Embedding Brainstorming Tasks in Twitter

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Abstract. In this study, we propose a system that encourages users to generate ideas using information about tweets they are reading as hints and creates opportunities for users to generate various ideas. By intervening during Twitter browsing, the proposed system aims to use time-consuming Twitter browsing as an opportunity for casual idea generation. To encourage users to come up with a variety of ideas, the proposed system presents a tweet with low similarity to existing ideas as a hint for generating ideas while the user is browsing Twitter. To evaluate the effectiveness of the proposed system, we asked participants to use it in our user study.

Keywords: UI/UX· User assistance· Creativity support.

1 Introduction

The automation and streamlining of routine tasks have accelerated the commoditization of technologies and services. Moreover, technological progress and social environment changes are diversifying values. Under these circumstances, companies seek innovation to distinguish their technologies and products [6]. Therefore, exercising creativity, and generating various ideas at work is becoming increasingly important.

People use Brainstorming [16] and MindMap [3] to generate ideas. Brainstorming is an idea-generation method that emphasizes quantity rather than quality by generating ideas in a group, combining and improving them, and diverging ideas [16]. Brainstorming is demanding because it requires several people to gather at the same place and time. For this reason, only a few people frequently use Brainstorming in their daily lives.

In our daily lives, we have free time for traveling, waiting, and so on. However, only some people use such free time for productive activities; many spend it on unproductive activities such as social media browsing [13]. In recent years, studies have been conducted to embed microtasks, such as writing, into such free time to promote effective use of free times [10, 5]. Nevertheless, to the best of our knowledge, there is no study on the implementation of creative tasks such as idea generation as microtasks.

Effective ideation is to generate a large number of candidates with valuable ideas. For this purpose, it is practical to incorporate various concepts into idea

generation [20, 15]. Brainstorming is a method of diversifying ideas by sharing people's ideas as hints to come up with ideas. However, although other people's ideas can be a valuable source of inspiration for idea generation, constant Brainstorming on the same theme will make it difficult to generate ideas over time. It becomes challenging to keep coming up with various ideas because the perspectives become fixed on the theme of the idea-generation effort [15].

In this study, we propose a **Twitter excursion** system that encourages users to generate ideas daily by embedding opportunities for idea generation in their Twitter browsing. In Japan, 45 million people use Twitter monthly, with 68.9% of users in their teens to 40s using it for 20 min or more per day, citing "killing time/leisure" as the purpose of use[3].

The proposed system is designed as a Chrome extension and supports idea generation on multiple themes predefined by the user. Figure1 shows an overview of the proposed system's operation. The system analyzes the user's Twitter timeline and the relationship between the predefined themes and the user's existing ideas related to them. When the system detects a tweet that may stimulate an idea, it prompts the user to generate an idea using the information in the tweet as a hint. When a user comes up with an idea, the user records the idea on the site, as shown in Figure2. The proposed system will create opportunities for users to generate ideas effectively in their free time, such as when browsing Twitter.

2 Related Works

2.1 Idea-generation support

In cognitive psychology and human-computer interaction, there are studies on idea-generation methods and idea-generation support tools [7, 8]. Paulus et al. found that mental ease and associations are essential for effective idea generation [14]. Wang et al. also stated that it is essential to incorporate various concepts for high-quality idea generation [20]. Hariharan et al. proposed affinity lens, which supports idea generation by analyzing and classifying information written on Post-its and visualizing the results in real-time using a computer [19]. A support for recommending a variety of images that contain concepts that are the basis of design ideas has been proposed to incorporate multiple concepts when generating ideas [15]. In this study, we support idea generation from various perspectives by making sentences computable using natural language processing as well as selecting and presenting tweets containing various concepts for users' existing ideas. Brainstorming is a typical idea-generation method aiming to efficiently generate diverse ideas by multiple people. Gallupe et al. proposed an online brainstorming system and solved interpersonal communication problems that inhibited idea generation [9]. As an advanced online method, crowdsourcing has been used to collaborate on ideas with an unspecified number of collaborators [18]. It is demanding to gather participants for these brainstorming methods,

[3] https://service.aainc.co.jp/product/echoes/voices/0014#blogSec11

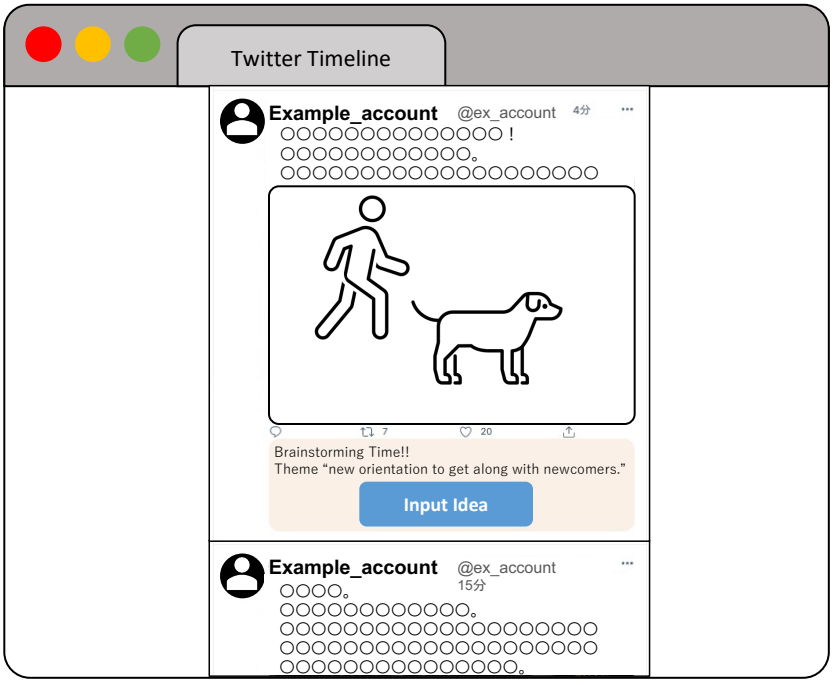

Fig. 1. Example of a link embedded in Twitter by the system

and the quality of the results varies because of the variation in participants' abilities and skills [17].

2.2 Support for effective use of unproductive time in daily life

There are several studies on the effective use of unproductive time in daily life. Belakova et al. proposed SonAmi, which creates an opportunity to reflect on writing by reading out the written text when the user lifts his/her mug while taking a break from writing a task that has been postponed [2]. Inie et al. proposed Aiki, which creates learning opportunities by redirecting users to a site where they can perform simple learning tasks, such as learning English words when they access a website where they are wasting time [12]. Hahn et al. proposed incorporating writing microtasks into Facebook timelines to leverage unproductive time in daily life to achieve meaningful goals [10]. The above systems all have one thing in common: they encourage productive activities by using time that has a low cognitive load in daily life and is available for use. Our proposed system focuses on Twitter browsing as an opportunity to embed an idea-generation task.

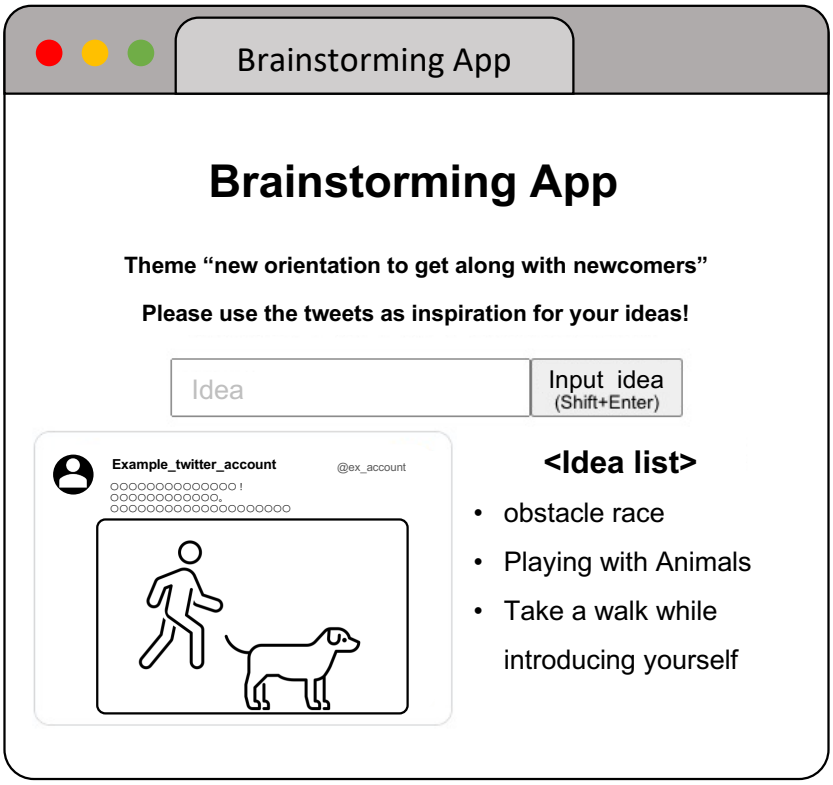

Fig. 2. Example of a web app for brainstorming tasks

3 Approach

In this study, we propose a system called Twitter Excursion. It creates valuable idea-generation opportunities by encouraging users browsing Twitter to generate ideas inspired by their read tweets. First, it creates informal idea-generation opportunities using the time spent on Twitter, which tends to be time-wasting. Second, it encourages diverse idea generation without being limited by existing ideas. We developed this system based on Hahn et al.'s [10] concept of casual microtasks. The proposed system comprises a Chrome extension that embeds an idea-generation task in Twitter and a web application (web app) that performs the idea-generation task. The Chrome extension selects tweets from the user's Twitter timeline that can be used as hints and embeds the theme and a link to the web app. The web app presents the tweet to be embedded as a hint and records the idea entered by the user. The details of each function and its implementation are as follows.

3.1 Embedding Ideation Tasks on Twitter

Figure 1.1 shows how the Chrome extension embeds a link to the ideation task in a tweet on a Twitter timeline. The light orange area is the embedded part. It contains a button with a user-defined idea-generation theme and a link to a web application for idea entry. When a user comes up with an idea, he/she presses the "Enter Idea" button to go to the web application. The Chrome extension sends the Tweet ID to the web app. The web app uses that ID to display the tweets. The tweets to be selected are those useful as hints for generating ideas. Section 3.2 describes the details of the tweet selection method. The proposed system selects one optimal tweet to embed for every ten tweets the user reads from the top timelines. As a specific scenario, assume that a user is thinking of an idea for a "new orientation to befriend newcomers." The user enters "new orientation to get along with newcomers" as the theme of the idea generation into the system and then enters as many ideas as he/she can think of, as shown in Figure 1.2. When the user cannot generate more ideas, he/she stops idea generation and browses Twitter. The system selects tweets suitable for hints and inserts a theme and the "Enter Idea" button into a tweet with a picture of a person and a dog walking, as shown in Figure 1.1. The user comes up with the idea of a "self-introduction walk" inspired by this tweet, goes to the web application shown in Figure 1.2, enters the "self-introduction walk," and enters other ideas.

3.2 How to Select Tweets to Embed Tasks

The proposed system selects tweets that embed opportunities for idea generation by considering similarity with existing ideas. The proposed strategy aims to increase the diversity of users' ideas by encouraging them to generate ideas different from existing ideas. In this study, we focus on excursions. Excursions are used to increase the number of ideas and diversify perspectives in idea generation [11, 1]. Word lists unrelated to the theme are used to generate new ideas. In this study, among the tweets on a user's Twitter timeline, the tweet with the lowest similarity to the user's previous idea is presented as an unexpected hint. We aim to achieve an excursion effect by doing so.

To calculate the similarity between tweets and existing ideas, the proposed system converts candidate tweets and existing ideas into a multidimensional vector. For vectorization, we use a pretrained universal sentence encoder (USE) [4]. A USE embeds a sentence into a multidimensional vector space. It calculates the vector of the entire sentence by vectorizing each word, considering its context. A USE can embed different languages, such as English and Japanese, into the same vector space. We adopted a USE for vectorization because many tweets are in Japanese and English and tweets are often sentences, so the semantic similarity can be calculated accurately by considering the context. Let $S = \{s_1, s_2, \ldots, s_l\}$ be the set of topics from which the user wants to get ideas, the set of tweets on the user's Twitter timeline $T = \{t_1, t_2, \ldots t_m\}$, the set of ideas previously generated by the user for theme s by $I_s = \{i_1, i_2, \ldots i_n\}$. Let $sim_{cos}(v_x, v_y)$

be the cosine similarity of the vectors v_x and v_y of x and y, respectively. The following equation defines the unexpectedness of a tweet $t \in T$ for a theme s.

$$U(t, I_s) = \frac{\sum_{i \in I_s} -sim_{cos}(\boldsymbol{v_t}, \boldsymbol{v_i})}{|I_s|}$$

Based on the above formula, the proposed system calculates the unexpectedness of each tweet on the timeline for all themes in the theme set S. Then, as shown in Figure1, the system embeds the most unexpected tweets for each theme as idea-generating opportunities (themes).

3.3 Web application for idea input

As shown in Figure2, the user interface of the web app of the proposed system (referred to as "proposal UI") comprises a theme, an idea input form, tweets, and a list of ideas. This web app refers to tweets based on the tweet ID received from the Chrome extension and presents them to the user. The entered ideas are saved and added to the "List of Past Ideas" when the "Enter Idea" button is pressed.

4 Experiment

4.1 Participants

We asked college students who visit Twitter at least once a day daily to cooperate in the experiment. We recruited a total of 20 participants. We experimented over seven days and paid participants 2,500 yen at the end of the experiment. The data of three participants were excluded from the analysis because they did not complete the task or the data were not collected correctly.

4.2 Idea-generation task

On the first day of the experiment, we gathered the participants in the laboratory and explained the experiment to them. After the explanation, the participants performed a 15-minute time-limited idea-generation task. From the second day of the experiment, the participants were notified by email at noon each day. They performed the idea-generation task according to the instructions in the email. Section 4.3 provides details on the emails. From the second day, each user entered as many ideas as possible on the same theme as the first day on the website shown in Figure 2. We instructed the participants to terminate their idea-generation task for the day if they ran out of ideas. We administered a daily questionnaire at the end of each day. The designated theme was "A new orientation to get along with newcomers." The theme was the same from the first day to the last day.

This theme has numerous possible ideas, and anyone can think about it regardless of knowledge.

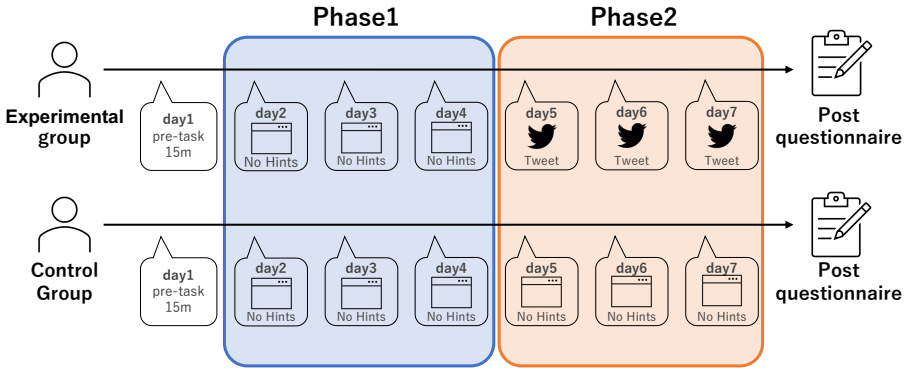

Fig. 3. Experimental Flow

4.3 Experimental design

In this study, we employed a one-factor between-subjects design of experiment in which the presence or absence of a hint was a factor. The hint factor had the following two levels.

- Experimental Group: presenting users with tweets that have low cosine similarity to the user's existing ideas
- Control group: no hints displayed

Figure 3 shows the experimental flow. On the first day, after confirming the participants' consent to participate in the experiment, each participant was given a 15-minute pretask to generate ideas. After completing the pretask, we assigned participants to the experimental and control groups. To minimize differences in individual ability to generate ideas between groups, we assigned participants to groups based on the number of ideas they generated on the first day. The procedure is to arrange all participants in descending order of the number of ideas they entered in the pretask and assign them alternately to the experimental and control groups, starting with the one with the most ideas. For example, consider the case where the number of ideas entered by eight participants in the pretask is [1,1,3,3,3,3,5,5]. If we group the participants so that the number of ideas is [3,3,3,3] and [1,1,5,5], we would expect the mean number of ideas to be the same but with individual differences in results. Therefore, in this example, we divide the number of ideas into groups of [1,3,3,5] and [1,3,3,5]. Table1 shows the assignment of participants.

The second through fourth days of the experiment is Phase 1. In Phase 1, all participants generated ideas with no hints. The three days following Phase 1 are Phase 2. In Phase 2, the experimental, and control groups generated ideas in different environments. Participants in the experimental group were presented with hints from the proposed system and performed the idea-generation task based on the hints. Participants in the control group performed the idea-generation task

Table 1. Number of ideas and grouping of participants in the experiment

Participant ID	Group	Quantity of ideas
1	Experimental	47
3	Experimental	23
5	Experimental	17
7	Experimental	14
9	Experimental	11
11	Experimental	10
13	Experimental	10
15	Experimental	9
17	Experimental	7
19	Experimental	7
2	Control	27
4	Control	18
6	Control	15
8	Control	13
10	Control	10
12	Control	10
14	Control	10
16	Control	7
18	Control	7
20	Control	6

without hints, as in Phase 1. The purpose of the proposed system is to encourage participants to come up with new perspectives by presenting ideas that are less similar to their existing ideas as hints. The effectiveness of the proposed system was verified by comparing the results with and without hints, with participants having generated all ideas they could generate. In Phase 1, both groups had no hints, so the experiment was designed to lose ideas gradually.

Participants completed questionnaires after each day's task and on the last day of the experiment. Each questionnaire includes items for all groups and the experimental group only. Tables 2 and 3 show the content of the daily questionnaire and the questionnaire given on the last day of the experiment, respectively. Response options for all questions are on a 5-point Likert scale (from 1: strongly disagree to 5: strongly agree). The daily questionnaire asked for a subjective evaluation of a day's task comprises two questions, as follows.

- Did you generate many ideas?
- Did you come up with different ideas compared with your existing ideas?

The last day's questionnaire investigated subjective resistance to and effectiveness of the proposed system's idea-generation method. This questionnaire assesses the extent to which users felt comfortable with the idea-generation opportunities created by the proposed system.

Table 2. Daily Questionnaire

Target	Question
Q1 Experimental Group	Were the tweets presented helpful in generating a lot of ideas?
Q2 Experimental Group	Were the tweets you were presented with helpful in coming up with ideas for a different perspective?
Q3 All	Do you think you were able to come up with a lot of ideas?
Q4 All	Were you able to come up with a different point of view?

Table 3. Post Questionnaire

Target	Question
$Q_{post}1$ Experimental Group	Do you think there is resistance to being interrupted with idea-generation tasks like this one when you are on Twitter in your free time?
$Q_{post}2$ Experimental Group	Do you think it is useful to be interrupted with an ideation task like this one when you are on Twitter in your free time?
$Q_{post}3$ All	How resistant do you think you would be to being forced to come up with ideas like this one at the appropriate time?
$Q_{post}4$ All	Do you think it is effective to be interrupted with an idea-generation task like this one at an appropriate time?

5 Result

We collected data on 544 ideas from 17 participants. We analyzed the data to determine the impact of the proposed system on the diversity of ideas generated by the participants. We also analyzed whether the proposed system creates opportunities for participants to generate new ideas by analyzing the questionnaire results. Because of the non-normality of the collected data, we performed the nonparametric Mann-Whitney U test. The significance level was set at $p < 0.05$. We used the SciPy statistical package [4] to analyze the results.

5.1 Daily questionnaire

We analyzed the participants' responses to the questionnaires given after each day's task as subjective data. The purpose of the proposed system is to help users generate more ideas or consider ideas from different perspectives. The answer choices for $Q1$ and $Q2$, which are questions about tweets, are 1 to 5, with 1 and 2 indicating that the tweets were not helpful, 4 and 5 indicating that the tweets were helpful, and 3 indicating neither, so we expected the average value to be higher than 3. However, as shown in Table 4, the mean values of $Q1$ and $Q2$ are below 3. The proposed system aims to make the participants feel that they could generate more ideas and a variety of ideas by presenting tweets as hints. Therefore, we expected that participants would feel they could generate more diverse ideas in Phase 2 than in Phase 1. To verify this expectation, we analyzed

[4] https://scipy.org/

Table 4. Result Daily questionnaire

	Control Group		Experimental Group		p-value
	Mean	Standard deviation	Mean	Standard deviation	
Q1	-	-	2.19	0.80	-
Q2	-	-	2.33	0.75	-
Q3	0.99	0.26	1.06	0.63	0.47
Q4	1.07	0.29	1.02	0.27	0.47

Table 5. Result Post Questionnaire

	Control Group		Experimental Group		p-value
	Mean	Standard deviation	Mean	Standard deviation	
$Q_{post}1$	-	-	3.44	1.30	-
$Q_{post}2$	-	-	3.00	1.41	-
$Q_{post}3$	3.50	1.20	2.88	1.05	0.29
$Q_{post}4$	2.87	0.99	3.33	1.12	0.56

the mean value of the sum of the responses in Phase 2 divided by the sum of the responses in Phase 1 for each of $Q3$ and $Q4$. If the mean value of $Q4$ is higher in the experimental group than in the control group, then the participants felt that the proposed system allowed them to generate more ideas. However, as Table 4 shows, there was no statistically significant difference between the experimental and control groups in both $Q3$ and $Q4$.

5.2 Post Questionnaire

We analyzed the responses to the questionnaire about the resistance and effectiveness of embedding idea-generation opportunities in Twitter timelines. $Q_{post}1$ and $Q_{post}2$ in Table 4 show the subjective evaluation values of the resistance and effectiveness of embedding idea-generation opportunities in Twitter timelines. We expected the mean value to be lower than 3 because 1 and 2 indicate no resistance, 4 and 5 indicate resistance, and 3 indicates neither. However, the result was that the mean value was not less than 3. Because the responses of $Q_{post}2$ were 1-5, 1 and 2 indicating inadequate, 4 and 5 indicating effective, and 3 indicating neither, we expected the mean value to be higher than 3. However, the results showed that the mean did not exceed 3. $Q_{post}3$ and $Q_{post}4$ in Table 4 show the resistance to being asked to perform the idea-generation task at the appropriate time and the subjective rating of the effectiveness of the idea generation. For $Q_{post}3$, the experimental group had a lower mean value, but the difference was not statistically significant (3.50 and 2.88 for the control and experimental groups, respectively; $p = 0.29$). For $Q_{post}4$, the experimental group had a higher mean, but the difference was not statistically significant (2.87 and 3.33 for the control and experimental groups, respectively).

6 Discussion

We analyzed the results of the daily post-task questionnaires and the questionnaire after completing all tasks. With the data from the daily post-task questionnaires, we analyzed the participants' subjective evaluation of idea generation. The analysis results indicated that the participants did not feel that the hints in the tweets helped them generate more or new ideas. There was no statistically significant difference between the experimental and control groups regarding whether the participants could generate more ideas or diverse perspectives. From the data of the questionnaire after completing all tasks, we analyzed the subjective evaluation of the resistance and effectiveness of the proposed idea-generation system. The analysis results did not support the predictions of the resistance and effectiveness felt by the participants to being interrupted in the idea-generation task while browsing Twitter. There was no statistically significant difference between the responses of the experimental and control groups concerning the resistance and effectiveness of idea generation. Therefore, the experimental results did not support that users would find it easy to generate ideas using the proposed system (Sections 5.1, 5.2).

However, the hint tweet may have influenced the content of the idea. The free comments in the last questionnaire were as follows.

> **While the hints from Twitter helped me generate ideas I did not have, the hints bound me.**

This response suggests that hints by the proposed system may encourage the development of ideas from new perspectives. However, it can be challenging to understand the perspectives of the hints; some participants felt that the perspectives of the hints restricted them, and this inhibited their free conception of ideas.

The last questionnaire evaluation results did not suggest that users found it easy to generate ideas when the proposed system created opportunities for idea generation. Moreover, the participants who did not feel much resistance to embedding idea-generation opportunities in their Twitter timeline and answered that it was highly effective responded as follows in the free-response section of the last questionnaire regarding the use of the proposed system: "It is hard to do it every day in a row." "It is not easy to keep coming up with ideas every day, but I found it very interesting if I did it in my spare time and thought it would be a good use of my time on Twitter."

7 Conclusion

In this study, we proposed a system that encourages users browsing Twitter to generate ideas using information from tweets they read as hints and creates opportunities for users to generate various ideas. The purpose of the proposed system is twofold: to make effective use of Twitter, which tends to be time-wasting, as an opportunity to generate ideas to encourage the creation of ideas

dissimilar to existing ideas. The proposed system creates a vector of previously generated ideas and selects tweets with low similarity to them as hints from the user's timeline. This strategy increases the diversity of the set of user-initiated ideas by providing users with various hints for existing ideas. The experimental results did not show significant results that the proposed system effectively uses Twitter as an opportunity for idea generation or that it encourages diverse idea generation. However, we found that the tweets we presented as hints could induce ideas generated by users. In the future, it is necessary to perform long-term intervention experiments to verify the effectiveness of the proposed system.

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