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Stimulating ideation in new teams with the mobile game Grapplenauts

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Abstract

Working in teams is a common approach to solving problems. However, new teams often suffer from a form of cold start, by which individual members are not yet comfortable expressing their ideas. Previous work has shown that ideation can be stimulated by promoting a sense of psychological safety among team members and instilling an ambiance of openness, and that games are helpful at establishing such social bonds. However, most such games only partially target psychological safety or openness, and often rely on the expertise of a facilitator, who may be unavailable for many teams. The ubiquity of mobile platforms opens up many opportunities for overcoming such drawbacks. We developed the mobile game Grapplenauts, a novel serious game directly focused on psychological safety and openness, that generates a beneficial atmosphere for ideation and does not require any facilitator. In Grapplenauts, team players have to gradually work together towards a team-wide goal, first in pairs and then among pairs, which has shown to be quite successful in promoting communication and collaboration. Play testing has shown that Grapplenauts was perceived as a fun, engaging and challenging collaborative game. In addition, results of a preliminary user study are cautiously optimistic about the success of the game in improving the perceived atmosphere within newly-formed teams.

Keywords: Ideation; Psychological safety; Openness; Team collaboration; Serious games.

1 Introduction

People often form teams in an attempt to increase their ability to solve problems. However, not all such attempts are equally successful. Especially when groups need to be creative, there are certain social barriers that prevent members from being as creative together as they would be alone [1]. Indeed, the purpose of a team is to create a synergy that allows its members to be more creative about solving a certain problem than they would be on their own; a team *should* preferably have more creative power than the sum of its parts [1]. Often though, when a team is formed, the members may not be familiar with each other, which can lead to various social phenomena that can inhibit creativity. To alleviate these problems, tools such as workshops, games, and professional guidance aid the team's creative performance [2]. However, such means are often inaccessible to a majority of teams, e.g. due to the high cost of professional mentors, or to the extensive session preparation, constraining time and place where the team activity is to be performed. Given the prevalence and availability of mobile technology in recent years [3], as well as relatively common ownership of mobile devices [4], such platform has great potential to be used as a tool to stimulate creativity in teams. Particularly, in addition to being accessible, a serious game could provide a fun and humorous experience that can relax, comfort and unite the team members, which could greatly enhance a team's performance.

We propose the serious game *Grapplenauts*, a novel mobile game that places newly-formed teams in a purposefully designed setting that minimizes social issues related to team activities. Results from social research (Section 2) show that psychological safety and openness can positively affect a team's ideation process in the long run. Potential use cases are student projects, research projects, surgical teams or other work groups, where these psychological factors strongly influence project success and the team's motivation and efficiency [5–7]. The main research question then becomes:

> *"How can a mobile game help generate a beneficial atmosphere for ideation in new teams?"*.

To answer this question, we designed and developed *Grapplenauts* incorporating elements that stimulate the aforementioned aspects of ideation (Section 3). We then assessed how the game performs at creating this beneficial atmosphere in newly-formed teams (Section 4).

2 Related work

In order to achieve the goal of stimulating ideation with a game, we first identify in the literature which factors determine the ideation process within newly-formed teams. We then analyse traditional methods that have been used for this purpose, as well as games, in order to determine what design elements could work to achieve this goal.

2.1 Theoretical background

In order to find out how to stimulate ideation within newly formed teams, we need to determine how exactly a team's creative performance manifests itself. Literature suggests that a team's creativity mainly depends on two factors. The first being the individual creative ability of the members themselves, which is more or less a fixed factor. The second factor is the social state of the team: how the members feel towards one another and towards the team as a whole [1]. There are various types of social phenomena that influence this latter factor, both positively and negatively. If one would get rid of all negative phenomena, a team would creatively perform at least as well as the sum of its parts, which is desirable. Examples of such negative phenomena are [1, 2, 8]:

- *Evaluation apprehension:* Fear of being judged by other team members for contributing ideas in a team.
- *Premature rejection of ideas:* members do not bother bringing up wild ideas under the assumption that they are not worth considering.
- *Social loafing:* Members display free-riding behaviour because they view their contribution as dispensable.

These phenomena can arise naturally in a team and can result in decreased creative performance. Related to this is the notion of psychological safety: the shared belief that the members of a team can take risks in decisions that affect the entire project without being faced with negative consequences [9]. In the same work, Edmondson developed a measure of psychological safety, defining the following seven metrics:

1. If you make a mistake in this team, it is never held against you.
2. Members of this team are able to bring up problems and tough issues.

3. People on this team never reject others for being different.
4. It is safe to take a risk on this team.
5. It is easy to ask other members of this team for help.
6. No one on this team would deliberately act in a way that undermines a team member's efforts.
7. Unique skills and talents of team members are valued and utilised.

Parallels can be drawn between negative social phenomena and the metrics of psychological safety. For instance, the first two metrics correlate with evaluation apprehension, the fourth metric correlates with premature rejection, and the seventh metric correlates with social loafing. Hence, in order to combat the negative phenomena for ideation, one can look at creating psychological safety in a team.

While psychological safety allows the team members to share opinions and ideas without worrying about a backlash from the other members, efficient communication is also required to make the team actually talk between each other. Together, they create a state of openness where people can freely communicate their thoughts. Here we understand openness as a transparency in sharing task-relevant information, which facilitates the alignment of goals and expectations within the team [5]. To reach this state, the members should not encounter problems communicating and sharing information with one another, "breaking the ice" of the communication barrier [10].

Psychological safety and openness thus seem to be the two key aspects that contribute positively to the desired beneficial atmosphere for creative work. Several tools that stimulate these aspects have been studied, icebreakers being the most common ones.

2.2 Icebreakers

To help members of a group begin the process of forming themselves into a team, ice-breaking activities are often used [11]. Icebreakers are commonly presented as a game to warm up a group and to help them get to know each other better. Icebreakers help group members get acquainted, begin conversations, and relieve inhibitions or tensions between group members. In addition, icebreakers build trust and make members feel more open to one another [10].

One commonly used icebreaker is the Human Web activity [10]. Here, a facilitator begins with a ball of yarn, introduces themselves and tosses the ball of yarn to another person. That person then introduces him/herself by describing how he/she relates to the previous person. This continues until everyone has been introduced. This icebreaker has been shown to facilitate several key aspects for group work, including, but not limited to: psychological safety, teamwork, social interaction, socialization, and group cohesiveness. Another well known icebreaker is Two Truths and a Lie [12], in which everyone in the group gives three statements about themselves, two of which are true and one is false. The others in the group have to guess which statement is false. Two Truths and a Lie is not only played as an icebreaker, but also as a fun party game. This shows that an icebreaker could be not only useful for the team, but also fun to play. These methods generally require a facilitator in order to be effective: people might not participate, or one team member will step forward as facilitator, which could create a pecking order. In addition, in these traditional methods, members are directly forced to talk, which may be experienced by some as unpleasant. Instead, it may be more effective to establish communication between members in a less explicit way, by giving the team a shared goal and the guiding narrative that helps tying the activity together with its motivation [13]. The immersive nature of video games is useful to provide a team with a common goal and context.

Games have shown to be capable of effectively stimulating psychological safety in teams [14], and to be, at least, as good as other non-game social activities for fostering social bonds among team members, while avoiding their negative effects [15]. It has also been shown that playing Table-top Role Playing Games (TRPGs) has a positive influence on creativity [16]. Grapplenauts contains elements that are similar in nature to the decision making present in TRPGs, while also providing a much more immersive and interactive game environment, which is absent in TRPGs. We can, therefore, conclude that using games for the purpose of ice breaking is both effective and promising.

2.3 Ice-breaking Games

Ice-breaking activities in video game format have already been used in different forms. For teamwork workshops, TeamUp [17] creates a setting where four players have to overcome a number of puzzles and challenges relying on effective teamwork. It was not designed as a stand-alone experience, but more as a tool for trainers to use during "teamwork workshops". The game has been specifically designed to include an extensive debriefing, providing a detailed report to the trainer, who then supports the team to identify improvements to their collaboration process. These sessions take at least 3 hours, of which 35 minutes are spent on the game itself [18]. TeamUp successfully generates a beneficial atmosphere for teamwork and stimulates a team to reflect on their performance. However, it is neither adequate nor fitting for smaller teams (e.g. student teams), due to the length of the sessions and the required attendance of a professional trainer. This suggests that a more accessible mobile game, which everyone can easily download and play, could be of much use to many newly-formed teams.

Let's Team! [19] fosters team competency by requiring both real-life interactions and in-game collaboration to progress. The players need to gather resources from a virtual environment to build a settlement. The levels are designed in such a way that players are subtly forced to communicate about resources, assistance and objects. The game is meant to run in parallel with real-life work activities and involves phases of work organization, resource negotiation and reflection. Similar to TeamUp, this game is designed as a tool for professional coaches and is, thus, unpractical for many smaller teams and projects.

Smart Icebreaker [20] is an ice-breaking game aimed at student groups, where players have to create a virtual avatar based on one of their team members and then discuss and comment on each other's avatar. Smart Icebreaker can be played without a facilitator, but only focuses on breaking the ice and does not take any psychological safety issues into account.

Overcooked [21] promotes ice-breaking by partnering up to four players in a virtual kitchen, where they have to prepare, cook, and serve a variety of orders. The game constantly changes kitchen layouts and orders, forcing the players to cooperate, communicate and adapt. Planning and teamwork are essential to succeed, but are also made very difficult by the circumstances. Overcooked is primarily focused on entertainment and challenges players to work together and rethink their strategy, but this also puts a high responsibility on each player. In terms of psychological safety, this could negatively impact players less adept at video games, as they could feel that they let their team down. A more lenient game could have less of a negative impact on psychological safety.

In the mobile game Spaceteam [22], players manage a space-ship using their cellphone. Teamwork is required as buttons and switches are distributed among all the players. Players are randomly prompted to press certain buttons, which requires communication with the team. If the players do not perform these tasks in time, the team fails and the game ends. As the game progresses the players get less time to complete their tasks, which slowly results in chaotic shouting. Spaceteam touches many of the aspects that make a team cooperate and communicate, but players with less presence could feel overruled and not brought into the

team, especially in later stages, which promotes social loafing.

Grapplenauts shares the spirit of Spaceteam as a modern mobile icebreaker game. However, instead of progressing difficulty and creating hectic situations, Grapplenauts allows the teams to progress at their own pace, while also using a more streamlined communication model that gives every player the chance to share their thoughts.

3 Game design

The game design of Grapplenauts builds upon the background theory and its conclusions regarding psychological safety and openness. This brings about various technical challenges which the game should solve and take into account in order to generate a beneficial atmosphere for ideation.

3.1 Overview

Grapplenauts is a top-down collaborative game set in outer space. The players work together, using spaceships equipped with grappling hooks, to collect and bring valuables to a dropzone. While performing this task, players try to avoid obstacles, such as junk and sticky space snot. Each spaceship is controlled by two players, each controlling a thruster at one side of the ship (see Figure 1 for an impression). When all valuables are collected, all ships have to meet at the dropzone to continue to the next level. The game starts off with two tutorial levels to let players get accustomed to the controls and mechanics of the game. After completing the tutorial levels, the game will prompt the players with a dilemma, offering them two options. Depending on their choice, the players face different challenges in the upcoming level. In total Grapplenauts contains 4 levels, with 2 dilemmas. Grapplenauts has been tested in numerous on-campus play testing sessions, in which the participants perceived it as a fun, engaging and challenging collaborative game.

3.2 Technical overview

Grapplenauts was developed for smartphones to reach a large audience and let teams jump right into the game. For this reason, it was created in Unity 2018.2.f1 to allow for cross-platform compatibility for both Android (6.0+) and iOS (9.0+). The smartphones connect to a provided match making server (written in `C#`) to easily host and join a game session. This matchmaking server lets the phones connect to each other via their local WiFi network. The game is controlled using touchscreen buttons, requiring two players to play on each device (see Figure 1).

3.3 Design challenges

Based on the seven metrics of psychological safety described in Section 2, we chose the following three representative design elements for the game:

1. *Cooperation:* The game must encourage the players to cooperate, instead of compete. The game should also promote that they safely ask for help.

2. *Engagement:* The game must be fun and humorous, creating a pleasant mood that makes players more likely to talk and actively take part. This ties back to making sure that every team member's capabilities are valued, but also keeps them interested in the game.

Figure 1: *The valuables (magenta) have to be dragged to the dropzone (green circle). If the junk (brown) ends up in the dropzone the score decreases. The space snot (large green blob) is an obstacle in which ships and valuables can get stuck.*

3. *Failure permitted:* The game should ensure that there are no particular situations where one individual can make the team fail. In addition, it should allow players to take risks without it being held against them, thus making it safe to take risks.

Since this third design element has the most overlap with the definition of psychological safety, we deem this as the most important element. Because of this, the game design was specifically tailored to allow players to take risks, without negative consequences.

By further incorporating *communication* elements, openness can be achieved when the team is in a psychologically safe state. The hypothesis is that this combination will eventually lead to improved ideation capabilities, as depicted in Figure 2. Based on our understanding, a successful game design should incorporate these four design elements to effectively support improved ideation. We will go over each of these design elements in turn and explain how the game mechanics relates to each of them.

3.3.1 Communication

The communication element is key to create openness, hence the game provides various methods to get players to talk. First of all, the game presents the players with various challenges, which require communication to solve efficiently. The game has two types of communication challenges: those inside the pairs of players and those among the pairs. An example of a challenge the players inside a pair constantly face, from the moment they enter the game, is that they control the spaceship together. A challenge among the pairs is to dislodge one ship when it becomes stuck in space snot, which requires the help of another ship. Both types of challenge encourage communication, though on different levels. Within the pairs, the communication is one-on-one, making it more personal and focused. Once players are comfortable sharing their thoughts and coordinating their actions within their pair, they will likely find it easier to do that with the whole group or speak up when they need help from other pairs. This is what triggers the inter-pair communication.

The game also gives the team various opportunities to discuss and make decisions together. After each level the team is greeted with a statistics screen asking them whether they

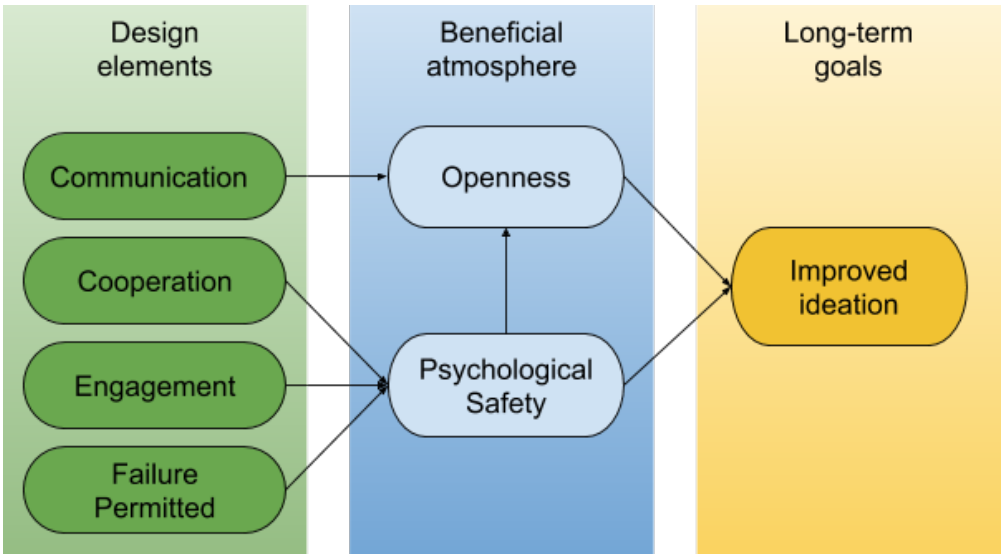


Figure 2: *Schematic model of how chosen design elements lead to a beneficial atmosphere for ideation.*

want to continue or to retry the level, which is intended to trigger discussion. If the team chooses to continue to the next level, they are faced with two challenges they can encounter, of which they must choose one. To proceed, the team must reach a consensus on the challenge. Ideally, they would briefly open up and evaluate their strengths and weaknesses and pick the challenge that suits them best.

3.3.2 Cooperation

A cooperative game implies that the objective and reward is shared with the team. In Grapplenauts, the shared goal in each level is to collect all the valuables. The game begins with mechanics where cooperation is merely beneficial. As the game goes on though, it is expected that the players start to better understand how to cooperate, hence introducing objectives and mechanics where cooperation is required to proceed. An example of a mechanic that benefits from cooperation is collecting valuables. If the valuables are heavy, it can be difficult and slow to pull them alone, but if the other ships help, it can become an easy task. Moreover, when the valuables are clustered together, the players can use use their grappling hooks to create a net, which can be used to collect the whole cluster in one go (see Figure 3).

Later on in the game, the players encounter challenges in which cooperation is a hard requirement. An example is the boss valuable, which is a heavy valuable in the final level that resists being pulled. It unfeasible to pull this valuable with a single ship, so to finish the level all the ships have to join efforts and pull it together.

3.3.3 Engagement

By keeping the players engaged, they feel compelled to keep playing the game, which is a requirement to make the game effective at achieving its goal: generating a beneficial atmosphere for ideation. Hence, the game has several design elements that keep players interested. First, the players control spaceships in pairs. With the cooperative behavior, players are involved with the game and pairs will not exhibit idle behaviour, thus preventing social loafing. Additionally, the mood in the game has been designed to allow a lighthearted atmosphere to develop among the players. According to proposed models on the role of humour on group

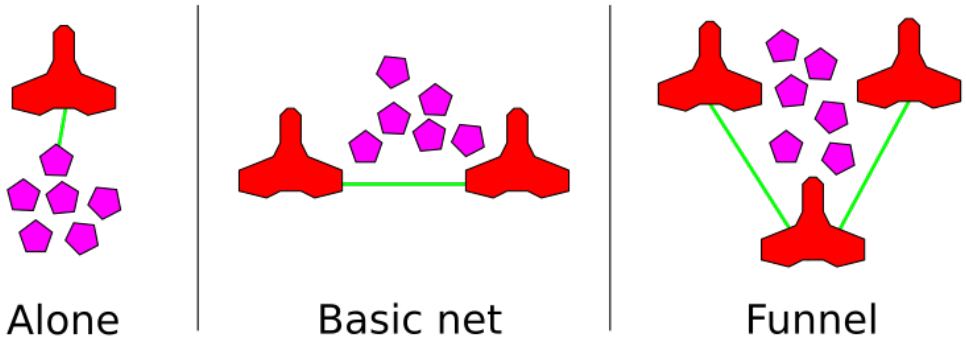


Figure 3: *If the grappling hook is fired at another spaceship, they form a net which can be used to transport multiple valuables in one go.*

effectiveness, humour contributes to creating an open communication environment [23]. So making the Grapplenauts challenges, visuals and audio lighthearted and fun aims at helping the players to laugh and loosen up, allowing them to communicate more comfortably and feel more engaged.

3.3.4 Failure permitted

By making players feel safe in a team, they should be able to take risks, without that being held against them. In Grapplenauts, a player cannot fail the game, since the challenges are built such that they only hinder players: as long as all the valuables are collected, they succeed. When the players get stuck in snot or collect junk, they are only slightly hindered, not setting the team back. Since the controls are challenging on their own, players are more forgiving towards their teammates. This means that getting stuck in snot or overshooting the dropzone are perceived as humorous instead of frustrating.

In addition, when a level is finished, the game is always positively encouraging. The team is awarded 1-3 stars based on their performance, along with an encouraging message pointing out how they can improve. The team can then evaluate their performance and choose whether to retry or to continue. Whenever possible, Grapplenauts subtly tries to transform what looks like a failure into either something funny, or something the team can improve upon.

4 User study

A user study was conducted among teams of volunteer students, to evaluate the extent to which Grapplenauts fulfils its goal of promoting a beneficial atmosphere for ideation in new teams. In particular, the study assessed whether team members (i) became more open to each other, and (ii) felt more psychologically safe, after playing Grapplenauts.

4.1 Methodology

The study was conducted among students at the faculty of Electrical Engineering, Mathematics and Computer Science (EEMCS) at Delft University of Technology. To assess how Grapplenauts influenced these aspects, an A/B testing experiment was used assessing the difference in the group behaviour between groups that played the game and groups that did not play. Initially, all student teams following the chosen project course were asked how many team members they knew beforehand. The teams selected for this study were only those in

which fewer than 3 people knew each other. A total of 11 teams were selected, each consisting of 6 students. From these 11 teams, we randomly selected 6 teams for group B, and the remaining 5 teams were used as our control group A.

The teams in group B were asked to play Grapplenauts at the start of the project, while those in group A did not. Over the first three weeks of their project, both groups were asked to fill a total of 3 questionnaires, aimed at gauging the degree of psychological safety present in the group. All questionnaires, handed out at the end of each week, were filled in individually.

The questionnaire consisted of 17 questions (see Table 2 in Appendix A). Two of the questions focused on openness; all other questions (plus one of the openness questions) covered the 7 metrics of psychological safety (see Section 2). These questions were phrased such that they would both be intuitively understood and easily answered. Consequently, the coverage of the various metrics in the survey is not uniform, resulting in that some questions cover more than one metric. All answers were measured on a 5-point scale, ranging from "strongly disagree" (0) to "strongly agree" (4). Three of the questions required the team members to have spent some time with each other, hence they were omitted in the first week (these questions belonged to metric 7 of psychological safety).

4.2 Results

For each group, the response per question was averaged over the teams in that group and, subsequently, these 17 results were aggregated into 7 scores, according to the corresponding metric categories (Appendix A). We then computed an average response within each category. This was done for each week, creating three data points per category, for each of the groups.

Figure 4 shows the average score for each metric, in both groups. When comparing them, it is striking that, for instance, the initial scores of the metrics start slightly higher on average for group B than for group A. In addition, psychological safety metric 7 (regarding utilising the unique abilities of the team members) seems to suffer a drop for group A after week 2, opposed to what happens for group B. This metric also seems to suffer from high variance especially in group A, hence deeper analysis was justified here. Figure 5 shows the scores of the individual questions related to Psychological Safety 7, indeed showing that for group A half of the questions scored significantly lower than the other half explaining the high standard deviation of Psychological Safety 7 in Figure 4. Lastly, the openness metric suffers a slight drop for group B after week 1, but eventually ends up around the same score for both groups.

In addition to the figures, Table 1 summarizes, for each of the metric scores, the relative improvements between weeks, and the overall improvements over the full period. In this table, group A and B show for the most part rather similar overall improvements. The Psychological Safety metrics 2, 5 and 7 had the largest improvements for group B in comparison to group A, while group A showed more improvements regarding Psychological Safety metrics 1 and 3 (note however that the initial values for these aspects were higher for group B, thus the final results are similar). The only metric with an overall deterioration for group A was Psychological Safety 7, which indeed had a far lower final score than group B.

To assess the statistical significance of the group differences measured, we used an independent two-sample t-test, with the assumption that the sample sizes are unequal (since group B is larger than group A) and the variances are equal, with the null-hypothesis that the means are equal. Since we have $36+30=66$ participants (samples), we have $66-2=64$ degrees of freedom and therefore a critical t-value of 2.00. We calculated this t-value on the last day (when the game should have had enough time to show a significant impact), for each of the metrics. The results, in the last column of Table 1, show that the null-hypothesis can be rejected for all metrics but one.

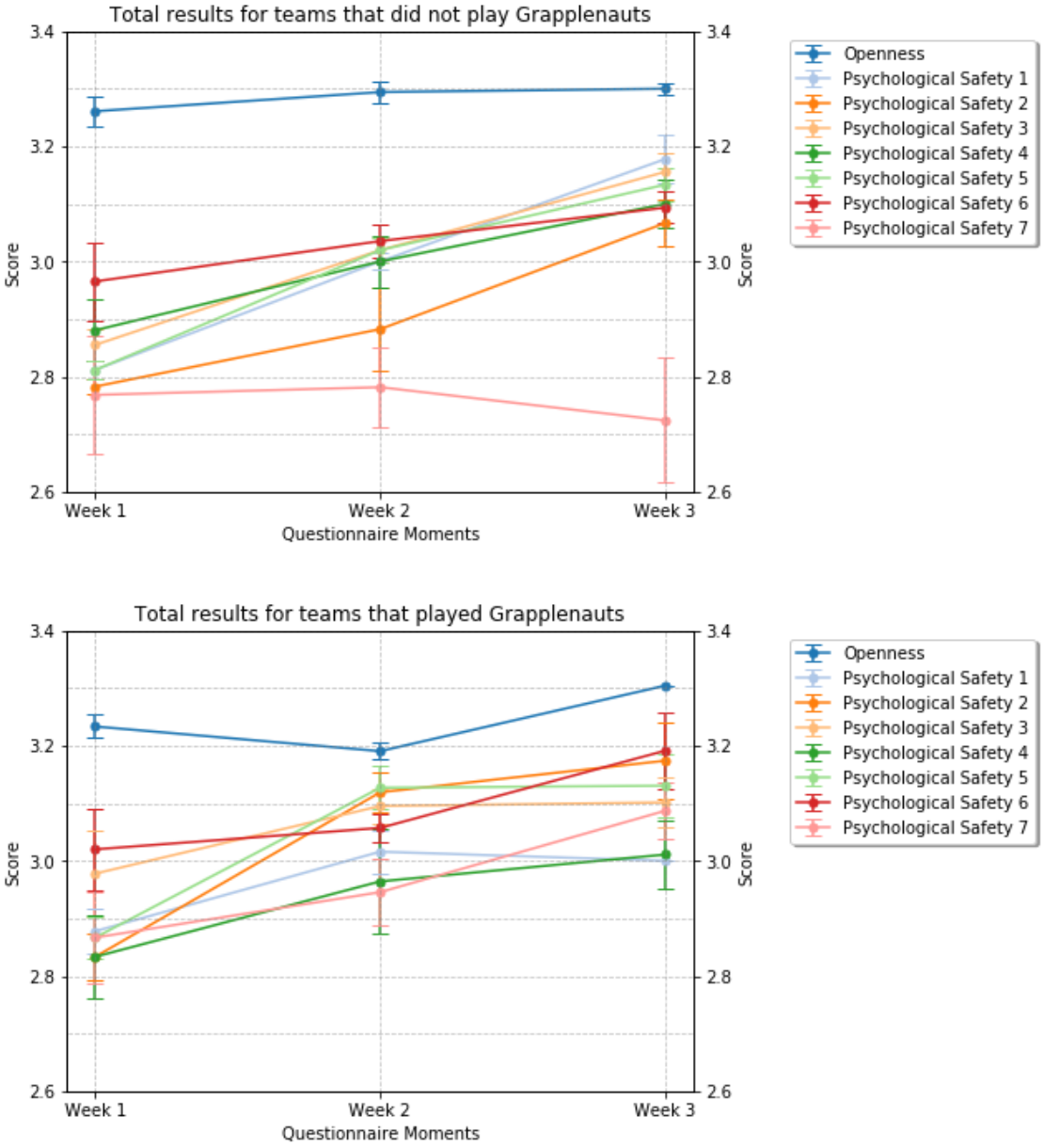
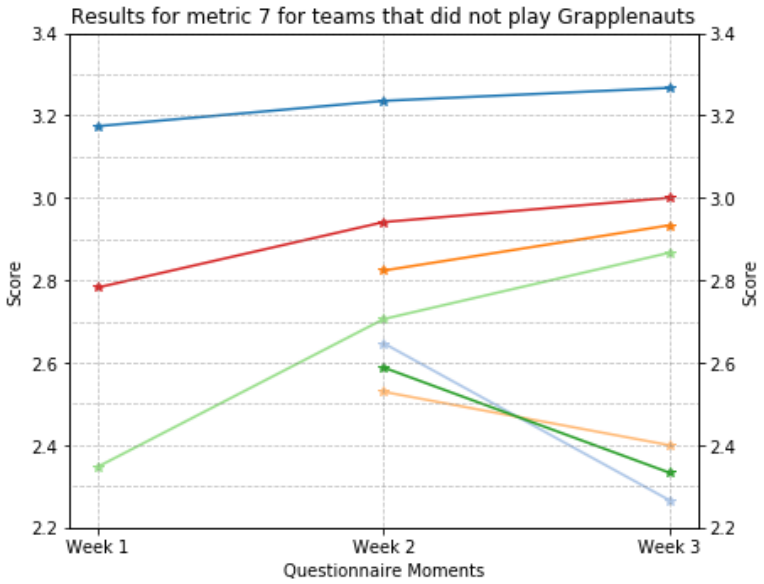


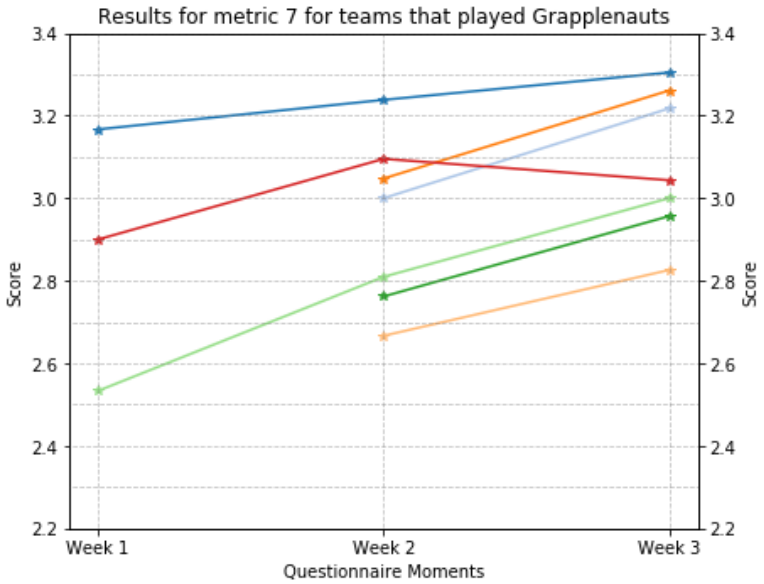
Figure 4: *The scores (from 0 to 4) for the different metrics averaged over all teams. Top: group A; bottom: group B.*

Table 1: *Openness and Psychological Safety improvements during the user study.*

	Improvements week 1-2		Improvements week 2-3		Improvements overall		t-Value week 3
	A	B	A	B	A	B	
Openness	3.32%	-4.29%	0.59%	11.39%	3.91%	7.10%	3.86
Psych. Safety 1	18.84%	13.81%	17.78%	-1.59%	36.6%	12.22%	38.43
Psych. Safety 2	9.97%	28.57%	18.43%	5.49%	28.41%	34.06%	8.02
Psych. Safety 3	16.45%	11.75%	13.59%	0.62%	30.05%	12.37%	5.59
Psych. Safety 4	11.96%	13.10%	10.00%	4.66%	21.96%	17.75%	6.96
Psych. Safety 5	20.80%	26.03%	11.37%	0.35%	32.17%	26.38%	0.27
Psych. Safety 6	7.01%	3.71%	5.80%	13.42%	12.81%	17.13%	8.22
Psych. Safety 7	1.34%	7.89%	-5.77%	14.14%	-4.43%	22.03%	19.30



(a) *Scores for group A.*



(b) *Scores for group B.*

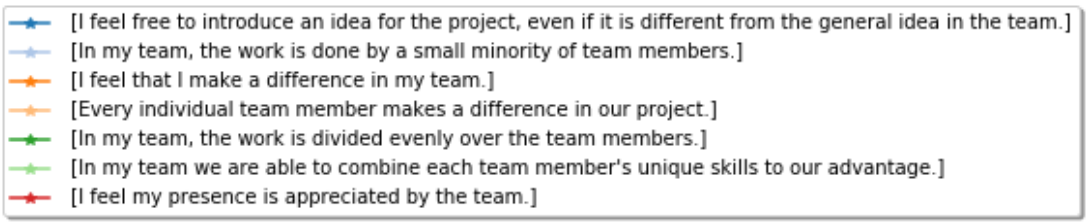


Figure 5: *The scores (from 0 to 4) for individual questions of Psychological Safety metric 7, averaged over all teams.*

4.3 Discussion

The results above show that, on average, the scores during the first 2 weeks are higher for group B than for group A. This is especially true for Psychological Safety metric 2, which concerned the idea that members are able to bring up issues. In week two, group B scored 3.11 ± 0.03 for this metric while group A ended at 2.88 ± 0.07. This, together with Psychological Safety metric 1, correlates with evaluation apprehension (see Section 2). This could hint that Grapplenauts helps the group members feel at ease with each other, at least early on in the project.

Surprisingly, the final score for Psychological Safety metric 1 is lower for group B than for group A; it did not grow further in week three. Apparently, group members of B did not experience further growth compared to the average of group A. This could be coincidental, meaning the A teams had on average a better team experience compared to B teams. It could also imply that the positive effects of using Grapplenauts mostly show up in the first two weeks, and not beyond that horizon, after more new challenges and events arise that put strain on the interpersonal relations of the group.

While the final scores are for the most part very similar between group A and B, the scores for Psychological Safety metric 7 differ drastically. For group B, this metric grows every week, with a final score of 3.09 ± 0.05. For group A, the score does not change between week 1 and 2, but decreases in week 3 to 2.72 ± 0.11. As mentioned in Section 2, this metric indicates how well the unique skills and talents of team members are valued and utilised. Looking at the individual questions contributing to metric 7 in detail, it appears that the three questions regarding workload distribution get low scores for group A, which is an indicator of social loafing. This makes sense, because metric 7 correlates with social loafing to some degree: when only a minority does the work, it means that not all skills in the team are utilized well. This seems to indicate that Grapplenauts helps prevent social loafing, since this phenomenon does not occur in group B.

With regard to the t-test, it showed all metrics to be significantly different between the two groups except for the Psychological Safety metric 5, which deals with whether the team members find it easy to ask each other questions. Looking at the weekly course, we see that both groups end up around the same score, but group B achieved it in week 2, whereas group A only did that in week 3. This could mean that the value around 3.13 ± 0.03 is a plateau for this metric. However, it could also mean that the groups simply need more time before this value increases. It is unclear whether Grapplenauts had an advancing effect or is agnostic regarding this metric.

Overall the results are cautiously optimistic and deserve further investigation. For instance, the fact that group B scored higher in the first two weeks but did not improve as much afterwards may be seen as a confirmation that playing Grapplenauts does help with the cold start at the beginning of a project but not so much after. In any case, it remains unknown what happens after week 3; monitoring the teams over the course of a longer period could potentially bring in new insights. Finally, a larger sample size might clarify the discrepancy in some of the final scores between the two groups.

5 Conclusion and future work

The ideation process in newly-formed teams is often sub-optimal due to various social hurdles. To counter this, activities, games and workshops, possibly with professional coaching, have traditionally been proposed, but they remain inaccessible in many contexts, including small teams and (student) projects.

We posed that in order for a mobile game to support teams in increasing psychological

safety, it should carefully integrate four key design elements: *communication*, *cooperation*, *engagement* and *failure permitted*. The serious game Grapplenauts, designed along these lines, smoothly combines cooperative mechanics, which avoid negative social phenomena, with game mechanics that encourage communication, while keeping the game entertaining and fun. The effectiveness of these design elements was assessed with a user study, concluding that Grapplenauts had a perceptible positive effect on psychological safety during the first two weeks. It also indicated that the game tends to improve how teams make use of the unique individual abilities of their members, reducing negative effects (e.g. social loafing). We can, therefore, be cautiously optimistic about Grapplenauts' ability to stimulate psychological safety in newly formed teams, improve their team dynamics and the ideation process.

Grapplenauts is directly focused on psychological safety and openness, in order to foster ideation in a newly-formed team. Future research should investigate whether this focus could be combined with other important objectives, as e.g. targeting interpersonal interactions and team building [24]. Another promising direction is to look into how game mechanics could be extended (e.g. mirroring the team's project roles to the in-game roles), or made more flexible (e.g. finding team-size-agnostic game mechanics to allow for more scalable gameplay). Finally, we believe that it would be worthwhile investigating the possibilities and impact of game mechanics customization on diverse audiences and cultures.

Grapplenauts is available world-wide and free-to-play on Google Play[1] and App Store [2].

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A Questionnaire

The following questionnaire was utilized in our user study. Each question corresponds to one or more metrics of Psychological Safety (see Section 2):

Table 2: *User study questionnaire.*

	Question	Metric
1	I feel comfortable interacting with my team members.	Openness
2	I feel free to introduce an idea for the project, even if it is different from the general idea in the team.	Openness, 4, 7
3	In my team, the work is done by a small minority of team members.	7
4	I feel that I make a difference in my team.	7
5	Every individual team member makes a difference in our project.	7
6	In my team, the work is divided evenly over the team members.	7
7	I feel trusted by my team mates.	1, 3, 4, 5, 6
8	I feel I can trust my team mates.	1, 3, 4, 5, 6
9	In my team we are able to combine each team member's unique skills to our advantage.	7
10	I feel comfortable asking the team for help when I don't understand something.	2, 5
11	In my team I feel it is safe to take risks.	4
12	I feel making mistakes is allowed in this team.	1
13	I feel accepted by everyone in my team.	3
14	I feel my presence is appreciated by the team.	6, 7
15	Somebody in the team hinders my ability to contribute.	6
16	I feel my effort is undermined by others in my team.	6
17	Regarding the project, I feel I can bring up problems and tough issues in my team.	2