

For a teacher, especially with little experience, it is not always easy to stimulate students or pupils. The advent of game consoles and, more generally, of digital world – professional or recreational – increasingly requiring working at a distance, worsens the situation. The young teacher is certainly familiar with these technologies but does

Amongst the most commonly cited soft skills, creativity is a recurring term. It has been identified with social intelligence as a key skill to get a job by 2030 (Zobrist and Brandes 2017, 56). In related studies, creativity is defined as "the ability to produce work that is both novel and appropriate" (Sternberg and Lubart 1999, 3), i.e., useful, adaptive, flexible with demanding tasks (Anderson et al. 2004, Lubart and Lautrey 1998, Lubart et al. 2015, Runco and Jaeger 2012). Individuals with higher levels of openness are both curious about their internal and external worlds and their lives, are richer in experiences, implying that open people are more creative. Furthermore, these people are also more willing to welcome new ideas and adopt unconventional

2. Ideas generation: Participants will now silently write down all the ideas that comes to mind related to the question. Participants cannot communicate with each other during this stage. This usually last for ten minutes;
3. Ideas sharing: Each participant will then share his individually-noted items with the others. No criticism is yet given at this point, instead participants should focus on writing new ideas that build upon others' ideas. This typically lasts 15-30 minutes;
4. Group discussion: Participants are now encouraged to discuss ideas and asked for specifications. The moderator needs to keep this procedure as neutral as possible, and no idea should be eliminated. The group combines different ideas in categories. This stage can last
5. 30 to 45 minutes;
6. Voting and ranking: Finally, when all the ideas are given and shared, participants rank or vote on the ideas by selecting the ones that answered the initial question at best. After this process, the results are directly given to the group and the session ends – hopefully – having reached a specific outcome.

Proposed Deployment in an E-classroom

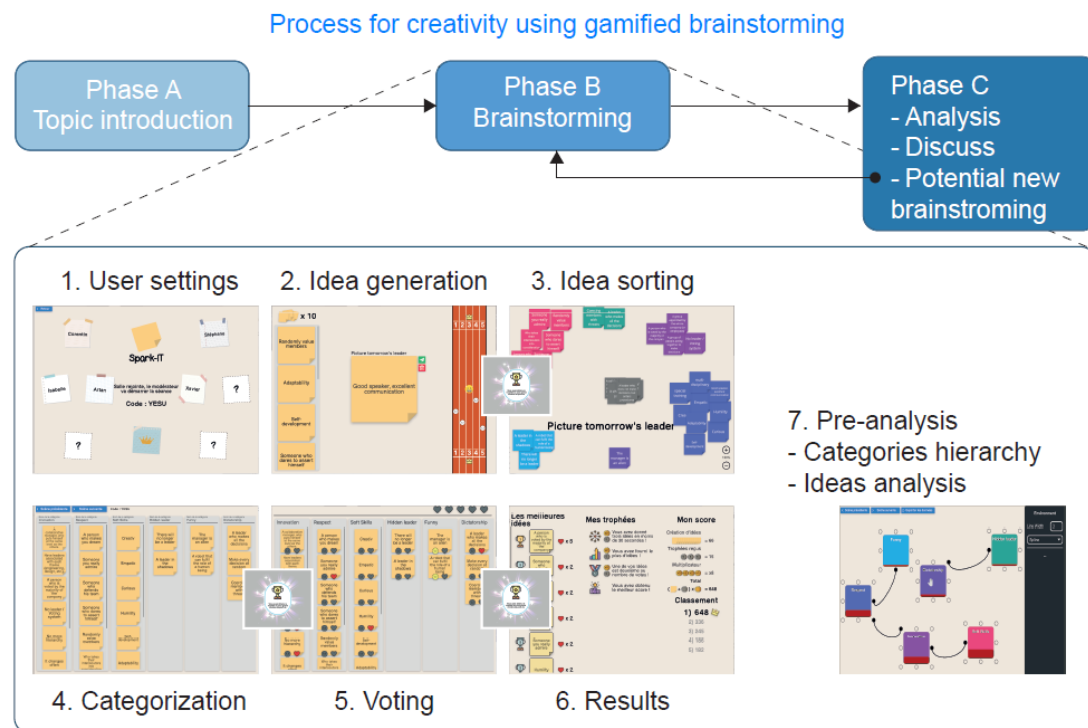


Figure 1. Three main phases – A. general introduction; B. brainstorming, composed of seven steps (1 - 7); C. conclusion phase.

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As shown in figure 1, we consider a hypotheticalal basic 3-phase teaching approach (upper part shown in blue). *Phase A*: Welcoming participants; presenting the general steps of the procedure; proposing a specific methodology; defining the framework, timing, rules to follow; detailing objective and purpose of the work; stating the subject to be studied precisely; asking if there are questions (but not related to the studied object). *Phase B*: Gamified e-brainstorming to stimulate interactivity – detailed in this article. *Phase C*: recognition of the accomplished work; questions or remarks about the process; present the rest of the work, such as the work in subgroups of each category; find a new subject to debate to fuel a new cycle of brainstorming.

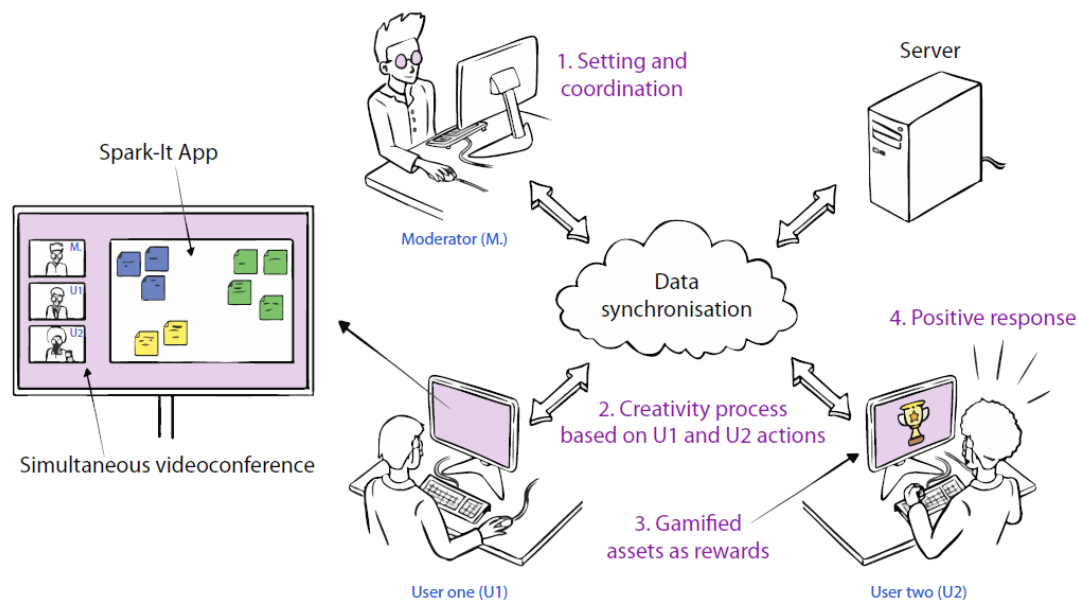


Figure 2. Illustration of how the creative process and social links can be enhanced using a gamified online brainstorming: the *Spark-IT* project.

To carry out our project *towards interactive e-classroom based on digitized and gamified brainstorming* (see figure 2), we had to make methodological choices that respected as much as possible the definition of the above Nominal Group Technique model. In this context, we want – despite the physical distance that separates participants – to recreate a social bond, a presence at the human scale that transcends the digital medium. The brainstorming tool allows us to set in motion a collective intelligence based on imagination, listening, sharing, debating, taking a position, and converging points of view into a mutual idea. Supported by imagination, this approach provokes at the same time a personal highlight, a shock of ideas and social communion opening even more the field of possibilities. In this context, we support the thesis that adding a playful dimension – through the deployment of gamification – can only promote the social relationship between pupils or students.

Table 1. Criteria to compare the brainstorming applications.

After further testing the tools, only the criteria that were significantly different and critical for the project were selected and weighted to find the best brainstorming program for our use-case. Three members of the project (A, B, C in table 2) rated each criterion on a scale from one to five. A score was then calculated for each of them.

Criteria	Application M			Application K			Application L			Weight
	A	B	C	A	B	C	A	B	C	
Connection process	4	3	4	5	5	5	5	3	3	1
User experience	2	3	4	4	4	4	4	2	2	2
Control over idea generation	1	1	2	5	4	5	1	1	2	2
Voting phase	5	5	5	1	2	2	5	5	4	2
Results view	5	5	3	2	2	3	5	5	4	1
Mean score in %	66%			70%			64%			

Table 2. Weighted criteria for the brainstorming software comparison.

The application *K* was selected despite the small advantage. What it lacks in its voting capabilities is made up by its ease of connection and better controls for the moderator.

Proposed Solution

Gamification

The project’s gamification objective is to measure its influence on the quantity and quality of produced ideas. Different elements have been implemented, ranging from trophies, a leaderboard, *funny* votes to a race during idea generation. They will be described in greater details in the next section, but here is an overview of all the implemented elements, and the purpose they serve.

- *Pricing:* Costs can be assessed in several dimensions. The costs of using an already available tool against developing our own solution is certainly not very advantageous. The development cost can be approximated to two

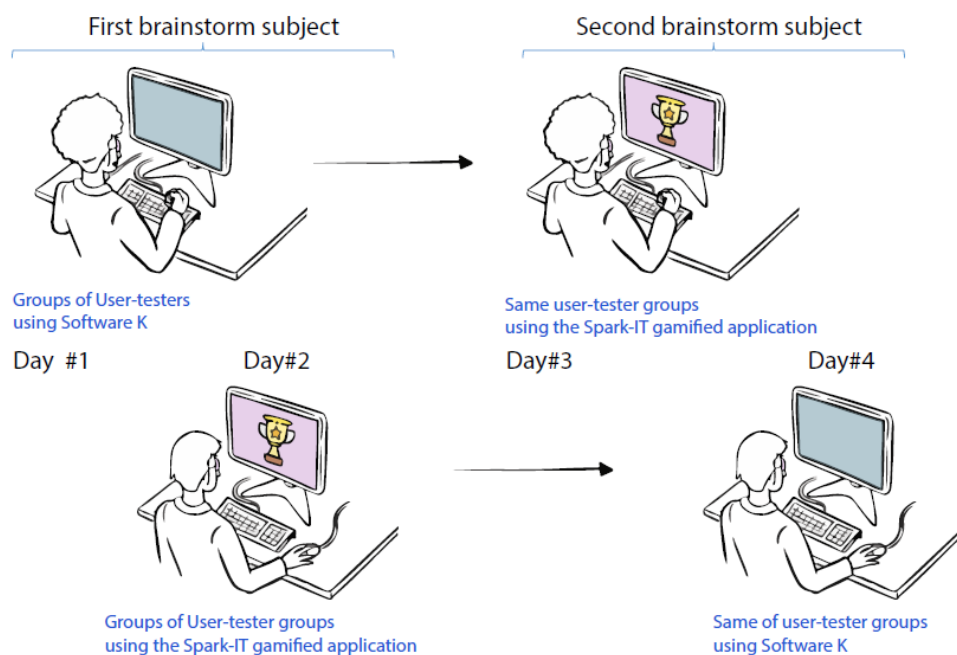
- *Account:* Accounts are not required for this application. Instead, users will enter their name or a pseudonym. This name is only displayed in the lobby when joining the application, so that users can see they have successfully connected to the session. However, the name is saved, when exporting the data, to be able to link the survey results to the given ideas;
- *User actions:* Since the application follows the desired steps of the classical brainstorming, all the implemented actions for the users are independent from the moderator. They can each do very different things, and the moderator has full control over the application;
- *Session topic:* The session topic is displayed throughout the application. Over the sticky note when writing ideas at the start and in the middle of the screen when sorting ideas later. It is always visible when needed;
- *User input:* As we decided to study only text ideas in the application, this is the only implemented option. A drawing feature could be implemented in the future, if the need arises;
- *View synchronisation:* During the sorting phase, the other systems allow to synchronise the participants' view to what is seen by the moderator. This is necessary as the whiteboard is an infinite plane where participants can zoom in and out until nothing is visible anymore. In the *Spark-IT* application, these controls are also available to the users, but the range is very limited and the centre of the whiteboard is always visible. In this case, the synchronisation is not needed;
- *Categories and List view:* Both have been implemented. Creating categories is simple in *Spark-IT* with the edge detection and the conversion to the list view. This functionality has been implemented to be as straightforward as possible;
- *Casting votes:* The voting phase is an important phase of the application, and was made as simple as possible to enable users to vote directly by pressing

different icons on the sticky notes. The same presentation in categories has been kept to locate the ideas;

- *Timer*: No timer has been integrated in the application (as it was decided not to show it to the participants). Only the moderator runs an external timer, and gives verbal information at different intervals (i.e., five minutes left, one minute left);
- *Data export*: At the end of a session, the moderator can click a button to download directly the formatted data as a CVS file. The data contains timestamps, author names, ideas content, categories and number of votes;
- *Results view*: A results view is shown at the end, listing the best ideas. This view is enhanced with different gamification elements, showing the earned trophies, the score and leaderboard.

Evaluation with Participants

Business school students were asked to participate in the evaluation of online brainstorming applications: application *K* and our solution *Spark-IT*. Every student performs two sessions: one per software. Two brainstorming topics were selected, making sure the participants were familiar with the concepts as to collect meaningful ideas. The subjects are: Imagine tomorrow's leader/manager; How to innovate in tomorrow's companies. Two principal biases were then identified in the project, the order of the applications use, and which topic was taken. To reduce these elements influence, we decided to conduct a blinded experiment, by splitting who will use which application first. Ten groups of five participants were formed; however, out of the 50-expected students, only 31 attended both experiments and filled entirely the surveys. The distribution of the blinded experiment is described in figure 4. With this organisation, each software has been used first by a different group, and each topic has been used individually in each software.



Participants had to fill a survey after each session, answering subjective questions about each experiment, and UI or UX-related (Bollini 2017) questions to see which software they preferred. The eleven-point Likert scale is used to answer the questions, and the user can also add a comment. Some subjective questions were optional. The survey questions are presented in figures 5, 6, 7, and 8. The survey questions aimed to answer a few core questions: what was the participant's experiences using the application itself (figure 5); were they previously familiar with these types of gamified applications (figure 6); and, finally, their thoughts on how the gamified elements in particular changed (or didn't change) their ideation processes (figures 7 and 8). This provided us both with an evaluation of the application itself, as well as the application as compared to other types of solutions.

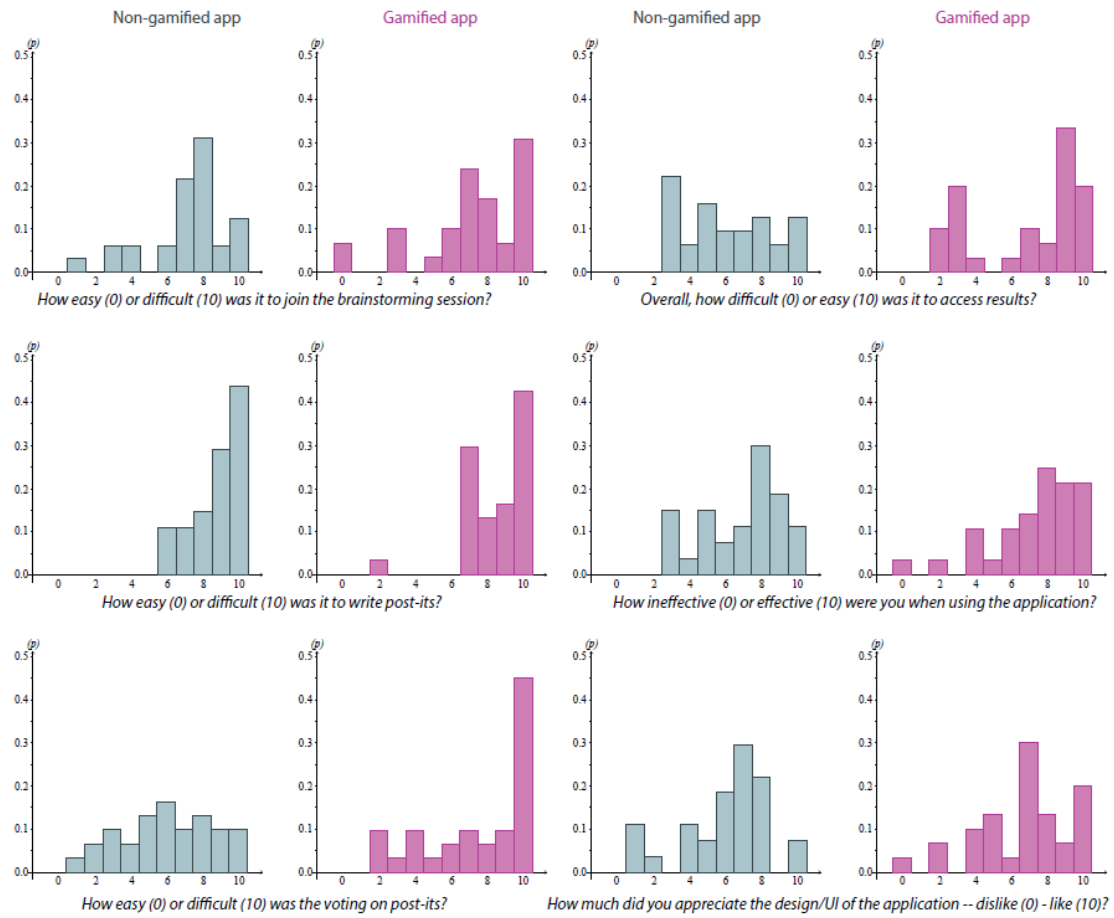


Figure 5. Resulting histograms relative to the ease of use.

How familiar are you with the brainstorming method?

Not at all familiar (0) - Very familiar (10)

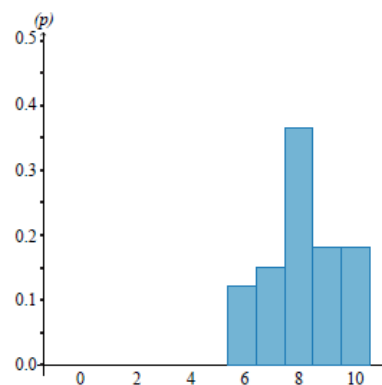


Figure 6. Each user-tester was at least moderately familiar with the brainstorming method.

in the *Spark-IT* application, due to a technical error that was detected and fixed during the tests. Both applications performed similarly here, joining with a link and a code was adapted for the audience.

How easy was it to write the post-its? The design of the writing area was similar for both applications, so they unsurprisingly performed similarly in the survey. Overall, the design works well and should be maintained.

How easy was the voting on the post-its? This is where the first big difference arises between the two applications. We knew from the start that application *K* was not adapted for this voting methodology. The implementation in *Spark-IT* is successful, as most users were very satisfied with it. The negative reviews are due to an UI issue when exporting to *WebGL*, where it was difficult to scroll down the lists of ideas as it would go relatively slowly.

Overall, how easy or difficult was it to view the results? Most users were dissatisfied with the results view in the application *K*, where it was only visible after users had sorted the list of ideas. During the sorting phase, they found it also difficult to navigate on the infinite whiteboard. The *Spark-IT* design was preferred by some, but a significant minority did not like the design they found too convoluted: The presentation in this last view could be revisited. Some also noted that they would like to see the funniest ideas displayed.

Do you think you were effective or ineffective in using the application? Participants seemed as effective using either application, and no significant difference can be noted here between both software.

If you had a magic wand, what part of the program would you change? For Spark-IT, users suggested the following parts:

- A way to name ideas when sorting them;
- Change the interface style;
- Fix the application slowness;
- Better leaderboard at the end, make a global rank using all the different sessions;
- Remove the race aspect as it is not the objective of a brainstorming;
- Better voting interface.

A few users were not satisfied with some of the interfaces, the overall slowness and the few bugs that occurred. They suggested to improve a few of the interfaces, mostly the results screen. Some suggestions are noteworthy, like the ability to name categories when making groupings.

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I really liked the badges given during the brainstorming session. Three participants did not like any of the gamification implementation in the *Spark-IT* application. Fortunately, most users found the usage of trophies added a significant value to the experience, as they felt more motivated.

I really liked the scores given during the brainstorming session. The scoring was a bit more divisive, as it was only shown at the end and the presentation was a bit confusing. Most participants liked its addition.

Do you think gamification added anything to this app? And do you think gamification is useful (in general)? These two questions should be analysed together. Most users think that gamification is a useful tool that can be leveraged. Similarly, a majority

also analyse the statistical meaning of the data. The quantity of ideas is known and can be used as a simple metric of the results.

In total, 33 people participated in both sessions, and generated 844 ideas using both software. Among these, 465 were written in *Spark-IT* and 379 in the application K. However, 28 of the ideas used with the gamified application were actually empty sticky notes – probably due to attempts to cheat in the race by certain participants. Still, an increase of 15% ideas were produced using the gamified application. To evaluate the participants' experiences of using the application, we asked them to compare it to non-gamified applications they've previously been using. Figure 8 shows the results of this comparison.

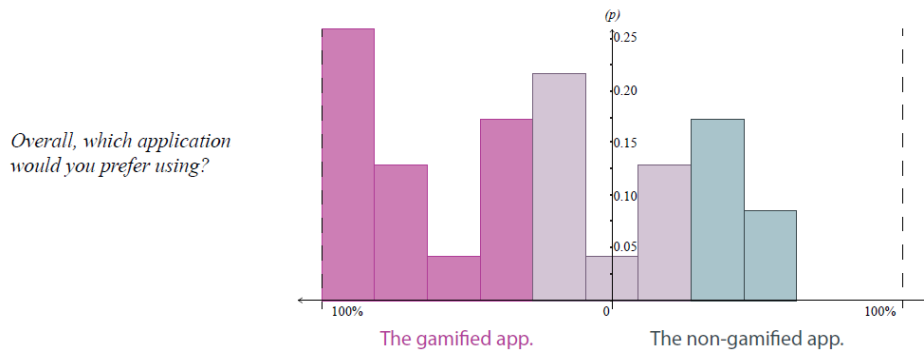


Figure 8. Final user-test question, which application would you rather use: a fifth of those surveyed would prefer a solution without gamification.

Social Bonding and Gamification

Based on the best brainstorming products on the market, we were able to develop a tool to compare the impact of a range of different gamification aspects. Our goal was to put the user at the centre of this project and to see how the social bond could be enhanced with this tool. Through the analysis of user tests, we have shown that something as nuanced as social connection clearly challenges our views on the use of

Spark-IT, a third slightly preferred *Spark-IT* and the last third slightly preferred the application *K*.

- User Experience: *Spark-IT* performed similar or better than the application *K* to perform the individual tasks during brainstorming: Connecting, Writing ideas, Categorising and voting. A few performance issues impacted some users' enjoyment.

The increased performance can be explained by multiple influences. First, it might just be a statistical error, as only eight sessions were performed with each application, generating around 50 ideas each time. Since the number of participants per session also varied, it is difficult to estimate the consistency. By just taking the raw data, the standard deviation is of 20 ideas, showing that more sessions are required to base a clear conclusion. The second explanation is the impact of gamification in the application. This can be disproved, since at the point of idea generation, no trophy or score has been shown to the user, as seen in the figure 3. Only the race had an influence at this point, and it would require repeated usage of the *Spark-IT* application to see the other gamified elements' effects.

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With current user-test settings, we cannot show significant impact detected on the performance of this aspect of brainstorming. New conclusions could be reached if more users were sampled to participate in the experiment. At this point, it might be interesting to find new gamified elements to incorporate before or during the idea generation, to stimulate even more its effect. Another possibility is, as mentioned earlier, to perform repeated sessions with the same users as they will become familiar with the trophies and scoring system.

The fact that the *Spark-IT* project is preferred over the application *K* is reassuring. It proves that the proposed implementation is successful and has a great potential for

further developments. This success can be linked to both the user experience and the gamified aspect. We can explain the preference of *Spark-It* by the fact that it was developed specifically for the use-case of this project. As the application *K* was repurposed to fit the desired brainstorming methodology, it was expected that the voting capabilities would be better in *Spark-IT*. It is still notable that where the application *K* performed the best (idea generation and sorting), it could be matched with the implementation done in *Spark-IT*. Even if the gamification did not impact idea generation so much, it certainly was well received by the participants, increasing their interest in the software. The use of gamification has then reached another objective: deliver a more enjoyable experience.

Perspectives and Needs

First of all, different ideas have been suggested by the participants during the survey; here is a list of the most recurrent ones:

- Provide new brainstorming types (brain shaking, brain writing, rapid ideation, starbursting, stepladder...). This could serve as groundwork to investigate the efficacy of the different techniques, while checking other gamification elements;
- Improve user interfaces to review results. The user interface (and more specifically its UX) had been done too quickly and some users were lost. The results of the *funny* votes should also be shown;
- Improve the application performance, as it is slow on older user laptops;
- A way to name ideas when sorting the ideas on the board;
- Integrate a video conference inside the application, so that the users can see each other when they brainstorm;
- Add collaborative tools for users to send questions.

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