The Effect of Structured Divergent Prompts on Knowledge Construction

Ginger S. Howell
Usenime Akapnudo
Mengyi Chen
Harding University

Autumn L. Sutherlin
Laura E. James
Abilene Christian University

ABSTRACT

Discussion forums are a widely used activity in online courses. However, knowledge construction within online discussion rarely stimulates high levels of thinking. Therefore, it is important to understand which aspects of online discussion encourage learning and increase knowledge construction. This paper investigates the effect three Structured Divergent prompts (playground prompts, brainstorm prompts, and focal prompts) have on knowledge construction as compared to Convergent prompts. Students (N = 58) were required to participate in an online discussion during a graduate education course at a private university. The Interaction Analysis Model was used to determine the levels of knowledge construction demonstrated within students' posts. The posts were given a score using the following codes: 0-no post/no understandable post; 1-sharing information, 2-disagreeing; 3-negotiation of meaning; 4-testing co-construction; 5-agreement of the constructed meaning. The analysis revealed two of the three Structured Divergent prompts (focal and brainstorm) yielded significantly higher levels of knowledge construction as compared to Convergent prompts.

I. INTRODUCTION

According to Gagne (1970), various internal and external conditions are required for learning. The underlying idea of Gagne's work is that external conditions affect the learner internally. As Gagne explained, "[a] learning event … takes place when the stimulus situation affects the learner in such a way

that his performance changes from a time before being in that situation to a time after being in it" (1970, p. 5). Gagne believed that external learning conditions should be planned before learning can occur. In his words, "[d]esigning instruction for initial learning is thus seen to be a matter of setting up a total set of circumstances within which learning can be embedded" (Gagne, 1970, p. 322). Gagne's principle of Instructional Design forms the basic underlying principle of this study.

One external condition studied using Bloom's Taxonomy is the prompt type used. Prompts can take many different forms. As defined by Berthold, Eysink, and Renkl, "prompts are requests that require the learners to process the to-be-learned contents in a specific way" (2009, p. 347). One way to classify prompts is as Convergent or Structured Divergent prompts. Andrews' (1980) implied that Convergent prompts require students to think too broadly or too narrowly, which restricts students from effectively solving the problem. Prompts which are classified as Convergent include general invitation, analytic convergent, single, multiple consistent, shotgun, quiz show, and funnel questions (Andrews, 1980). For example, in this study we used the following convergent funnel prompt for the control group: "What are your thoughts about how the legal system or education system works as discussed in chapter one? What jumped out at you that you did not already know? What are some things you already knew? Do you still have questions about the legal system?"

Divergent prompts help students focus on the question at hand and require learners to work together to provide an answer. Structured Divergent prompt types include the following: playground, brainstorm, and focal questions. First, playground questions are prompts which focus on "a promising sub-aspect of the material," such as a specific aspect of literature, history, or concept being studied (Andrews, 1980, p. 157). As Andrews discussed, the playground question takes an aspect of the content and asks students to discuss the topic within the bounds set. This keeps students talking about the same topic, yet allows for different aspects to be discussed. In this study, for example, the following playground prompt was used: "What are your thoughts about limiting or eliminating gangs in schools?" This prompt allows discussion on how to limit gangs, possibly through stricter regulations, extra-curricular activities, or omit stronger support systems within the school. It allows students to also discuss the positive and negative aspects of limiting gangs in schools. Many aspects can be discussed. However, the prompt restricts students from discussing anything outside of limiting gang activity, such as the manifestation of gangs, signs of gangs in schools, and impact of gangs in a school system.

Second, Andrews described brainstorm questions as those that generate ideas and solutions by encouraging students to collaborate. As an example, in this study the following brainstorm question was used: "In what ways do you believe that school personnel could be charged with slander or libel?" This prompt requires students to collaborate ways or instances that school personnel could be charged with libel. With such a prompt, students don't just regurgitate information, but they read each other's posts and come up with original answers to build upon previous discussion.

Third, Andrews (1980) defined focal questions as questions which involve a complex controversy with more than one possible solution. These prompts force students to choose an argument and prepare a supportive rational. In this study, the following focal prompt was used to address the topic of safety: "What security and safety measures should be implemented or eliminated in schools? Explain your argument." By requiring students to explain their opinions of what safety measures should be put into place, students have to choose and justify their argument. Often times, students need to read others' arguments first before they come up with their argument.

Previous studies, such as Andrews (1980), Bradley, Thom, Hayes, and Hay (2008), and Wruck (2010) created a foundational understanding of prompts and discussed the impact of Structured Divergent prompts on critical thinking. These studies determined that certain prompts can affect students' thinking, and identified which prompt types are most effective. Without using the above studies, the researchers of this study would not have known which prompts to examine. Once the effective prompts were identified, the researchers measured knowledge construction in students' discussion posts using the Interaction Analysis Model (IAM), which differs from previous studies.

II. LITERATURE REVIEW

A. Impact of Structured Divergent Prompts

Andrews (1980) studied eleven types of prompts within the two larger categories of Convergent and Structured Divergent designs. He found that different prompt types can impact and/or limit the extent of student responses within a discussion. According to Andrews (1980) divergent prompts (brainstorm, focal, and playground) helped instructors encourage a more robust discussion because students have the freedom to fully discuss the topic without getting off track. Andrews (1980) investigated the effect of the prompt types in a face-to-face environment.

One of his research questions examined certain characteristics of prompts and their association with various levels of participation. His results showed that Divergent prompts are more productive than Convergent prompts. The study also found that higher-level prompts, based on Bloom's Taxonomy, received more responses from students. Prompts that exhibited structure and boundaries were more productive when generating discussion than prompts without structure and boundaries. Interestingly, there was no significant difference between unfocused prompts and low-level divergent prompts, which address the first three levels of Bloom's Taxonomy: knowledge, comprehension, and application. It was found that unfocused prompts were less effective than Structured Divergent prompts. However, it was noted that a larger pool of unfocused prompts is necessary to replicate and validate the results.

Overall, Andrews (1980) found Structured Divergent prompts to be three times more productive in discussion than other types of prompts. It was seen that when teachers used Structured Divergent prompts consistently, the results were "fruitful" (Andrews, 1980, p. 154). Andrews reported that although the Structured Divergent prompt types were effective, they differed in various qualities. For example, focal questions were most likely to encourage student-to-student interaction while brainstorm questions relied on the teacher to focus productivity. Focal questions encouraged competition, whereas playground questions encouraged collaboration. The study showed that all three Structured Divergent prompt types were classified at the higher end of Bloom's Taxonomy, but the three types differed in how they required students to process data. Playground questions required students to interpret data; focal questions were deductive; and brainstorm questions were both inductive and deductive.

Andrews' (1980) study showed that prompts are an external condition that affected the internal response of the learner. In addition, the study narrowed down a number of prompt types and found that Structured Divergent prompts were the most effective. It is also important to note that although the study determined which prompt types were designed to reflect levels of critical thinking, Andrews did not code student responses to determine if higher levels of critical thinking were actually demonstrated.

In 2008, Bradley et al. used Bloom's Taxonomy to examine whether different types of prompts influenced learning during online discussions. Prompt types used were direct link, course link, brainstorm, limited focal, open focal, and application. Bradley et al. investigated which prompt type generated the highest word count, generated the most complete answers, and resulted in higher-order thinking in answers and responses.

Bradley et al. (2008) used Gilbert and Dabbagh's (2005) coding scheme to examine higher-order thinking in student responses based on the three highest levels of Bloom's Taxonomy. The researchers also examined word count and answer completion in the transcripts of eight online discussions provided by 114 undergraduate students in three sections of a hybrid child development course. The eight discussions, each consisting of three prompts, were considered hot-topics in child development. The responses were divided into two groups: answers, which consisted of 1380 analyzed posts, and responses, which consisted of 849 analyzed posts.

Statistical analysis of word count showed that limited focal prompt generated the most words. Similar to the conclusions from Andrews' (1980) study, the authors believed this was because controversy introduced by the prompts allowed for opinions and other alternatives to be discussed. Application prompts encouraged the least amount of words.

Gilbert and Dabbagh (2005) also rated student responses using a four-point Likert scale from "no response" to "full response." A statistical analysis showed that limited and open focal prompts encouraged students to complete the answers while application and course link prompts did not. This was again thought to have occurred because the limited and open focal prompts encouraged opinions. However, writing a lengthy comment that addressed each part of the prompt did not mean students gave higher-level answers and responses.

In the third portion of the study, Gilbert and Dabbagh's coding system was employed to determine whether the answers and responses were rated as higher-order in Bloom's Taxonomy. The following codes were given to students' posts: knowledge (1), comprehension (2), application (3), analysis (4), synthesis (5), and evaluation (6). When students answered incorrectly, a zero was given. It is important to note that when students demonstrated two levels of critical thinking in their answers, an average score was given. For example, "a student with two responses rated a one and three received the average rating of two" (Bradley et al., 2008, p. 893). This average does not show the highest level a student eventually reached, and it is not noted how many responses were an average and how many responses reached only one level. The results showed that most of the participants' answers reflected lower-order thinking skills; however, at a statistically significant rate, course link, brainstorm, and direct link prompts encouraged higher levels of critical thinking than open focal and application, which produced the lowest. Although course link prompts did not score high in the other research questions, the prompt type produced higher-order thinking responses because it encouraged students to discuss prior knowledge and other resources. The brainstorm prompts and direct link prompts ranked high. Bradley et al. stated that the brainstorm question type "seemed to facilitate students justifying their solution by bringing in prior knowledge or examples from their own life…" (p. 898).

Bradley et al. (2008) did not discuss which specific levels were reached. Instead, the authors reported the results in terms of two groups: lower levels of thinking (levels 1-3 of Bloom's Taxonomy) or higher levels of thinking (levels 4-6 of Bloom's Taxonomy). At times, Bradley et al. noted that an average level was demonstrated. However, the reader cannot determine if any posts ever reached a particular higher level, since no specifics were given.

Wruck (2010) also studied the effect of prompt types on critical thinking using Bloom's Taxonomy. Unlike the study done by Bradley et al. (2008), this study used archived discussions from graduate students and, overall, was more elaborate in describing its findings. The study examined which levels of Bloom's Taxonomy were exhibited when students responded to several Computer-Mediated Communication (CMC) prompt types and the pattern among responses in relationship to Bloom's Taxonomy for each prompt type.

Wruck (2010) stated that "[t]he review of literature commonly illustrate[d] five prompts, including (a) read and respond, (b) scenario, (c) case study, (d) controversy/debate, and (e) search and critique (Christopher et al., 2004; Hmelo-Silver, 2004; Hughes & Dayken, 2002; McDade, 1995; Moore & Marra, 2005)" (p. 1). Wruck (2010) examined courses in a Doctor of Business Administration (DBA) program that used at least four of the five prompt types she was investigating. Two courses from the DBA core and two from the concentration areas were selected using the Excel sampling feature.

After the discussions were chosen, each post within the discussion was assigned a level of Bloom's Taxonomy: knowledge (1), comprehension (2), application (3), analysis (4), synthesis (5), and evaluation (6). The codes were used to determine if a pattern existed between the type of prompt and the level of Bloom's Taxonomy. A total of 491 learner responses were analyzed. The researcher counted the number of posts in each category for each strategy to obtain the average cognitive level.

Wruck (2010) found that 83% of the learner responses consisted of the second, third, and fourth levels of Bloom's Taxonomy (application, analysis, and synthesis). Read and respond prompts averaged a level three (application) but also had reached level four (analysis) once. Scenarios demonstrated a level four (analysis) as an average and reached a level six (evaluation). Case study averaged a level five (synthesis) and also reached a level six (evaluation). The average level of controversy/debate prompts was a level

three (application). Search and critique prompts demonstrated a level three (application) as well. The overall results of Wruck's (2010) study showed a link between cognition and instructional design, as some prompt types yielded higher levels of Bloom's Taxonomy than others. This demonstrates that the external condition of prompt type affects learner achievement.

These studies from Andrews (1980), Bradley, Thom, Hayes, and Hay (2008), and Wruck (2010) show Bloom's Taxonomy can be used to evaluate discourse and that prompt designs affect student learning. However, Bloom's taxonomy was not used for this study. Booker (2007) stated that Bloom's taxonomy has been misused in education because it was created by thirty-four educators, psychologists, and school examiners to classify test questions, not to assess student responses. The previous articles discussed used Bloom's taxonomy to classify both the prompts and the student responses. Therefore, to more accurately determine whether prompt designs affect student responses, the Interaction Analysis Model (IAM), which is a tool designed to assess student knowledge construction within discourse, was used for this study. In addition, IAM was used for this study because previous studies have not examined prompt design using this method.

B. The Interaction Analysis Model

Gunawardena and colleagues (1997) used France Henri's (Henri, 1992) research to create a tool specifically designed to analyze knowledge construction in CMC. Another model was needed because Henri's model, based on instructor-centered learning, did not examine the collaborative learning process. In addition, Henri's model did not holistically investigate discussion and made it difficult to distinguish between the metacognitive and cognitive dimensions (Gunawardena et al., 1997). After investigating a number of analysis tools, the Interaction Analysis Model (IAM) was designed, based on constructivism, to categorize segments of online discussion posts into five levels of knowledge construction. Each level had multiple sub-category descriptions solely to aid the coders in determining the level of knowledge construction (Figure 1). However, the IAM analysis tool did not give individual scores that distinguished among subcategories.

Gunawardena et al. (1997) used a coding sheet to identify the level (Figure 1: next page) demonstrated within each message. Submitted comments were given a number associated with a level of knowledge construction. Posts which yielded multiple codes were recorded at the highest level (Gunawardena et al., 1997; Dunlap et al., 2007). Gunawardena et al. found that the number associated with each level could be used to quantifiably track knowledge construction.

Gunawardena et al. (1997) noticed two themes when analyzing dialogue using IAM. First, knowledge construction proceeded from level one to level five in some discussion threads. Second, multiple levels of knowledge construction could be demonstrated within one post. The authors found most posts demonstrated only the first level of knowledge construction. However, some students started at lower levels and moved towards the third level, but rarely exceeded the third level.

C. Summary

While previous studies have addressed the effect of divergent prompts on critical thinking in both online and face-to-face environments, the effect of divergent prompts on knowledge construction using IAM has not been studied. Therefore, the question remains, how can higher levels of knowledge construction be consistently achieved in online learning? Hopkins et al. (2008) claimed that it is probable that some task designs can promote knowledge construction. A better understanding of which external conditions create successful online discussion is needed. Studies have already examined prompt types using Bloom's Taxonomy (Bradley et al., 2008; Wruck, 2010), but student responses using IAM have not been studied in correlation to specific prompt types

Figure 1

1. Sharing/Comparing Information
    a. Statement of observation/opinion
    b. Statement of agreement
    c. Supportive examples/comments
    d. Asking/answering questions
    e. Define/describe/identify problem
2. Dissonance or inconsistency among ideas
    a. Disagreeing
    b. Asking/answering in concerns to disagreement
    c. Restating position
3. Negotiation of meaning/co-construction of knowledge
    a. Negotiation or clarification of the meaning of terms
    b. Negotiation of the relative weight to be assigned to types of argument
    c. Identify areas of agreement
    d. Proposal and negotiation of new statements showing compromise and co-construction
    e. Metaphors or analogies
4. Testing/modifying synthesis or co-construction
    a. Testing synthesis against shared responses
    b. Testing against schema
    c. Testing against experience
    d. Testing against data
    e. Testing against literature
5. Agreement statement(s)/applications of newly constructed meaning
    a. Summarization of agreement(s)
    b. Application of new knowledge
    c. Metacognitive statements of participants illustrating understanding

Figure 1. Knowledge Construction Hierarchy (Gunawardena et al. 1997)

III. STUDY

A. Questions

Question 1: How does the playground prompt affect the levels of knowledge construction based upon IAM scores compared to students who respond to prompts that do not use any of the three Structured Divergent prompts after controlling for pre-test IAM scores?

Question 2: How does the brainstorm prompt affect the levels of knowledge construction based upon IAM scores compared to students who respond to prompts that do not use any of the three Structured Divergent prompts after controlling for pre-test IAM scores?

Question 3: How does the focal prompt affect the levels of knowledge construction based upon IAM scores compared to students who respond to prompts that do not use any of the three Structured Divergent prompts after controlling for pre-test IAM scores?

B. Participants

The participants in this study consisted of 58 students (N = 58) enrolled in a mandatory online graduate level school law course taught by three instructors in the spring of 2013. The southern faith-based university at which the study was conducted has a student population of approximately 6,000 students with 1,000 students enrolled in graduate education programs. As part of the course orientation during the first week of the semester, students were asked to participate in the study. Students declined or gave permission for their work to be collected and analyzed. Participants were identified before the treatment began. All students participating in the study signed an informed consent form approved by the university's Internal Review Board.

C. Method and Procedure

Students were randomly assigned to four discussion groups within the course before the study began. Each of the four groups was assigned the type of prompt they would receive. The four groups consisted of 15, 16, 15, and 12 students respectively. The groups stayed the same after students identified whether they were willing to participate in the study, and all students were exposed to the same content and expectations. All four groups discussed the same topic, however, prompts were worded differently to reflect the prompt type assigned to each group. In addition, the participants were subjected to different instructors. Three instructors taught four sections, with one instructor teaching two of the four sections. Non-participants' discussion posts were not included in our results.

Before the start of the course, Convergent and Structured Divergent prompts were designed with the input of the course's instructors. A trained instructional designer created prompts for both the control group and the treatment group. The control group received Convergent prompts (multiple consistent, funnel, general invitation, analytic convergent, quiz show, shotgun, lower-level divergent, and single questions), and the three treatment groups received the Structure Divergent prompts (playground prompt, focal prompt, or brainstorm prompt).

For the control group, the instructional designer used prompts that have been implemented in previous sections of the course since they already reflected a variety of Convergent prompts. For example, the researchers used a convergent funnel prompt in the control group for a chapter focusing on the legal system. This prompt had many questions that students had to answer. Therefore, students' thoughts were not focused on one idea, but many. For the treatment group, the designer used Andrew's (1980) article, the course textbook, and the section instructor's input to change existing prompts into Structured Divergent prompts. One of the playground questions for the chapter on gangs asked students to discuss their thoughts about limiting or eliminating gang activity in schools. This prompt allowed discussion on how to limit gang activity in schools, possibly through stricter regulations, extra-curricular activities, or omit stronger support systems within the school. As described earlier, the prompt restricts students from discussing anything outside the scope of gang activity. One of the brainstorm prompts for the chapter discussing slander asked participants to come up with ways school personnel could be charged with slander or libel. This required students to develop a list together, not just regurgitate information from text. One of the focal prompts of the chapter focusing on safety asked participants to identify the best security and safety measures that should be implemented or eliminated in schools and required students to defend their answer. This encouraged students to not solely rely upon information they read, but to use personal experiences to back their argument.

A pre-test/post-test equivalent group design was used for this study. During the first three weeks of the course, all groups received Convergent prompts during the discussion. Then, the data was collected at week 3 so that students were accustomed to Convergent prompts; therefore, the level of knowledge construction was not influenced by the unfamiliarity of the prompt type. To provide a baseline that would

serve as a covariant, all groups were exposed to Convergent prompts through the third week and week 3 responses were scored using the IAM analysis tool. Each response received a rating of 0-5 on the IAM analysis tool. A zero was given when students did not respond or responded but did not measure on the IAM scale. For each student, the ratings from all three posts were combined to give the student a score of 0-15. Three posts (one initial response and two replies) were required each week. Therefore, only three responses from each student were used. During weeks 4 through 12, the three treatment groups received their assigned Structure Divergent prompts. The control group continued to receive Convergent prompts from week 4 to week 12. The data was collected during week 12 to allow students to have an adequate amount of time to be subject to the treatment before an assessment was done. Since the researchers were not concerned about a gradual change, an assessment was not done in the middle of the treatment period. Responses to week 12 discussions were scored as the post-test using the same method described for the pre-test.

D. Instrument

The Interaction Analysis Model (IAM) tool was designed to detect and understand knowledge construction during collaborative discussions (Saritas, 2006). The IAM responses were classified in the five levels of knowledge construction (Figure 1) in a social constructivist environment (Schellens et al., 2007; Buraphadeja & Dawson, 2008; Wang et al., 2009; Gunawardena et al., 1997): "(1) sharing and comparing information, (2) identifying areas of disagreement, (3) negotiating meaning and co-construction of knowledge, (4) evaluation and modification of new schemas that result from co-construction, and (5) reaching and stating agreement and application of co-constructed knowledge" (DeWever et al., 2009, p. 181). Krippendorff's alpha inter-rater reliability for the IAM has been determined to range between 0.40 and 0.80 (DeWever et al., 2009).

E. Data Collection, Analysis, Storage, and Protection

Data was collected electronically from the course's learning management system. The instructors compiled students' responses—both students' identities and the prompts assigned to each group were masked. Only the first three responses posted by each student were included in the statistical analysis. The researchers used the IAM to assign codes from zero to five to indicate the levels of knowledge construction demonstrated in multiple student discussions (Gunawardena et al., 1997; Hew & Chueng, 2011). They used the knowledge construction hierarchy shown in figure one to categorize each of the responses. Following Gunawardena's procedures, the subcategories were only used in identifying the level of knowledge construction and for analysis did not receive scores that distinguished among them within a single level. When the posts consisted of more than one code, the highest code was used for analysis. When the student did not post or if the post did not demonstrate any of the levels, a zero was assigned. Two teams of researchers at two universities coded participants' posts. Each team consisted of a lead coder and assistant coder. The lead coders and assistant coders individually rated the posts. The lead coder and assistant coder compared their codes and any conflicted codes were agreed upon. The two lead researchers then compared the codes and a consensus score was assigned to each post. Krippendorff's alpha inter-rater reliability between the two sets of consensus codes was 0.52, which is comparable to the results obtained by DeWever et al. (2009). Intraclass correlation (3, k) between the two sets of codes was also determined to be 0.69. The coding teams were unaware of which prompts were Structured Divergent prompts and Convergent prompts.

The Statistical Package for the Social Sciences (SPSS) was used to conduct statistical analysis. Kolmogorov-Smirnov statistics were examined for each group to test the assumption of normal distribution. A one-way analysis of covariance (ANCOVA) of IAM scores, where the week 3 posts were used as the pre-test covariant, was used to test for overall difference between the groups. To specifically address the research questions, simple non-orthogonal contrasts were used as follow-up to ANCOVA, individually comparing each treatment group to the control group.

IV. RESULTS

A. Descriptive Statistics

All students received Convergent prompts for the first three weeks of the course. Week 3 posts were used as a pre-test and analyzed with the IAM rubric. Responses to the Convergent prompts by all groups could then be used as a covariant for analysis. During weeks 4 through 12, groups were given their assigned prompt types: Convergent, playground, brainstorm, or focal. Student responses for week 12 were then analyzed with the IAM rubric as a post-test. Only the first three posts from each student were used for analysis. Summaries of the responses by group are shown in Table 1.

1. Playground group: Pre-test

When receiving the Convergent prompt, the 15 students in the playground group responded 40 times out of the required 45. One student gave an unrequired fourth post. Five zeros were assigned because no post was given. Thirty posts reached a level one. Eight posts reached a level two. One post reached a level three. One post achieved a level four, and no posts received a level five. The average score on the pre-test was 1.2 (Table 1).

2. Playground group: Post-test

Fifteen students received the playground prompt and gave 36 out of the required 45 posts. In addition, there were five posts beyond the required three posts per student that were not included in statistical analysis. Nine zeros were given because the participants did not post a required response. Twenty-seven posts reflected level one, three reflected level two, two reflected level three, four reflected level four, and zero reflected level five. The average score on the post-test was 1.2 (Table 1).

3. Brainstorm group: Pre-test

Sixteen students in the brainstorm group responded to Convergent prompts 29 out of 48 required times. Three of the posts were an unrequired fourth or fifth post. A total of nineteen zeros were given when students did not post a required response. Twenty-three posts reached level one, two posts level two, and four posts level three. No posts achieved levels four or five. The average score on the pre-test was 0.8 (Table 1).

4. Brainstorm group: Post-test

Sixteen students participated in the brainstorm group with 37 out of 48 required posts. Three additional posts were not included in the statistical analysis as they extended past the three per student-required posts. Eleven zeros were given because students did not post a required response. One post did not score on the IAM rubric and also received a zero. Twenty-seven posts reflected level one, two reflected level two, three reflected level three, four reflected level four, and zero reflected level five. The average score on the post-test was 1.2 (Table 1).

5. Focal group: Pre-test

Fifteen students in the focal group posted 36 out of a required 45 times on the convergent prompt pre-test. Three of the posts were an unrequired fourth or fifth post and therefore were not included in statistical analysis. Nine zeros were assigned because a student did not post a required response. Twenty-four responses reached level one, seven reached level two, four reached level three, one reached level four, and zero reached level five. The average on the pre-test was 1.2 (Table 1).

6. Focal group: Post-test

In response to focal prompts, 15 students posted 41 out of a required 45 times. An additional four posts were not included in the statistical analysis as they extended past the three required posts. Four zeros were given because students did not post a required response. Twenty-five posts reflected level one, four reflected level two, one reflected level three, eleven reflected level four, and zero reflected level five. The average on the post-test was 1.8 (Table 1).

Table 1

Number of posts at each IAM level.

	Playground		Brainstorm		Focal		Convergent	
# of Students	15		16		15		12	
Required Posts	45		48		45		36	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Total Posts	41	41	32	40	39	45	23	14
No Posts	5	9	19	11	9	4	14	22
Extra Posts[a]	1	5	3	3	3	4	1	0
Level 0	5	9	19	12[b]	9	4	14	22
Level 1	30	27	23	27	24	25	13	11
Level 2	8	3	2	2	7	4	8	0
Level 3	1	2	4	3	4	1	1	2
Level 4	1	4	0	4	1	11	0	1
Level 5	0	0	0	0	0	0	0	0
Average Score	1.2	1.2	0.8	1.2	1.2	1.8	0.9	0.6

Note: Pre-test posts were from week 3 when all students received convergent prompts. Post-test posts were from week 12 when students received the type of prompt indicated by their groups.

[a] Students were expected to post 3 times. Some students, however, chose to post more than the expected 3. These were not included in analysis.

[b] One post did not score on the rubric.

7. Convergent group: Pre-test

The twelve students of the convergent group posted 22 out of the required 36 times. There was one unrequired fourth post. Fourteen zeros were assigned because students did not post a response. Thirteen posts received a one, eight posts received a two, and one post received a three. No posts reflected levels four or five. The average on the pre-test was 0.9 (Table 1).

8. Convergent group: Post-test

Twelve students in the Convergent group posted 14 out of the required 36 times. There were no extra posts. Twenty-two zeros were given because students did not post a response. Eleven posts reflected level one, none reflected level two, two reflected level three, one reflected level four, and zero reflected level five. The average on the post-test was 0.6 (Table 1).

B. Statistical Analysis

SPSS was used to conduct ANCOVA of IAM scores to assess whether various Structured Divergent prompts (playground, brainstorm, and focal) affected graduate students' level of knowledge construction as compared to the control group when controlling for pre-test IAM scores. Before running ANCOVA, Kolmogorov-Smirnov statistics were examined for each group to test the assumption of normal distribution. The assumption was met for the playground group (p = .051) and for the brainstorm group (p = .189). Although this assumption was not met for the focal group (p = .043) and the control group (p = .002), ANCOVA is known to be robust against such mild violations (Leech, Barrett, & Morgan 2011). The assumptions of homogeneity of variances F (3) = .755, p = .525, and homogeneity of regression slopes F (3, 41) = .708, p = .553, were also examined and met. Results of the ANCOVA revealed that pre-test IAM scores served as a significant covariate in the analysis F (1, 44) = 9.11, p = .004 (Table 2). Furthermore, all treatment prompts together had a probability of .015, which indicated that there was a significant difference in IAM scores between the groups after controlling for pre-test IAM scores (Table 3). It is important to note that the three scores demonstrated by each student were combined for a maximum score of 15. Therefore, the mean reflects a total of fifteen, instead of the five levels used to code each individual post. Because a pre-test was compared to a post-test, any student who did not complete the pre-test or post-test was not used in the analysis. Therefore, the participant numbers dropped to 14, 12, 14, and 9 as seen in Table 3 (next page).

Table 2

Analysis of Covariance for IAM Scores as a Function of all Structured Divergent Prompts, after Controlling for IAM Pre-test Scores

Source	df	MS	F	p	η^2
Pre-test IAM	1	26.90	9.11	.004**	.172
All Treatment Prompts	3	11.44	3.88	.015*	.209
Error	44	2.95			

* Significant at p<.05

** Significant at p<.005

Finally, to address each research question, a simple contrast analysis was conducted as a follow up to the omnibus ANCOVA comparing each IAM prompt group to the control group. The contrast results indicated a statistically significant difference between the adjusted group mean for the control group and those of the brainstorm group (p = .03, d = 1.01). Similarly, a statistically significant difference was found between the adjusted control group mean and the adjusted mean for the focal group (p = .003, d = 1.42). However, no significant difference was observed between the adjusted control group mean and the adjusted mean for the playground group (p =.18, d = .60). The differences between the control group and the focal and brainstorm groups represented a large effect according to Cohen's guidelines (Leech, et al., 2011).

Table 3

Post-Test Cumulative IAM Score Means: Unadjusted and Adjusted for the Pre-test IAM Score

		Unadjusted		Adjusted	
Source	N	M[a]	SD	M[a]	SD
Playground	14	3.93	1.59	3.77	.46
Brainstorm	12	4.33	2.15	4.47	.50
Focal	14	5.36	1.78	5.16	.46
Control	9	2.33	2.00	2.72	.59

[a] The cumulative score is a sum of the three IAM scores for each student.

V. DISCUSSION

Previous studies have demonstrated the effect of different prompt types on student responses. Andrews (1980) showed that Structured Divergent prompts in face-to-face discussions caused students to give a more productive answer. Bradley et al. (2008) and Wruck (2010) both used Bloom's Taxonomy to look at the effect of various prompts in online discussions. Bradley et al. (2008) found that limited and direct link prompts generated longer responses, while limited and open focal responses generated the most complete answers. Course link, brainstorm, and direct link prompts encouraged higher levels of critical thinking than open focal and application. Wruck (2010) found that scenario, case study, controversy/debate, and search and critique prompt types averaged a level three (application) in Bloom's Taxonomy, while read and respond only averaged a two (comprehension). Although two of these studies looked at the level of thinking skills as a function of prompt type, none addressed knowledge construction. We, therefore, attempted to look at the effect of the Structured Divergent prompts on students' knowledge construction in an online discussion.

Students in this study were assigned to four groups. During the first three weeks of the course all groups were given Convergent prompts as a pre-test. During the third week, three posts from each student were given an IAM score. During weeks 4 through 12, each group was given a different prompt type (playground, brainstorm, focal, or Convergent). Three posts from each student were scored on the IAM rubric during the twelfth week as the post-test. In both the pre- and post-test, the scores for the three prompts from each student were added to give a score out of 15. These cumulative scores were then used as a mean for each group.

A. Question 1

How does the playground prompt affect the levels of knowledge construction based upon IAM scores compared to students who respond to prompts that do not use any of the three Structured Divergent prompts after controlling for pre-test IAM scores?

Playground prompts focus on one aspect of a topic that is more likely to produce discussion (Andrews, 1980). When controlled for the pre-test, the playground group, with an adjusted mean score of 3.77, did not show a significant improvement over the control group with an adjusted mean score of 2.72 ($p = .18$) (Table 3). Using the IAM scale of 0-5, the playground prompt averaged 1.2 while the control group averaged 0.6 (Table 1). In the playground group, level one was demonstrated the most in the post-test with twenty-seven posts. Level four was the highest level demonstrated (Table 1).

From pre-test to post-test, the number of non-posts increased from five to nine. This was the only one of the Structured Divergent prompts to have the number of non-responses increase. This prompt had only one extra post in pre-test and five extra posts in the post-test, which was the highest number of extra posts of all prompts.

This was the only Structured Divergent prompt not to have a statistically significant increase in the mean score. It could be that playground prompts appeal more to some students than others. Because it focuses on one specific area of the overarching subject, students are more likely to participate in the discussion when they are interested in that subject-area. On the other hand, if they are not interested in the topic, their participation may drop off. It can also be speculated that playground prompts, although they provide limits within which to answer, may still have been too broad for students to focus on a concise thought, thus producing insignificant results.

B. Question 2

How does the brainstorm prompt affect the levels of knowledge construction based upon IAM scores compared to students who respond to prompts that do not use any of the three Structured Divergent prompts after controlling for pre-test IAM scores?

Brainstorm prompts encourage students to work together to generate ideas and discover different connections (Andrews, 1980). The number of non-posts dropped from 19 to 11. The adjusted mean for brainstorm prompts (4.47) was statistically significantly ($p = .03$) higher than the adjusted mean (2.72) for the control group, which received Convergent prompts (Table 3). With the IAM scale of 0-5, the brainstorm prompt averaged 1.2 while the control group averaged 0.6 (Table 1). Out of 36 posts on the post-test, level one was demonstrated the most at 27 times, and level four was the highest level reached. It was also the only prompt for which a post received a zero because it did not reflect a level.

Even post treatment, the majority of students achieved only lower levels of knowledge construction. However, because the question required students to come up with solutions or possibilities, they negotiated meaning and synthesized with each other. Therefore, as compared to the control group and the pre-test from the brainstorm prompt group, more students' prompts reached a level of three or four. The fact that the brainstorm prompt had significantly higher levels of knowledge construction versus the control is consistent with Bradley et al. (2008), who did not study knowledge construction, but found that brainstorm prompts also caused an increase in the levels of the related field of critical thinking.

C. Question 3

How does the focal prompt affect the levels of knowledge construction based upon IAM scores compared to students who respond to prompts that do not use any of the three Structured Divergent prompts after controlling for pre-test IAM scores?

Focal prompts introduce a complex controversy, which may elicit more than one possible solution (Andrews, 1980). When corrected for the pre-test, responses to focal prompts received a statistically significantly ($p = .003$) higher adjusted mean score (5.16) over the control (2.72) (Table 3). With the IAM scale of 0-5, the focal prompt averaged 1.8 while the control group averaged 0.6. In the post-test, most of

students' responses (25) were classified as level one. Level four was the highest level achieved. This group reached level four eleven times, far more than the next closest group with five posts that achieved level four.

Similar to the Brainstorm prompt, most student posts reflected lower levels of knowledge construction. However, because the question required students to come up with an answer and argue their defense, the participants synthesized together and constructed knowledge with each other. This may have tested their thinking, schema, and prior experience. As a result, eleven posts reflected a level four as compared to only one pre-test post, and only one post from the post-test control group'.

The focal prompt group saw very little change in the number of extra posts from pre-test to post-test. Of the four groups, the focal prompt group participated the most during the pre-test and the post-test. However, even with an already high participation rate, the focal group saw a small increase in participation. The increase in IAM scores and participation is consistent with the conclusions by Andrews (1980) and Bradley et al. (2008) that introducing controversy allows for opinions and alternatives to be discussed.

D. Convergent Prompts

The following Convergent prompts were used in the study: multiple consistent, funnel, general invitation, analytic convergent, quiz show, shotgun, lower-level divergent, and single questions. These questions were chosen because they best fit the original prompt design given in previous course offerings. Each prompt ranged from being used once to up to four times.

Twelve students were included in the Convergent prompt group, which served as a control. While all groups received Convergent prompts during the first three weeks, when the other three groups received the treatment prompts, the Convergent group continued to receive Convergent prompts. The Convergent group was the only group to have the total number of posts go down from the pre-test (23) to post-test (14). Because students did not post the required responses, level zero was demonstrated the most. When students did post, the posts rarely scored higher than level one. In addition, this group's posts were more concise than the others. Unlike the other prompts, students in the Convergent group did not post more than required by the course in the post-test.

The Convergent group had a statistically significant lower cumulative mean than the focal and brainstorm groups. This group received the lowest average (0.6) on the IAM scale of 0-5 (Table 1). This indicates that Convergent prompts lead students to use lower levels of knowledge construction as compared to the Structured Divergent prompts. This lower participation and lower IAM scores again were similar to previous studies (Andrews, 1980; Bradley et al., 2008; Wruck, 2011) that show that Convergent prompts are less productive, generate fewer student posts, and required lower levels of critical thinking.

E. Limitations

It should be taken into account that although students were randomly assigned to the groups not all of the students assigned agreed to participate in the study. Only 58 out 76 students enrolled in the course participated, giving a smaller *n* for statistical analysis, particularly in the control group. The small sample size in this study clearly diminished the statistical power of our analysis. However, the specific effect of the prompt types on the students who chose not to participate is unknown. Had they participated, the results may have been different. In addition, although non-participants' posts were not analyzed they posted in the discussions with the participants of the study, and the non-participant posts could have influenced participants' posts. Students were recruited for the study at the beginning of the course. It is possible that the knowledge that they were part of a study may have influenced their responses.

There are factors that may have affected the quality of the responses. Three instructors taught the four sections, with one instructor responding to two groups and one instructor each responding to the other two groups. Therefore, the manner in which professors interacted with students in discussions may have affected participants' responses. Other factors such as the age, gender, and degree program of the participants may have affected the students' participation. This data was not collected.

VI. CONCLUSION

In this study, we found that using specific Structured Divergent prompts increased knowledge construction. The two prompts shown to increase knowledge construction as measured by IAM were the brainstorm and focal prompts. This supports portions of the findings by Andrews (1980) and Bradley et al. (2008). Andrews showed Structured Divergent prompts produced posts with higher levels of Blooms' Taxonomy compared to Convergent prompts. We found in this study higher levels of knowledge construction were present only when using brainstorm and focal prompts, but not the playground prompt. In Bradley et al. (2008) course link, brainstorm, and direct link prompts encouraged higher levels of critical thinking using Bloom's Taxonomy than open focal and application prompts, which produced the lowest levels. Although we found brainstorm prompts produced higher levels of knowledge construction when analyzed through IAM, our focal prompts were just as successful. Therefore, if instructors wish to stimulate knowledge construction, they should avoid the less productive prompts, which would be playground and Convergent prompts. Instead, instructors and designers should create prompts that naturally encourage students to collaborate in creating solutions and ideas or require students to chose an argument and defend their opinion.

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