Affordances of Brainstorming Toolkits and Their Use in Game Jams

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ABSTRACT

Brainstorming is an important part of creative design, related to exploring the associativity of different ideas and the combination of their parts. Previous work has investigated social interactions, productivity, techniques, and quality of brainstorming activities. The paper contributes to this body of work by studying the design affordances of brainstorming toolkits, and the relationship between idea associations and brainstorming. We examined 21 brainstorming toolkits designed for creative brainstorming within the context of game design, which led us to four tiers of design affordances that specify the supportive qualities of toolkits for brainstorming. To gain further insights into the use of tools, we surveyed game jams participants about their brainstorming activities and the use of tools at Global Game Jam 2017. We found a large number of participants using traditional stationery to aid brainstorming and a common usage of mind mapping and rearranging post-it notes. These findings inform our discussion of how idea creation is leveraged by a hybrid use of traditional and digital tools.

CCS CONCEPTS

• Human-centered computing → Interaction design theory, concepts and paradigms

KEYWORDS

Brainstorming toolkits, game jams, design affordance.

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1 Introduction

Brainstorming is an active research area, in particular regarding its effectiveness for problem-solving and coming up with ideas [4, 33, 35, 41]. Brainstorming by itself is an imperfect process, subject to peer dynamics and hampered by social issues such as social loafing, evaluation apprehension, and production blocking [11]. Unstructured and overly long brainstorming sessions can lead to groupthink, "a psychological drive for consensus at any cost that suppresses dissent and appraisal of alternatives in cohesive decision making groups", which leads to poorer design decisions [18].

Structured rules, and active time-moderating are two techniques used to overcome these problems [21]. Brainstorming toolkits that incorporate random ideas and combination of unusual themes have humorous, wild results. We define brainstorming toolkits as *resources designed to facilitate and support quality idea generation in a collaborative setting*. When everyone has goofy or fringe ideas, participants are less likely to reject risky ideas and as such are more likely to create unique designs.

Previous work on brainstorming toolkits describe them as sources of inspiration [28, 29, 31] and has found that in reality they work by imposing design constraints on their participants [22]. The more specific the design constraints are, the more they can "elicit more gameful outcomes" [12]. These design constraints become "enablers for the creation process" [21], granting clearer directions to everyone involved, and help participants focus on their creative tasks. Brainstorming is an iterative process of "transforming, combining and adapting elements" of previous work, as well as drawing from other phenomena [8].

In this paper, we are exploring game jams as a research environment [6]. Game jams are timeboxed events in which participants gather to make games. Our work aims to investigate how ideas emerge as an associative, networked relationships. Our research questions are: "What affordances do brainstorming toolkits provide", and "what is the relationship between brainstorming and idea associations?"

Game jams are often used interchangeably with hackathons, because they share a similar format: creating something within a

limited time. Participants, called jammers, gather together to brainstorm and make a game in this informal collaborative event. Game jams as a research environment offer a magnified view into the game design process for researchers to study ideas from start to finish [6].

The roots of game jams can be traced back to Indie Game Jam in 2002, and then in 2006 at Nordic Game Jam, two of the first major game jam events. It provided a collaborative space where "people [are] willing to help other teams as needed ... to solve problems. It's often a learning experience ... with people specifically experimenting with new technologies or ideas" [27]. The void of prizes removes the extrinsic motivation for competition. In addition, jammers are not tackling real-world problems—as it is often the case with hackathons—but instead creating their own games around a central theme. These themes add constraints around jammers for their game design challenge [44].

Game jam themes are designed to be open-ended and ambiguous [12], allowing room for creative freedom. Kultima [19] framed "game jams as 'compressed development processes' ..., [and] being able to go through different steps of game development in a short period of time" is one of the key reasons game jams are attractive to researchers.

Using game jams as a context, this paper investigates the use of toolkits for brainstorming through a review of 21 toolkits and a survey of game jam participants at the Global Game Jam 2017. The paper contributes 4 tiers of design affordances of brainstorming toolkits, and notes hybrid adoption and use of traditional and digital tools for brainstorming, suggesting that there may be a need for a generic idea sharing platform that can also support and facilitate brainstorming with proper guidance, as we will discuss in the next two sections.

2 Qualities of Brainstorming Toolkits

Elements of brainstorming toolkits design are interdependent to their human factors: what makes these tools work in collaborative settings, and how people brainstorm with them [5]. The all-too-familiar blank canvas problem, during which participants are searching for a starting point, is alleviated by clashing many new ideas. Brainstorming toolkits enhance social dynamics by defining the social contract of idea exchange to better structure collaborative thinking [21]. Random ideas are "surprising stimuli which force the player to think outside the box thus resulting in ideas that would not necessarily otherwise emerge" [21]. A person may draw random words from different categories, and attempt to describe a game based on what they turned up [15].

Game jams promote focus, low risk, and skill mastery [13]. They advance the quality of games across domains, community structure, and expertise of participants [42]. Brainstorming toolkits can offer consecutive, serendipitous encounters much quicker than normal conversations, hastening idea generations with risk-averse mindsets. Every team is like a themed restaurant where chefs work together around some central ingredient; or as Lehrer [26] put it, writing about creative thinking: "the metropolis is like a sonic blender; every street is a mix tape." Well-structured brainstorming toolkits make jammers think about relations between subjects in hand, instead of the most obvious solution [28]. The tension of random ideas and game rules create an equal contribution opportunity for everyone to participate, a factor for success in collaborative learning and design. In other words, the collaborative design process and tension mimics that of collaborative gameplay [3].

3 Affordance of Brainstorming Toolkits

In this section, we examine the affordance of brainstorming toolkits based on Norman's design affordance, defined as the relationship between the human and the object, and what can be accomplished by their interactions [32]. This relationship has a great impact on the outcomes of a brainstorming session, the object in context being the brainstorming tools. For example, brainstorming toolkits are defined to generate a large number of ideas in a short amount of time, because they leverage idea relationships to leap from one idea to the next. Efficient idea generation can therefore be considered an affordance of brainstorming toolkits.

To systematically identify the affordance of toolkits, we first reviewed studies about the use of brainstorming toolkits [16, 21, 22, 29, 31]. This allowed us to develop a systematic understanding of what is considered as a 'good' or 'well-structured' brainstorming activity [24, 35–37], and linked them to the affordances of brainstorming toolkits. We then reflected on the brainstorming facilitation complexity, and produced four tiers of affordances according to their function: *generating, transforming, constraining*, and *guiding* (Figure 1).

Generating. At the heart of every brainstorming toolkit is the generation of ideas, whether it is a new object, event, theme, location, or an abstract concept. The identifying element of generating is a random function—like drawing a card from a shuffled deck of cards—from which an independent idea is introduced into the mix. More independent quantity of ideas is often necessary to produce higher quality ideas later [37]. The primary use is surprise, an emergence of wild and interesting combinations [39]. At this tier, the brainstorming toolkit only offers introductions of new ideas, with a hint to combine them with other new ideas.

Transforming. Brainstorming toolkits can provide means to transform and combine different ideas, clashing them to create something new. This is often done through group dynamics [37]. Applied creative strategies such as *S.C.A.M.P.E.R.* [7, 34] concentrates solely on the transformation of ideas. It is especially crucial in a game jam setting, because when more than 20,000 groups of people are brainstorming with the same

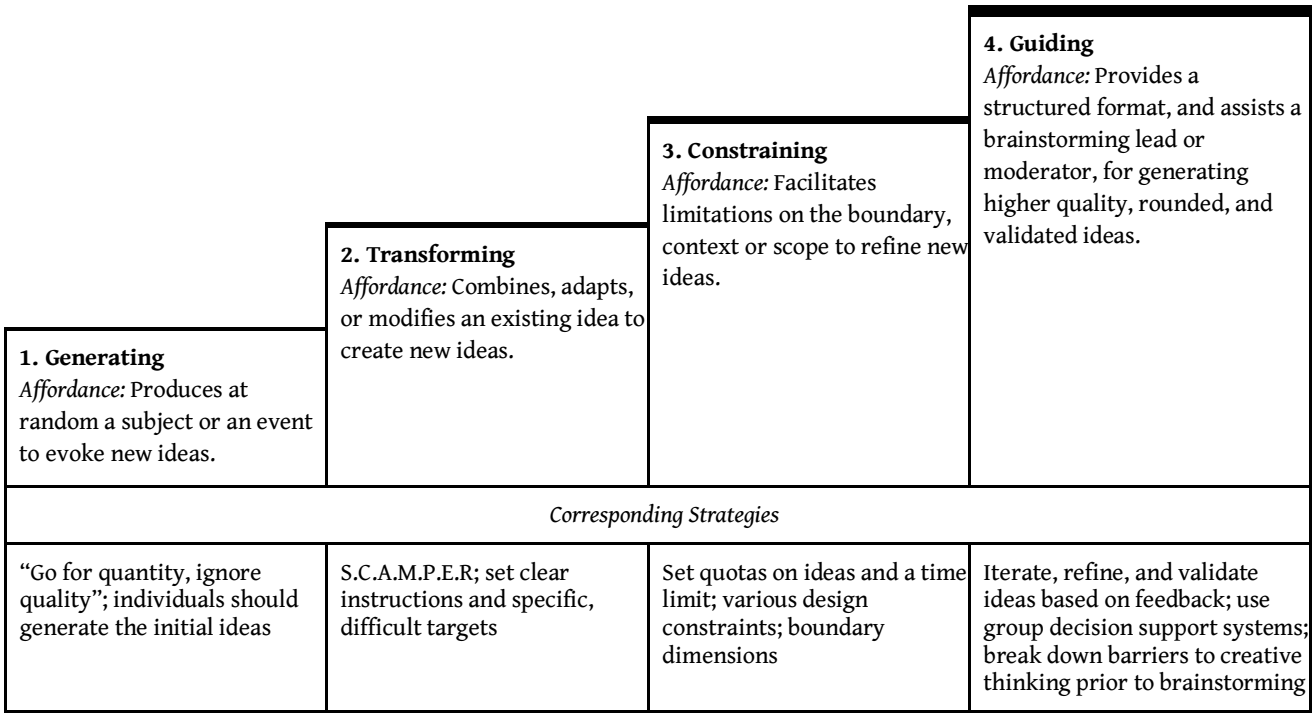

Figure 1: Affordance Tiers of Brainstorming Toolkits

central theme to come up with games ideas, chances are that some of the first five ideas will be the same as other groups' ideas. Unlike *generating*, which is about producing a broader idea spectrum, *transforming* is about altering existing ideas to create deeper ideas that are normally improbable to realise, or randomise.

Constraining. Toolkits can impose constraints by adding a context or description. Other toolkits set limitations, such as a time limit, to engage a more focused kind of participation [41]. They seek to define concrete background stories of the ideas at hand, or adding a boundary dimension to the idea itself [31]. Even though adding an idea is a constraint in and of itself, the intention here is expansion by constraints [2]. Unlike *transforming*, which is concerning with coming up with deeper ideas that are more unique and improbable to randomly encounter, *constraining* is about reaching a clearer definition, adding refinements. It is about asking the why, the how, but not the what-if.

Guiding. Structured brainstorming toolkits can guide brainstorming members on the same journey. As we discussed in the introduction, the reason for having a structure is to produce higher quality results, for unstructured brainstorming sessions can lead to dangerous groupthink [18]. Structures incorporate iterative steps and building on the previous phrase to validate ideas and their use [10]. They resemble the three phases of creative problem-solving process originally proposed by Osborn [34]: fact finding, idea finding, and solution finding. In *Creative Thinking and Brainstorming*, Rawlinson [36] proposes a similar procedure that he argues as "the right way to introduce brainstorming to a group": identify barriers to knock them down, brainstorm with a neutral example, and tackle the live problem. Structured brainstorming sessions also provide specific roles, and rules of play, giving every member instruction to work together [24]. Unlike *constraining*, which seeks to impose constraints for more specific outcomes, *guiding* is about giving as much instructions for the brainstorming moderator as possible, and ensuring the session is on track.

Each tier is a subset of the next tier, meaning that if a brainstorming toolkit satisfies tier 3, it automatically satisfies tiers 1 and 2. This classification does not suggest that a brainstorming toolkit on a lower tier is less effective than a toolkit on a higher tier. Rather, higher tier refers to a more complex ruleset that has been designed to facilitate a more structured brainstorming process.

We found that physical, card-based toolkits provide more complex functions, and had higher tiers of affordance. However, this does not mean that online tools are limited by their medium, and they could be more developed to facilitate higher tier affordances. Our observation shows that online generators harbour a much larger pool for fetching a random idea. Online generators have design gaps to learn from physical, card-based toolkits. We only examined brainstorming tools catered for game

design ideas, and our search turned up many random generators. We argue that there is opportunity for online brainstorming toolkits to develop more functions to facilitate useful, structured brainstorming sessions.

On the lower two tiers, brainstorming toolkits offer a number of ways to support individuals developing many ideas quickly, and they tend to generate better ideas in groups [24]. We found some brainstorming toolkits that support organisation of the generated ideas. The more ideas are thrown into the collective ideation process, the higher likelihood of resulting in higher quality, refined ideas [4, 40]. People employing brainstorming toolkits are more likely to encounter new ideas outside of their collective knowledge, and be challenged by new ways of thinking [14], and foster a more creative culture [12, 19].

On the higher two tiers, brainstorming toolkits impose design constraints to provide guidance. Design constraints can increase focus, and narrow down potential pathways of new ideas [20, 44]. Constraints can produce more interesting game design, and make a better game jam experience [19]. Well-imposed constraints can elicit more gameful outcomes [12]. Wild scenarios and improbable boundaries do not obstruct creativity. In fact, they appear to foster creativity and boost "unconventional ways around a problem, perspectives on a story, and fundamentally interesting and novel designs" [1].

In short, we have presented our own analysis and synthesis of toolkits that are designed to facilitate brainstorming. In the following section, we will describe our survey study asking about brainstorming activities, an analysis of our findings, and discuss the linkage to idea networks.

4 Brainstorming Toolkits

This section examines the utility of brainstorming toolkits and discusses how they support collaborative brainstorming. We divided them into two groups based on their media: card-based, and online random generators. We identified 21 toolkits that focus on creative thinking and can be applied to game design. We included toolkits that support idea generation, provide a broader frame of thinking, and aid idea growth in the process. Toolkits were sampled from existing literature specifically applied to game jams or hackathons, and from search engine results. We made three passes. In each pass, we examined literature that proposed new brainstorming toolkits to support collaborative ideation. For the search engine terms, we used related terms like 'brainstorming tools', 'ideation', 'game jams', and 'hackathons'. In the third pass, when we did not find any new brainstorming toolkits, we deemed the search sufficient. Each search result was individually evaluated against our criteria listed above and added to our collection if it satisfied those criteria.

4.1 Card-based Toolkits

There are many card-based toolkits available to inspire game developers. General-purpose card-based toolkits, not intended for making games, include *S.C.A.M.P.E.R.*, *Oblique Strategies*, and *IDEO Method Cards*. They switch on the 'what if?' mindset, offer alternative strategies to overcome mind blanks, and ask participants to think outside of the box. They keep participants with design strategies in mind, and encourage them to try out different strategies when one falls short. Table 1 describes each of the brainstorming toolkits we examined, and gives a sample of the available prompts in them, briefly illustrating the intent of each brainstorming toolkit and their use. For clarity of source, in-text citations for each brainstorming toolkit are collated in the table itself.

Other card-based toolkits intended for game design include *Grow-a-Game*, the *Values at Play Framework*, *Thinkpak*, *ThinkCube*; *Verbs, Nouns, and Adjectives (VNA)*, *GameSeekers*, *GameBoard*, and *PLEX Cards*. These toolkits tend to converge towards creating a goal that would define the game itself.

Table 1: List of card-based toolkits surveyed

Name	*Description*	*Samples*
S.C.A.M.P.E.R. [7, 34]	7 general strategies designed to promote out-of-the-box thinking.	*Substitute, Create, Amplify, Modify, Put to other use, Eliminate, Rearrange or Reverse*
Oblique Strategies [9]	A deck of 22 strategies to be drawn at will to provoke novel ways of thinking by process. The latest edition is the 5th, published in 2001.	*List the qualities it has. List those you'd like. Back up a few steps. What else could you have done?*
IDEO Method Cards [17]	Empathy tool cards divided into four categories, Learn, Look, Ask, and Try. Each card has a title, "how", and "why" to facilitate usage.	*Guided Tours: Accompany participants in spaces relevant to the project. This helps people recall their values.*
Values at Play Framework [10]	A design process with three iterative phases: Discovery, Translation, and Verification.	*Do system features afford activities that support identified values?*
Thinkpak [30]	56 cards using the SCAMPER principle and nine design strategies for creative thinking.	*Can you make it do more things? Can you find more uses? Increase functions? Get a higher performance level?*

ThinkCube [38]	88 idea cards, 88 keyword cards with a definition a visual thesaurus, and 24 verb cards to mutate them.	*Story: Legend, Adventure, History, Tale.*
GameSeekers [21]	4 decks: red cards, subjects or abstract themes; purple cards, black and white patterns; green cards, game genres or social aspects; blue cards, game mechanics.	*A row of black lines, a photograph of a woman in snow, time management, simplify.*
GameBoard [21]	A board of 11 card slots, and two decks. Core cards with mechanics and themes, and Gameplay cards with structure, feature, and special cards.	*Players take turn to play cards and ask each other to explain how it fits the game they are creating.*
PLEX Cards [28, 29]	22 categorial cards with keywords, a brief description, and 2 photographs. 2 instructional cards.	*Exploration: investigating an object or a location*
Tangible Interactions Framework: The Card Brainstorming Game [16]	4 categorical cards inspired by the tangible interactions framework, each with a question, subcategory, and a picture.	*Can users be proud of skilled body movement? Can they develop skills overtime?*
Verbs, Nouns, Adjectives (VNA) [22]	3 decks of cards with high-level, distinct categories to stimulate shared ideas. Different versions can be tailored for a theme.	*Rotate, Bogey, Glimmering* *Death, Only a handful of individuals survive, Extermination*
Exertion Cards [31]	4 categories of cards that include the Responding Body, the Moving Body, the Sensing Body, and the Relating Body, with degrees varying from 'a little' to 'a lot'.	*To what extent is physical risk considered? To what extent are physical movements mapped to the virtual world?*

To use any of the toolkits, participants draw and play a card and then decide what it means in the context of the design process. Using toolkits this way is like a game in which there are no winners, and participants are "trying to reach the status of 'idea dictators'" [21]. Most toolkits provide items, rules, and detailed descriptions to participants, although no groups play the same way. These toolkits are primarily designed for group play to encourage sharing ideas, but they can also be used with a single player. Some toolkits are available online in their entire set of cards, laid out in A4 or letter pages, making it possible to "print and play". A few toolkits, like *Thinkpak* and *ThinkCube*, are only available with a commercial purchase.

4.2 Online Random Idea Generators

There are many online random idea generators that offer random items at the click of a button, which we include as brainstorming toolkits with similar affordances. For instance, *Ludum Dare* is one of the world's largest online game jams, receiving 2,867 entries in December 2015. Toolkits like *Ludum Dare Game Idea Generator* build their idea database from its entries. In this way, ideas enter a lifecycle generated from generators, and jammers are the writers of these ideas.

Other online toolkits specifically designed to inspire new combinations of mechanics and gameplay include *Boardgamizer*, *Orteil's Game Idea Generator*, and *Gigster*. We searched game jam websites and forms to see what people linked for random idea generators for brainstorming. They usually provide random combinations of ideas in various categories. For example, *Gigster* provides random generation in five categories: themes, genres, core aesthetics, objectives, and design challenges. It can randomise one category at a time, or randomise all five. Participants can also keep one or more categories and randomise the others, narrowing down ideas they are looking for. *Boardgamizer* generates a game mechanic, theme, victory condition, and design constraint. The list of online random idea generators surveyed is given in Table 2. It is by no means exhaustive judging from the number of results discoverable by search engines.

Table 2: List of online random idea generators surveyed

Name	*Description*	*Samples*
Insanity Jam Game Idea Generator	Randomly fills out a sentence by genre, player action, and a possible secondary factor. Genre can be fixed by the user.	*A trivia game where you can never escape indecision.*
The Video Game Name Generator	One button to generate a videogame title. Templates change between adjectival nouns and	*Monty Python's Banana Gladiator, Combat Sniper*

	"nouns of nouns."	
Boardgamizer	Provides mechanics, two themes, a victory condition, and a hidden constraint which can be revealed with an additional button.	*Mechanics: Dice Rolling. Theme: Encounter, Extreme Sport. Victory: Solve a puzzle/mystery. Constraint: Must use paper money*
Random Game Jam Theme Generator	Randomly picks one of over 2,000 suggested ideas from Ludum Dare to the Berlin Mini Game Jam	*Decision dilemma, Electricity*
Orteil's Game Idea Generator	Single click to generate a mashup of game mechanics. There is a toggle "sanity" for darker results.	*A student project where you paint portals through social engineering.*
Cowface Games Ludam Dare Theme Generator	Randomly picks a suggested theme from Ludam Dare, shortlisted by the community. Results are presented as a Google link per Ludam Dare tradition.	*Time Limit, Simulism, Descent*
Cowface Game Idea Generator	Populates a list of game titles from "Notable Games" in Ludam Dare entries, genres, Ludam Dare themes, and nouns. User can choose a number of results from each category. Results are presented as a Google link.	*Command, Persistence, Gratuitous Space Battles, Spore*
Streaming Colour Studios Game Idea Generator	Mashes a description, two game genres, and a location.	*Fast-paced, word game combined with rhythm game, set on a farm.*
Gigster	Generates five categories with accompanying art: theme, genre, core aesthetic, objective, and design challenge. Offers one button to generate all five, one at a time, and options to swap out single categories.	*Theme: suspense. Genre: dance. Core Aesthetic: dance. Objective: heal/save. Design Challenge: emotional rollercoaster.*

Using a random idea generator does not mean committing to its results, because users can keep hitting buttons or customise randomisation factors until they get something they like. They are free to visit every corner of the knowledge bank until something clicks with their minds from idea generators.

The strength of digital tools is the ability to hold much, much more content than its physical counterpart. Two thousand items are considered as a small database and many databases hold tens of thousands of entries. Printing them on cards would be prohibitively expensive. Distributing them, even more.

4.3 Affordance Tiers

The affordance tiers we proposed in Figure 1 describes the level of guidance and facilitation. As part of the survey, we categorised each brainstorming toolkit into an affordance tier (Table 3). This was done by examining each toolkit's contents, description, rules, examine reports of use (if available), and matching them against the descriptions of the design affordance in Figure 1.

Table 3: Our examination of brainstorming toolkit affordance tiers

Tier	*Brainstorming toolkits*
1. Generating	*ThinkCube, Insanity Jam Game Idea Generator, The Video Game Name Generator, Boardgamizer, Random Game Jam Theme Generator, Orteil's Game Idea Generator, Cowface Games Ludam Dare Theme Generator, Cowface Game Idea Generator, Streaming Colour Studios Game Idea Generator, Gigster*
2. Transforming	*Oblique Strategies, S.C.A.M.P.E.R., Thinkpak, GameSeekers, PLEX Cards*
3. Constraining	*IDEO Method Cards, VNA, GameBoard, Exertion Cards, Tangible Interactions Framework: The Card Brainstorming Game*
4. Guiding	*Values at Play Framework*

The category is not meant to limit the potential of each toolkit; instead, the tiers plainly show how much facilitation and support for running quality brainstorming activities the toolkit can offer out of the box. Using brainstorming toolkits alone without prior

experience may not mitigate issues such as production blocking or social loafing mentioned in the introduction.

Facilitating an open-minded, structured brainstorming session has a significant impact on the quality of the brainstorming outcome. When using lower tier toolkits, experienced members will tend to fill in roles that provide a higher affordance tier wherever possible. Examples include *transforming*, where people handle related ideas together and quickly to identify similar themes [16]; *constraining*, where people write down brainstormed ideas in layouts of lists and maps to keep an idea structure [4]; and *guiding*, where people remind each other the purpose of the brainstorming and the "importance of professional skepticism" [24].

In the next section, we will describe our second study at Global Game Jam 2017, and report on the use of brainstorming toolkits and adoption of traditional, and digital tools for brainstorming in game jams. Because the second study took place in parallel, we were not able to curate an intervention to see how specific brainstorming tools were used. Instead, the study reflects what tools were used by Global Game Jam participants, and it gives an insight by what kind of design affordances were reported.

5 Game Jams and Brainstorming Use

We conducted a survey following one of the world's largest game jam events, *Global Game Jam 2017*, held on 20-22 January of that year. As part of the global survey, we asked participants, "*Did you use any tools to brainstorm for ideas? If so, how did you use it.*" This question was collated with the global survey administered by the *Global Game Jam* organisers. Our intention was to accurately capture what tools were used by game jam participants in the wild, how they were used, and specifically did not instruct game jam organisers to advertise or hand out brainstorming toolkits. The survey was made available online to all jammers 3 weeks after the event. Participation in the survey was completely anonymous, and entirely voluntary with no extrinsic rewards. The purpose of the overall survey was to record their experience to improve subsequent game jam events. However, we note here that we only were granted access to responses to Question 13 and 14 for the purpose of this study.

According to the *Global Game Jam* published statistics, the 2017 event attracted 36,401 jammers across 701 jam sites from 95 countries. 1,925 jammers responded to the *Global Game Jam* 2017 survey, with a total of 812 jammers responding to our question about brainstorming. The corpus we collected had 17,792 words in total. We encoded for brainstorming techniques, names of brainstorming toolkits, and any other tools (for example, "pen and paper"; that is, tools that were not specifically designed for brainstorming activities), websites, collaborative activity descriptions, self-reflections on idea developments, and writing utensils. Survey respondents are referred only by a unique ID number, like '5187197465'. For simplicity, we use the last 4 digits of their IDs with a prefix, like 'P7465', when quoting responses from specific participants.

To assist with the data analysis, we manually corrected typos in the participants' recording of tool names, and replaced similar tools with different names by the same name. For example, we considered 'blackboard' and 'whiteboard' as the same tool in our analysis, since they offer very similar affordances. There were two Japanese and one Portuguese response translated into English in preparation for the data analysis.

The frequency count, as shown in Figure 2, was done by examining the frequency of tool names. Names included frequency of bigrams and trigrams, meaning two or three words appearing side by side, to account for phrases like 'sticky notes' and 'pen and paper'. In our survey results, we were surprised by the amount of improvised stationeries (e.g. pen and paper, whiteboards, blackboards, sticky notes, notebooks, and blank cards, including pencils, markers and other writing utensils) being used in brainstorming activities. Words with little contextual meaning, such as 'the', 'a', and 'then' are excluded from frequency counting. Some jammers reported more than one tool in their responses, for which we count once for each tool.

474 (58%) out of 812 respondents mentioned traditional stationery. Digital tools account for 63 (7%) out of all counts, mostly found in the long tail. Of great relevance for the design of future toolkits was that many participants reported using both a traditional tool, and also using a digital tool like *Trello* for assigning to-do lists and keeping track of ideas. This resulted in the total number of tools found being larger than the total number of survey respondents.

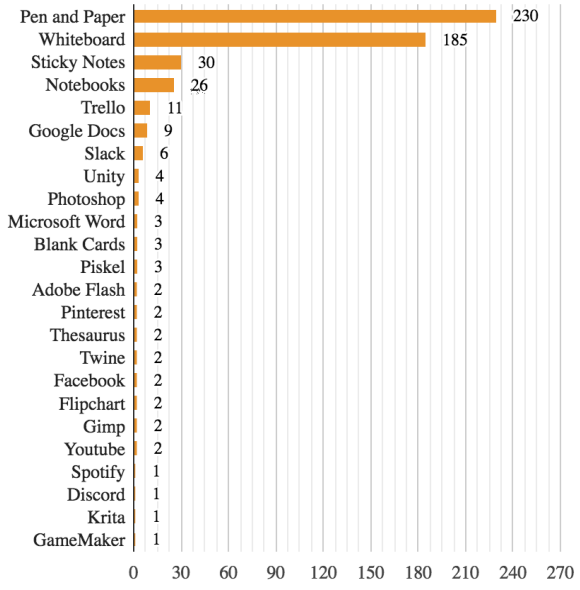

Figure 2: Reported Brainstorming Toolkits at *Global Game Jam 2017*

A variety of more general tools were used: project management (*Trello*), writing (*Google Docs, Twine*), finding inspiration (*Pinterest, Flipchart, Spotify, Youtube*), communication (*Slack, Facebook, Discord*), visual development (*Photoshop, Piskel, Gimp*), and prototyping (*Unity, Flash, GameMaker*). Real-time collaboration tools like *Google Docs* and *Trello* were more popular than the others.

Goddard et al. [12] noted that experienced jammers, especially those already working in the games industry, are familiar with structured brainstorming sessions, and are comfortable with collaborative work using traditional tools. As such, we expected to see many different brainstorming techniques being used in conjunction with these tools.

Mind mapping was the most frequently mentioned brainstorming technique. Jammers reported that they played word association games, drawing links between similar ideas from each team member, or organised their thoughts using mind maps. Three respondents reported that they created mind maps as a group, and linked related ideas together. They primarily used mind maps as a technique to record ideas, and as ideas came in, they are connected with adjacent ideas. P7430 said that their group used "two brainstorming techniques: telling out loudly our ideas, and mind maps." P1014 wrote that they "listed all the ideas that passed our mind map, and decided to choose from them depending on how fast we could finish them ... and are they even acceptable as a game or not."

Sketching was reported by 39 respondents. They sketched out ideas visually and shared them with the team. They organised sketched ideas on different papers, or in close proximity to other similar ideas. Two reported that sketching was how they explained their ideas to their teams. P9359 wrote that "a whiteboard and marker were used to write and sketching plans for the game we were making, as well as a checklist for things that needed to be done." P0981 was specific in describing how they used a blackboard and chalk: "mainly only to explain the concepts, not to organize the ideas." P7902 also sketched with a similar intent: "whiteboard to list potential ideas, sketching to explain ideas where needed."

According to Trainer et al. [42], many people think of sketching as visual design methods, but in brainstorming they are often used as visual aid to explaining what the ideas are about, granting others a shared perspective. Sketching is a 'low-fi' activity, suitable for concentrating discussion in structure and feature, less on look and feel of the polished version [23, 25]. Leaving out the details of 'how' features are presented, but emphasising what features are available can lead to a more creative discussion [43].

The most reported activity was some form of 'talking', by 47 respondents. To better understand what participants labelled as 'talking', we looked for other activities mentioned together with 'talking'. Out of the 47 respondents, 5 of them reported 'talking out loud' to each other, engaging in what they commonly label as 'verbal brainstorming'. 4 reported they talked and talked, and had to reason with each other until they agreed on the details. 12 others reported that they discussed using pen and paper, on the whiteboard, or with sticky notes. P4825 recorded in vivid detail: "[We used] many small *3M* cards to write down and collect ideas from every jammer in our team for 10 minutes, and [displayed] them together on whiteboard to talking with [each other], trying to find the most interesting idea that we all want to make."

Rearranging ideas using sticky notes was a favourite with many jammers. Four respondents reported that they 'throw ideas on paper' and passed it to their teammates for feedback. Participants used sticky notes in combination with other techniques like mind maps, and voting for their favourite ideas as a group. P4113 recalled that they "stuck partial ideas on the wall and talking them connecting together and shaping the idea." P9054 wrote a similar ideation method: "[We wrote] key phrases related to the theme on bits of paper for five minutes. [At the end, we compared] with fellow group members to see which things we have in common that can be the core of our game idea."

6 Implications of Brainstorming Design

Ideas are associative by nature. Brainstorming activities leverages that nature to expand the possibilities of ideas. In this section, we will briefly discuss the relationship between brainstorming and idea networks, drawing from findings of the two studies presented in this paper.

Through design affordances of brainstorming toolkits, we observed some of the ways ideas are structured in brainstorming activities. First, there is the wild combinatorial nature of clashing two ideas together, enabled by *generating* affordance of brainstorming. Second, ideas can be progressively developed by *transforming* them, such as reversing roles, exaggerating effects, or negating it for opposite effect as seen in *S.C.A.M.P.E.R.* Third, mind mapping supports the associative structure of ideas by visualising the core idea, and its related offspring, and offering a useful way to organise them. Fourth, post-it notes can be rearranged to bring closer ideas together into clusters, labelling them under the same category.

Brainstorming toolkits are designed for idea generation, and supporting the way collaborative idea generations work. This paper shows that design affordances of brainstorming toolkits align with the associative nature of ideas. The goal for the four affordance tiers of brainstorming toolkits is to inform design and reuse. Readers interested in using a brainstorming toolkit for brainstorming activities can be better educated by the varying complexity of functions the toolkits provide. Designers interested in creating new brainstorming toolkits can take away the fundamental understandings in their support functions.

7 Limitations

In Section 5, we reported the tools used, and the ways ideas are organised during brainstorming activities that took place at *Global Game Jam 2017*. We saw jammers favouring traditional stationeries for brainstorming, for their flexibility and simplicity of use. However, we speculate that the short (48 hours) nature of the event meant that jammers may favour tools that everyone involved is familiar with, which may exclude more complex toolkits and frameworks. Another reason may be that participants were not aware of commercial or free brainstorming toolkits available to them. A third reason may be that the overhead of teaching another team member a new brainstorming activity is too high for most teams. This is not a critique of more high-fidelity tools, but rather a reflection of technology and tool adoption at game jams. We acknowledge the limitation of our survey methods, and this may be investigated further in a future work.

Both of our studies are on a relatively small scale, and may not reflect the actual brainstorming toolkits affordances and the game jam population. We only surveyed 21 toolkits related to game development, noting that there are hundreds of tools out there for brainstorming generally. Our *Global Game Jam* sample of 812 (2.2%) out of the total 36,401 participants covers a small percentage. We may have missed the population who employed brainstorming toolkits in practice.

8 Conclusion

We presented two studies on brainstorming toolkits and brainstorming activities to examine their design affordances and constraints to support collaborative ideation, and the nature of idea association. In the first study, we surveyed 21 brainstorming toolkits appropriate for generating new game designs, and from the findings we proposed four tiers of design affordances for brainstorming toolkits, ranked by their complexity and function. We listed each brainstorming toolkit in the corresponding tiers, and drew from the literature to support their affordances. These tiers of design affordance can inform others in choosing existing brainstorming toolkits, and designing new ones. We discussed how these brainstorming toolkits and activities are related to the associative nature of ideas. Idea association structures are critical for defining, understanding, exploring, and creating new ideas in the existing landscape, because these structures are designed to aid comprehension and the support of thought.

In the second study, we conducted a post-event survey in *Global Game Jam* 2017, asking jammers about their brainstorming tools, activities, and how they used the tools in the activities. The results show a high adoption in simple stationery, like pen and paper, which indicates a low adoption in brainstorming toolkits specifically designed for idea generation activities. Existing literature has focused on how brainstorming toolkits can empower game design [1, 10, 21, 22, 28, 29, 31], but we could not find research about a low adoption rate of brainstorming toolkits. This highlights a gap in existing literature and provides opportunities for further research investigating the barriers for the adoption of brainstorming toolkits. Nonetheless, we observed many hybrid use of tools together with stationery combined with collaborative technologies like *Trello* and *Google Docs,* signalling a need for generic idea sharing and arrangement platforms that also supports the affordances of brainstorming to overcome the challenges of an unguided idea creation session.

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APPENDIX A: Survey Questions

Note: the survey was instrumented by Global Game Jam 2017 organisers. We were *only* granted responses to Q13 and Q14 for the purpose of our study.

Q13. Did you use any tools to brainstorm for ideas? If so, how did you use it.

Q14. What was your favorite moment in GGJ?