</i>	<i>t</i>
	Instructor-generated	Self-generated		
Number of brief reflective responses completed (out of 24)	22.00 (2.78)	22.28 (3.20)	71	−0.40
Number of questions asked in responses (out of 24)	0.84 (0.65)	16.53 (6.95)	36 ^a	−13.50**
Number of self-references in responses (out of 24)	2.11 (1.02)	4.03 (4.95)	38 ^a	−2.28*
Enjoyment of activity	3.80 (0.71)	3.45 (0.79)	61	1.81
Encourages thinking about lecture material	3.87 (0.90)	4.00 (0.87)	61	−0.60
Engagement with course material	4.37 (0.67)	4.48 (0.87)	61	−0.60
Course material is relevant to daily life	4.50 (0.63)	4.79 (0.49)	54 ^a	−2.02*
Average exam score (out of 100%)	86.77 (7.82)	86.73 (9.10)	70	0.02

Standard deviations appear in parentheses.

^aLevene's test indicated unequal variances ($F=8.55$, $p=0.01$), so degrees of freedom were adjusted from 61 to 54.

* $p < 0.05$; ** $p < 0.01$.

Question 2: examination scores in the self-generated versus instructor-generated prompt conditions

Correlations show that, among students in the self-generated prompt condition, completing more responses was positively related to examination scores. This was not found among students in the instructor-generated prompt condition (see Table 2). In addition, among students in the self-generated prompt condition, asking more questions was related to increased examination scores. However, an independent-samples *t*-test found no difference between the two conditions in examination scores (see Table 1). Given the subtle differences between the self- and instructor-generated prompt conditions, this is not surprising.

Question 3: indirect effect of self-generated prompts on examination scores via the amount of thought or engagement with material

We examined whether the self-generated prompts were related to greater student performance via the amount of thought or engagement with course material using the PROCESS macro (Model 4; Hayes, 2018). The indirect effect was tested using a bootstrap estimation approach with 5000 samples. We tested the effects of the type of prompt on examination grades mediated by amount of thought and, separately, engagement with course material. We controlled for course section, gender, year in school, and the number of content reflections completed.

Table 2. Means, standard deviations, and correlations of brief reflective response activity ratings and exam grades in the self- and instructor-generated conditions.

Variable	M	SD	1	2	3	4	5	6	7	8
1. Number of responses completed (out of 24)	22.28 (22.00)	3.20 (2.78)	–							
2. Number of questions asked (out of 24)	16.53 (0.84)	6.95 (0.65)	0.47** (-0.39%)	–						
3. Number of self-references (out of 24)	4.03 (2.11)	4.95 (1.02)	-0.02 (0.43***)	-0.74* (-0.18)	–					
4. Enjoyment of activity	3.45 (3.80)	0.79 (0.71)	0.31 (0.18)	-0.02 (-0.27)	.13 (0.01)	–				
5. Encourages thinking about material	4.00 (3.87)	0.87 (0.90)	0.31 (-0.05)	-0.06 (0.14)	0.07 (-0.11)	0.50** (0.23)	–			
6. Engagement with course material	4.48 (4.37)	0.87 (0.67)	-0.03 (-0.24)	0.06 (0.26)	-0.003 (-0.32)	0.35* (0.09)	-0.17 (0.31)	–		
7. Material is relevant to daily life	4.79 (4.50)	0.49 (0.63)	-0.30 (-0.21)	-0.05 (0.32)	-0.08 (0.03)	-0.15 (-0.23)	-0.15 (0.24)	0.47** (0.37%)	–	
8. Average exam score (out of 100%)	86.74 (86.77)	9.10 (7.82)	0.62** (0.16)	0.35* (0.05)	0.04 (0.09)	-0.09 (-0.19)	-0.03 (-0.21)	0.18 (0.36)	0.11 (0.31)	–

Data for the instructor-generated prompt condition appear in parentheses.
* $p < 0.05$; ** $p < 0.01$.

These analyses revealed no indirect effect of the type of prompt on examination grades for either amount of thought, $b=-0.10$, standard error (SE)= 0.36 , 95% confidence interval (CI)= $[-1.18, 0.24]$, or self-reported engagement with course material, $b=0.35$, $SE=0.82$, 95% $CI=[-0.70, 2.55]$. Therefore, the effect of this brief reflection activity on examination performance is not explained by simply considering the amount of thought students put into their response or by considering their engagement with the material.

Question 4: indirect effect of self-generated prompts on examination scores via perceived relevance of course material or self-references

In both conditions, correlations show that participants who reported being more engaged with course material also felt that the course material was more relevant to their daily lives (see Table 2). However, the number of self-references students made in their responses was not related to perceptions of how relevant the course material was to their daily lives. In other words, making meaningful personal connections with course material was independent of how often students chose to share those personal connections.

To examine whether self-generated prompts were related to greater student performance via their effect on the perceived relevance of course material or self-referencing responses, we tested an additional mediational model (described above). This analysis tested the effects of the type of prompt on examination grades mediated by perceived relevance of the material and the number of self-referencing responses. The type of prompt significantly predicted perceived relevance of course material and perceived relevance significantly predicted student performance (see Table 3). Type of prompt also predicted the number of self-references, but this was unrelated to student performance. We found a significant indirect effect of the type of prompt on examination scores via perceived relevance of course material to daily life (see Table 4). This suggests that our brief reflective response activity enabled students to perceive the course material as relevant to their daily lives which indirectly increased examination performance even controlling for the number of times students wrote about such connections.

Table 3. Model coefficients for the mediational model of condition predicting student performance.

	Perceived relevance of course Material			Number of self-referencing responses			Exam grade		
	<i>b</i>	<i>SE</i>	<i>p</i>	<i>b</i>	<i>SE</i>	<i>p</i>	<i>b</i>	<i>SE</i>	<i>p</i>
Constant	6.54	1.05	<0.001	4.55	7.16	0.53	28.50	15.26	0.07
Condition	0.32	0.14	0.03	1.84	0.97	0.06	0.30	1.71	0.86
Perceived relevance of course material	—	—	—	—	—	—	4.75	1.48	0.002
Number of self-referencing responses	—	—	—	—	—	—	−0.01	0.22	0.98
	$R^2=0.14$			$R^2=0.14$			$R^2=0.38$		
	$F(5, 57)=1.83, p=0.12$			$F(5, 57)=1.79, p=0.13$			$F(7, 55)=4.89, p<0.001$		

Discussion

This study showed that the brief reflective response activity is a useful active-learning technique for increasing perceived relevancy of course material and, in turn, overall performance. As in

Table 4. Relative direct and indirect effects of the mediational model of condition predicting student performance.

	<i>b</i>	<i>SE</i>	95% confidence interval
Total effect	1.81	1.71	−1.60, 5.23
Direct effect	0.30	1.71	−3.14, 3.73
Indirect effect via perceived relevance of material	1.53	1.07	0.03, 4.00
Indirect effect via number of self-referencing responses	−0.01	0.31	−0.64, 0.63

previous research (Stead, 2005), students generally liked the activity. Students in both conditions also attended class regularly and completed the majority of responses. Responding to a flexible, self-generated prompt was related to increased perceptions that course material is relevant to students' daily lives, and this perception, in turn, increased student performance. Importantly, this effect was found controlling for the number of times students explicitly referenced the self in their responses. Thus, merely encouraging students to think about connections between course material and their daily lives increased perceptions that material is self-relevant regardless of what students chose to share with the instructor. This effect was specific to perceptions of relevancy, not how deeply students believed that they thought about course material or how engaged they felt with it.

Results for the self-generated reflection condition extend previous research showing the effectiveness of reflection assignments on student performance (Connor-Greene, 2000; Conrad, 2013; Dunlap, 1998; McGrath, 2014). We believe that allowing students the flexibility to choose the format of responses motivated reflective learning, which is characterized by examining the strengths and weaknesses of their views on a topic, trying to better understand others' perspectives, and reevaluating prior understanding of an issue or concept (Nelson Laird et al., 2014). Although the amount of thought about course material was not different between the two versions of the activity, students in the self-generated prompt condition may have been motivated to reflectively consider the course material in search of a topic for their responses, rather than simply identifying the information needed to answer the instructor-generated prompt. In doing so, the students may have been more likely to consider a wider range of course material and to make meaningful connections to their personal lives.

In addition, this activity produces useful feedback for instructors about which topics continue to be sources of confusion and which topics or activities were interesting and meaningful to students. Such feedback plays an important role in helping instructors monitor their own teaching effectiveness and decide how to proceed with the rest of the course (Hattie and Timperley, 2007). Given the brief amount of time required to implement this activity, instructors may benefit from implementing this flexible active-learning technique in their courses.

Because research suggests that one-minute papers improve examination scores (Almer et al., 1998; Chizmar and Ostrosky, 1998), we did not include a no-activity control condition in this study. This limited our ability to test whether completing versus not completing this activity was directly related to examination grades. Our results suggest that there was no difference in examination grades between students in our self-generated and instructor-generated conditions. This supports previous research indicating that any form of active learning may be beneficial compared to standard lectures (Schneider and Preckel, 2017).

The content of our instructor-generated prompts may have limited our ability to test whether self-generated (vs instructor-generated) prompts lead to higher examination grades. Because we wished to conduct a stringent test of our self-generated brief reflective responses, the instructor-generated prompts encouraged more engagement with course material than simply repeating information from

the lecture. For example, students had to use what they learned about dissonance theory to explain whether they would be happier with a recent purchase if they were allowed to make returns, compared to if the sale were final. In addition, the instructor announced the correct response to the instructor-generated prompts and responded to questions from the self-generated reflective responses at the beginning of each class. The fact that students who completed both versions of this activity were present for these announcements and that students in both versions were encouraged to deeply process the material may have contributed to the lack of direct effects on examination grades. Future research could assign prompt types to different course sections (rather than random assignment within a class) and use factual questions from course material to reduce contamination between conditions. This research was also limited to a fairly small number of students, who were all taking the same psychology course at the same university and within the same cultural context. This limits the generalizability of the results. Future researchers may want to test the effects of the brief reflective response activity in larger classes and a wider variety of class subjects and universities.

In comparison with previous versions of the one-minute paper and the instructor-generated prompt condition, the self-generated brief reflective response activity has several benefits. First, self-generated brief reflective responses are easier to implement than instructor-generated reflections, take less class time, and avoid certain pitfalls inherent in using instructor-generated prompts. Specifically, instructor-generated prompts require careful planning and preparation to ensure that each question is thought-provoking and that the class lecture includes the relevant information needed for students to respond correctly. In comparison, self-generated prompts allow students to select material that they find the most provocative or challenging to use as the basis of their reflection.

Second, allowing students to determine what aspect of the lecture material they wish to reflect on allows instructors to know which elements of the lecture caught students' attention and when students may be struggling to understand the course material. Perhaps not always requiring students to ask questions with self-generated prompts (as has been done in the past; Stead, 2005) may provide instructors feedback about students' understanding of the material. Because students have the option of choosing another form of response, it may more accurately reflect confusion about a topic when questions are included in the reflections. Moreover, broadening the scope of the brief reflective responses allows instructors to capture other information, including student interest in practical applications of the material to everyday life. Doing so may reveal where the instructor may reinforce or expand a lecture to meet student needs. This may be especially helpful in courses that are still under development or when new concepts or activities are introduced.

This activity takes very little class time to complete and can be adapted to fit a specific course. Future research should determine how variations of this activity could be best used to support student learning. Instructors may wish to explore additional forms of this brief reflective response activity to determine the method that works best for a specific class. Modifications may depend on both the course topic and the size of the class. For example, small classes allow for more personalized feedback than large classes (e.g. answering all student questions rather than just two or three questions). Alternatively, instructors may choose to use instructor-generated prompts but allow students to deviate from the given prompt if they have a specific question or comment. In other classes, it may make sense to alternate between self- and instructor-generated prompts depending on the time of the semester or the content. For example, the instructor may temporarily use self-generated prompts following the introduction of new content.

Future instructors can also adapt the method of prompt delivery or feedback, perhaps adopting technological advances to this paper-and-pencil technique. For example, rather than responding to questions at the beginning of class, questions could be uploaded to a class forum where other students could respond. Using online delivery methods would also allow instructors to respond to questions and to provide correct responses before the next class, preventing students from studying

incorrect information. This may be especially useful for brief reflective responses completed in sessions immediately preceding examinations, although further research is needed to determine how different feedback techniques affect this activity.

In conclusion, the brief reflective response activity is a quick, useful, active-learning technique for instructors. Although we tested this activity in a psychology course, such an activity may be used in a variety of content areas in the liberal arts or sciences. Evidence from our study suggests that having self- versus instructor-generated prompts influences students' perceptions of the activity and of the class material itself, but the overall appeal of this activity is robust to variations in the specific instructions provided. Furthermore, allowing students to select the topic and content of their brief reflective responses indirectly improves student performance by helping students to relate course material to their own lives. We encourage instructors to explore variations that may fit their specific class needs.

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