Formalised Online Creativity using ThinXels

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Abstract

Computer-supported creativity tools are one example of Group Support Systems (GSS) which have been shown to outperform their traditional face-to-face counterparts. We present a framework for GSS which is based on formal languages and the new concept of a ThinXel. The name "ThinXel" (thinking element) is formed analogously to the well-known "pixel" (picture element) in Computer Science. We claim that ThinXel-based GSS can provide significant advantages.

A ThinXel is defined as an elementary instruction leading to a response which has a well-defined function in the context of the group's goal. ThinXels can be sequenced according to formal rules to form more complex modules like the statements in a computer programming language. These modules can be collected to form a library which can be assembled to create facilitation scripts for entire meetings or workshops.

Our approach allows an unambiguous, compact representation of the facilitation steps for both traditional and computer-based group processes. We believe that it will eventually allow them to be completely formalised and to a large extent even automated.

We will present experimental results carried out with a ThinXel-based software tool. These illustrate concepts from ThinXel-based ideation and provide quantitative evidence which supports our claim.

1. Introduction

In a world of rapid change, affected by globalization, geopolitical developments and an ever-growing number of new technologies, companies are forced to adapt to new market situations more and more rapidly. The development of innovative products and services plays a crucial role in maintaining a competitive position in local and global markets. But companies are limited in their creation of new innovations by the creative capacity of their employees: each individual has only limited experiences and resources to support the innovation process. By using collaboration techniques they can combine their potential and expertise and can accomplish more than they could as separate individuals.

A creativity workshop is a classic example for this collaboration. By using creativity techniques like Brainstorming [12] the participants can be supported in realizing a problem, analysing it and searching for ideas to solve it. Group Support Systems (GSS) can increase the productivity of this group work, by offering a variety of tools to assist

the group in the structuring of activities, generating ideas, and improving group communication [6, 11, 20]. They represent an information technology-based group meeting environment which can be used to manage a creativity workshop with virtual teams across vast geographical boundaries. Under certain circumstances, groups using GSS for ideation can produce more ideas, and more good ideas than teams using pen-and-paper methods [16]. But experience shows that the value of the technology depends on how purposeful and skilful it is used [3].

To improve the efficiency and effectiveness of ideation, multiple factors have to be taken into account during the design and execution of group work in GSS. Most GSS consist of many different tools, each of which can be configured in different ways to implement creativity techniques. Today several collections of creativity techniques exist, which provide a classification and instructions on how to apply these techniques [17]. But these instructions are mostly very abstract and require experience to guide the participants during the creative process. This makes it difficult for practitioners with no facilitation expertise to design a group process with new creativity techniques. In this case participants use only known generics techniques like Brainstorming for ideation. Another factor is formed by the facilitation itself. A facilitator`s instructions have significant influence on psychological collaborative effects (e.g. production blocking, frustration or distraction). These can be observed in face-to-face workshop, and may also appear in group work using GSS [8, 5]. They originate in the process of collaboration and can have a negative as well as a positive influence on the efficiency of a system. Facilitation expertise is needed to take these effects into account during the design and execution of ideation. For this reason, companies use professional facilitators, who have expertise in the design and execution of group work and can improve group productivity. However skilled facilitators can be expensive and therefore only few groups can benefit from facilitation intervention. So the potential of a GSS for ideation cannot be fully exploited.

The challenge is to find a way to design and execute an efficient and effective group process, which linked the participant via computers by using GSS without facilitation expertise. This would do much to support ideation by using GSS. In this paper, we claim that a formal language for creativity techniques can improve the efficiency and effectiveness of ideation when using GSS. Our approach is to support the communication between facilitator and participant in a creative process. We define a thinXel as an elementary facilitator instruction, and describe its influence through this formal language.

2. Collaboration Engineering

Collaboration Engineering (CE) is an approach for the design and deployment of collaboration processes for recurring high value tasks in companies [1]. The purpose of this approach is to create a collaboration processes that can be executed by participants without ongoing support by professional facilitators. These processes have been organized into six key patterns of collaboration (for further information see Briggs et al [1]). Researchers use this classification to collect, create, document, and test collaboration activities, called thinkLets, that together form a pattern language for group collaboration [2]. Briggs et al [1] describe a thinkLet as a named, scripted and reusable collaborative activity for creating a specific known pattern of collaboration among people working together toward a goal.

The specification of a thinkLet consists of different components: identification, script and selection guide [18]:

The identification contains a name attribute, which is intended to emphasise the specific group dynamics the thinkLet invokes.

The script presents the rules for a participant to create the required pattern of collaboration. These rules describe the actions that a participant must execute using the capabilities available to him or her under some set of constraints [9].

The selection guide contains different attribute like patterns of collaboration to support the participant in the selection of a thinkLet.

Some thinkLets are illustrated in Table 1 through their scripts [9]. Research has shown that practitioners with no facilitation expertise, who know the specification of a thinkLet, can predictably and repeatably engender the pattern of collaboration a given thinkLet is intended for [19].

Table 1
thinkLet examples (Kolfschoten et al [9])

Name & pattern of collaboration	Rule (constraint)	Capability (name)	Action (name)	Parameter (not instantiated)
Pin-the-Tail-on-the-Donkey Converge	1. Select the amount (X) of ideas (Y) that you consider key contributions 2. Read the indicated key contributions 3. Explain and discuss why a selected idea is a key contribution	X discriminators	Judge Read Discuss	X: amount Y: idea
LeafHopper Diverge	1. Add ideas to page in scope of the discussion topic (X) and scope (Y) 2. Add to any page at random as your interests dictate	A page for each X	Add	X: discuss topic Y: brainstorming question
Mood Ring Build consensus	1. Indicate your opinion on issue (X) on criterion (Y) ranging from scale min (A) to scale max (B) 2. Discuss the issue 3. Indicate any change in opinion 4. Continue until there is sufficient consensus	A reusable scaled discriminator for the Issue	Judge Discuss Judge	X: issue Y: criterion A: scale min B: scale max

Through this, CE represents an interesting approach to support the efficiency and effectiveness of ideation when using GSS. The ThinkLet concept could build a structural principle for the design of reusable blocks based on creativity techniques for ideation. But this concept uses only abstract instructions to achieve the collaboration pattern. For example, the thinkLet “Pin-the-Tail-on-the-Donkey” (illustrated in Table 1) contains the rule “Explain and discuss why a selected idea is a key contribution”, which should create the activity discuss. In our opinion this rule can lead to three different activities: select a concept; explain a concept and discuss a concept. In this case the script still leaves open the question, which facilitation instruction should be used to

achieve these actions. Therefore it depends on the experience of the facilitator which instruction he uses.

The significance of a good facilitator instruction design is demonstrated by Shepherd et al [15]. The paper showed that slight variations in facilitator instructions that had no impact on rules, but rather touched on motivation, produced significant differences in group productivity. To compensate this weakness, we suggest that a structural principle for the design of reusable blocks for ideation should include a specification of the facilitation instruction. This would support participants without facilitator experience in executing a creative process in a more efficiently way.

3. The ThinXel Approach

Our design approach for reusable blocks based on creativity techniques for ideation is called a thinXel. We define a thinXel as an elementary facilitator instruction leading to a response which has a well-defined function in the context of the group's goal. The name "thinXel" (thinking element) is formed analogously to the well-known "pixel" (picture element) in Computer Science.

The goal of the thinXel concept is to support the communication between facilitator and participant in a group process. Our research is based on the Shannon-Weaver Model of a communication process [14], which describes the transmission of a message between a sender and a receiver. In this model the sender encodes a given intention in a message, which will be transmitted to the receiver via a channel. The receiver needs to decode the message to understand the intention and be able respond to it. Noise can degrade the quality of the transmission, so that the interpretation of the message might not match the intention of the sender. The facilitator instruction represents a coded intention of the facilitator for the participants of a group process. A thinXel is a facilitator instruction which allows practitioners without facilitation expertise to execute a group process by achieving an intended effect.

The design of a thinXel is influenced by the research on the cognitive load of a participant. It has shown that the working memory of a participant is limited. People can only pay attention to about seven concepts at the same time [10]. Without a refresh by conscious rehearsal or by external stimuli, the content of the working memory would fade within seconds [4]. Our experience with commercial creativity workshops shows that the facilitator can lose the attention of the participants for the group process by using instructions with induced a high cognitive load. This would support occurrence of collaboration effects like distraction [13], frustration and social loafing [8], which have a negative influence on the efficiency of a group process. An example for a high cognitive load is the facilitator instruction represented in Table 4. This instruction contains two different intentions of the facilitator: “associate new concepts for the word innovation” and “organize the new concepts by existing clusters”. It says nothing about the way how the participant should execute the intended activities. It is up to the participant whether he will switch between the activities associate and organize or divide the process into two different parts. In this situation the facilitator loses the control of the creative process and the efficiency and effectiveness of the group work is no longer guaranteed.

Table 4:
A facilitator instruction with high cognitive load

facilitator instruction	Action (name)	Intention
1. Please associate some concepts of the word Innovation and sort them by Parts and Processes.	Create Select Put	associate new concepts and organize them in clusters

By taking these factors into account, we claim that a thinXel should contain only one intention of the facilitator that leads to one action in the context of the group's goal. To limit the cognitive load of the participant the instruction may contain only those pieces of information that must be conveyed to the participant in order for him or her to perform the action intended by the facilitator. This makes a thinXel to an atomic instruction. An example of a thinXel-based facilitation is illustrated in Table 5, which specifies the instruction shown in Table 4. This way, the instruction from Table 4 is divided into a sequence of instructions, which each produce only one activity. The participant knows in each part of the process what he or she should do. This makes a process more controllable and allows a participant without facilitator experience to efficiently and effectively execute an unknown group process.

These properties, to produce limited cognitive load and to lead to one action in the context of the group's goal, define a thinXel as a reusable facilitation block. We claim that these blocks can be sequenced according to formal rules to form more complex modules like the statements in a computer programming language. These formal rules can be combined to form a formal language for creativity techniques.

Table 5:
A thinXel examples

thinXel	Action (name)	Intention
1. Please take a pen and some sheets of paper.	Take	material for work
2. Please write down on a sheet of paper the word “Innovation”	Create	define a work cluster
3. Please create the cluster “Innovation” by putting the paper in the middle of the desk	Put	create a work cluster
4. Please write down on a sheet of paper a concept, which you associate with the word Innovation.	Create	associate a concept
5. Please put the new concept into the cluster “Innovation”	Put	cluster the concept
Repeat steps 4 - 5 until time > X or number of concepts > Y		

6.	Please write down on a sheet of paper the word “Parts”	Create	define a work cluster
7.	Please create the cluster “Parts” by putting the paper on the desk	Put	create a work cluster
8.	Please write down on a sheet of paper the word “Processes”	Create	define a work cluster
9.	Please create the cluster “Processes” by putting the paper on the desk	Put	create a work cluster
10.	Please write down on a sheet of paper the word “Miscellaneous”	Create	define a work cluster
11.	Please create the cluster “Processes” by putting the paper on the desk	Put	create a work cluster
12.	Please select a concept from the cluster “Innovation”	Select	select a concept
13.	Please put the concept into the cluster “Parts”, if the concept is a “Part” of “Innovation”	Put	cluster the concept
14.	Please put the concept into the cluster “Processes”, if the concept is a “Process” in “Innovation”	Put	cluster the concept
15.	Please put the concept into the cluster “Miscellaneous”, if the concept is not an element of the cluster “Parts” or “Processes”	Put	cluster the concept

Repeat steps 12 - 15 until time > X or number of concepts in cluster Innovation = 0

4. An Approach of a Formal Language for the Creative Process

To develop a formal language for creativity techniques based on thinXels, we drew on the formal language approach that has become the basis of the development of a computer programming language. For our purpose we will not discuss the full formal language approach, but present a simple specification (for further information see Harrison [7]). The basic theory of the formal language approach is to divide a process into an alphabet and a grammar. The alphabet represents the elements of the process. These elements can be combined to form new words by formal rules which are described in the grammar of the formal language. This grammar G consists of the four components G = (N, T, S, R), which are defined as:

N: The alphabet of non terminal symbols. These symbols do not appear in the formal language. They will be substituted by terminal symbols.

T: The alphabet of terminal symbols: Terminal symbols create the words of the language.

S: The start symbol of the grammar. This symbol is a special element of N. All formal rules of the language use this symbol as a basis to form new words.

R: The set of formal rules. A formal rule describes how the symbols of N and T are be replaced by other symbols of N and T.

The design of a formal language for creativity techniques required a process model for all creativity techniques. A closer look at the approach of creativity techniques shows that a technique can be describe as an abstract specification of steps. Each step represents an intention of the facilitator and can be encoded in a thinXel. In this way, a sequence of thinXels would support the creativity process. We propose that a model of the creativity process builds the basis for the design of a formal language for creativity techniques. This formal language would allow to reproduce all creativity techniques as a word of this language.

Figure 1 illustrates our approach of a formal language for the creative process as a flow diagram. This language is based on the model of the creative process by Wallas [21], which divides the creative process into four phases:

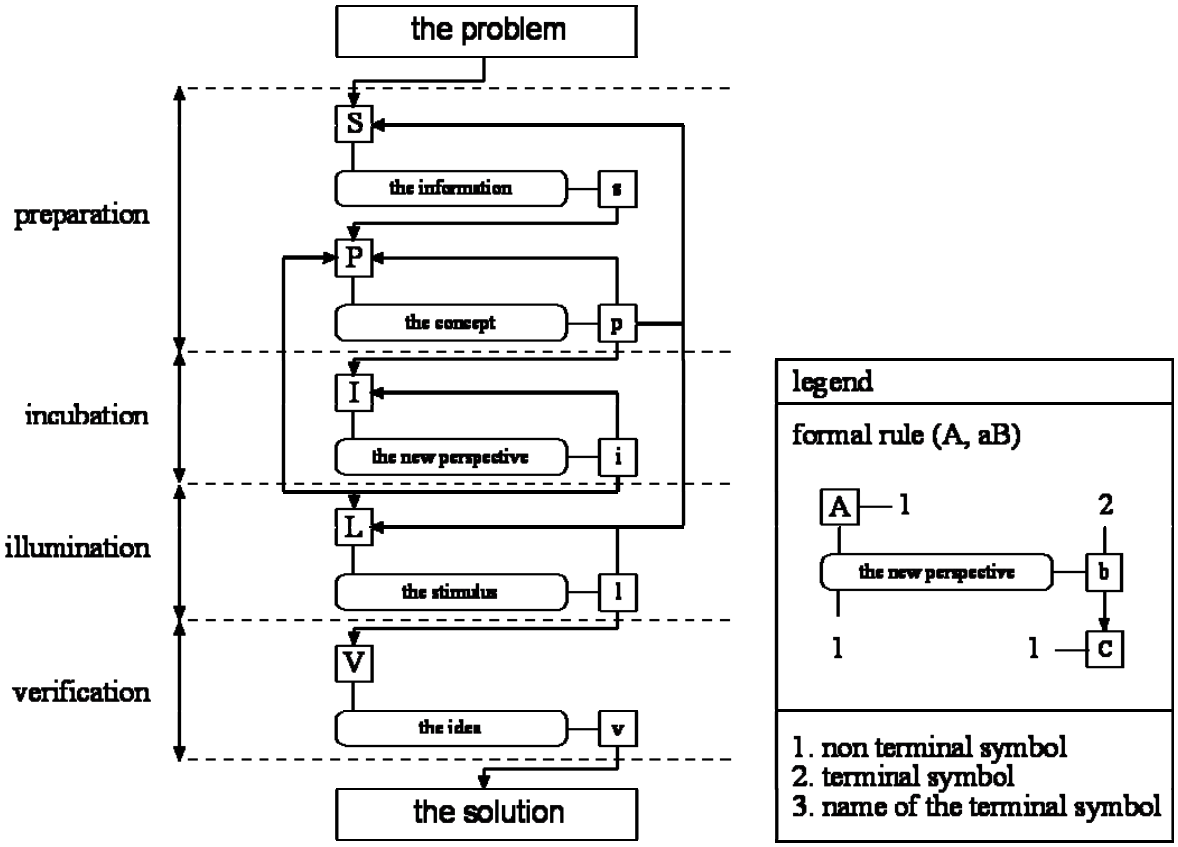
Preparation (P): The participants analyse the existing situation / problem which call for a creative process.

Incubation (I): The participants create a new perspective on the situation / problem by modification and combination of the existing concepts.

Illumination (L): Describes the moment when a new stimulus for an idea emerges.

Verification (V): The participants extend the stimulus by verification to an idea for the situation / problem.

Figure 1:
A formal language for the creative process



We use the phases of the model to create a grammar of the formal language, which can be described as follows:

The alphabet of the non terminal symbols (N): {S,P, I, L, V}

The alphabet of the non terminal symbols represents the four phases of the model of the creative process and the start symbol (S) of the grammar.

The alphabet of the terminal symbols (T): {s, p, i, l, v}

The alphabet of the terminal symbols is defined by the results of the different phases of the model. The start symbol of the grammar represents an existing situation which calls for a creative process. This situation can be regarded as a set of pieces of information (s). The participants use this information in the phase "Preparation" to create new concepts (p), which describe the existing situation. In the phase "Incubation" these concepts are modified and combined to create a new perspective (i) on the situation. The participants use this perspective to receive a stimulus for an idea (l) in the phase "Illumination". By verification of this stimulus the participant create an idea for the situation (v) in the phase "Verification".

The set of the formal rules (R): { *(S, sP),*
(P, pS), (P, pP), (P, pI), (P, pL),
(I, iP), (I, iL),
(L, lL), (L, lV),
(V, v) }

On the basis of the alphabet of the non terminal and terminal symbols the following formal rules can be designed:

Start Symbol (R: {(S, sP)})

The non terminal symbol (S) represents a set of pieces of information (s) which will be analysed in the phase "Preparation" (P).

Preparation (R: {(P, pS), (P, pP), (P, pI), (P, pL)})

The participants create new concepts (p) based on the information on the existing situation. These concepts can once again be analysed in the phase "Preparation" (P) or modified in the phase "Incubation" (I). A new piece of information can be taken from the origin situation by a formal rule for the "Start Symbol" (S). Also a formal rule for the phase "Illumination" (L) exists because the moment for the creation of a stimulus is not defined.

Incubation (R: {(I, iP), (I, iL)})

By modification and combination of the concepts, the participants create a new perspective (i) on the existing situation in the phase "Incubation" (I). This leads to new information which can be analysed in the phase "Preparation" (P). The new perspective can support the development of new stimuli in the phase Illumination (L).

Illumination (R: {(L, lL), (L, lV)})

In the phase “Illumination” new stimuli (l) for an idea appear. These stimuli can support the occurrence of other stimuli or can be verified in the phase Verification (V).

Verification (R: {(V, v)})

By verification of the stimuli, the participants create new ideas (v) for the existing situation.

This formal language allows the reproduction of a creativity technique as a word of the language (some examples are illustrated in Table 6 [17]). This word represents the algorithm of the technique and contains no details of its implementation. For example the algorithm of the creativity techniques “Analogies” [17] can be reproduced by the word “s p i p l v”:

s: 0. Information about the existing problem
p: 1. Identify concepts of the existing problem.
i: 2. Find analogies, which include the same concepts.
p: 3. Describe the analogies.
l: 4. Use the description of the analogies to suggest new ideas for the problem.
v: 5. Verify the ideas for the existing problem.

Table 6
Reproduction of some creativity techniques as a word of the formal language

Creativity techniques	Word of the formal language
Analogies	s p i p l v
Assumption Reversal	s p s p i p l v
Attribute Analogie Chains	s p p i p l v
Attribute Association Chains	s p p p p l v
Attribute Listing	s p s p i p l v
Bionic	s p s p i l v
Catalog	s p i l v
Forced-Object	s p s p i p l v
Free Association	s p p l v

Researchers can use the formal language to create new concepts for the execution of creativity techniques. Our approach is to integrate the thinXel concept into the formal language. Through this, an algorithm, which is reproduced by the formal language, can be described as a sequence of thinXels. This sequence would allow the participant without facilitation expertise to execute an unknown creativity technique. An example

of the integration of the thinXel concept is illustrated in Table 7 and shows a formal description of the creativity technique “Analogies” [17]. In this description, a thinXel is designed in a way which allows the participants to achieve the intended activity without additional information. This makes it easier for a facilitator to reach the group´s goal and use the benefit from the creativity technique. To provide this advantage to the users, the combination of the formal language and the thinXel approach can be used, to design a specification language for group work. This specification language can define comprehensibly procedures for face-to-face and computer-based creativity processes.

To provide the efficiency and effectiveness of ideation when using GSS, the specification language can be used for the development of a new technology-based group meeting environment which includes a library of thinXel-based creativity techniques. This system can support the facilitator by proposing a thinXel-based sequence for a selected creativity technique. The facilitator can specify this sequence for the existing goal of the group process by defining some parameters. A parameter can be the problem, which calls for a creative process or a criterion, which will be needed for the selection of a concept. These parameters can be included automatically into the thinXel-based sequence and create an individual sequence of facilitator instructions for the group process. This approach eases the usage of GSS in ideation.

Table 7
A formal description of the creativity technique “Analogies”

character of the formal language	thinXel	Action (name)	Intention
s			
p	1. Please write down a core concept which you associate with the existing problem.	Create	associate a concept
	Repeat this steps until the time > X or number of concepts > Y		
	2. Please select a core concept	Select	select a concept
i	3. Please write down an analogy which has the same concept.	Create	associate an analogy
	Repeat steps 2 - 3 until the time > X or number of concepts = 0		
	4. Please select an analogy	Select	select an analogy
p	5. Please write down a concept which you associate with the analogy.	Create	create a concept
	Repeat steps 4 - 5 until the time > X or number of analogy = 0		
	6. Please select a concept from the analogy.	Select	select a concept
l	7. Please write down an idea how this concept can be used to solve the existing problem.	Create	create an idea
	Repeat steps 6 - 7 until the time > X or number of concepts from analogy = 0		
	8. Please select an idea.	Select	select an idea
v	9. Please mark the idea if the idea meets the criteria which describe a good idea	verify	mark an idea

5. Experiment

To verify our thinXel design approach, we analysed a variation of facilitator instructions in a creative process. We used a thinXel-based software tool called “Netstorming”, which reproduces a creativity technique as a sequence of questions, which build on each other. This GSS allows the design of different variations of the creativity technique, which are distinguished by the facilitator instructions. We hypothesize that a thinXel-based creativity technique will produce low cognitive load on the participants and hold their attention to the group process. We suggest that the participants will create more concepts which increases the efficiency and effectiveness of the creative process.

We designed an experiment with three different variations of the creativity technique “Analogies” [17]. All techniques used the same algorithm, which were defined by the formal language, but are distinguished by their facilitator instructions. They were executed in a creative process using the GSS “Netstorming”. Each variation of the technique was executed three times by different groups for the duration of 36 minutes. The creative topic was “What new services can a Citizens' Advice Bureau provide to the citizens”. We included the focuses: Problem, Person and Process into the facilitator instructions to lead the analysis of the situation in a Citizens' Advice Bureau into different directions.

The participants in these experiments were 27 students (14 male, 13 female), which were divided into groups of three persons. The students’ age ranged from 21 to 28 years (M= 24.67; SD= 2.17). Upon arrival, participants were informed verbally about the task of the experiment. They received an introduction to the functionality of the GSS “Netstorming”, and were then seated in front of a computer. Participants were told that they would be generating ideas, following the facilitator instructions which the GSS provides. No verbal communication was allowed between the participants during the experiment, but they were allowed to use an application of “Netstorming” to communicate with each other.

We recorded all concepts and communications of the participants with timestamps during the experiment. The attention of the participants to the group process was determined by the time interval between two concepts a person produced. We assumed that the interval should be short during a high attention period to the process and that the private communication between the participants will be decrease. The creativity technique “Analogies” uses three focuses to support the participants in the generation of new ideas. An efficient and effective creative process should therefore create a set of ideas, which results from concepts of these focuses. We counted the numbers of non-redundant ideas grouped according to the three focuses of the technique. A questionnaire was used to document the impressions of the participants about the creative process. These questionnaires use a scale from 1 to 6, at what the value 1 represent the best value.

Experiment A

This experiment used a thinXel-based variation of the creativity technique “Analogies” to create new service ideas (illustrated in Table 8). The technique was divided into three basic techniques, which each created their own focus on the creative topic. We used the focuses: Problem, Person and Process to analyze the situation in a Citizens' Advice Bureau. Each phase of this technique was executed for three minutes.

Table 8
Experiment A: a thinXel-based creativity technique “Analogies”

Facilitator instruction		Duration
1.	Please write down a problem which you associate with a Citizens' Advice Bureau.	3 minutes
2.	Please write down an institution which also has this problem.	3 minutes
3.	Please write down a service which this institution offers its clients.	3 minutes
4.	Please write down a new service idea, by adapting this service to the Citizens' Advice Bureau.	3 minutes
5.	Please write down a person which you associate with a Citizens' Advice Bureau.	3 minutes
6.	Please write down an institution where this person can be met.	3 minutes
7.	Please write down a service which this institution offers its clients.	3 minutes
8.	Please write down a new service idea, by adapting this service to the Citizens' Advice Bureau.	3 minutes
9.	Please write down a process which you associate with a Citizens' Advice Bureau.	3 minutes
10.	Please write down an institution where this process also exists.	3 minutes
11.	Please write down a service which this institution offers its clients.	3 minutes
12.	Please write down a new service idea, by adapting this service to the Citizens' Advice Bureau.	3 minutes

During the experiment A no communication between the participants was detected. All participants followed the facilitator instruction. The evaluation of the questionnaire shows that they understood the facilitator instruction (M: 1.33 SD: 0.5), and always knows what they were supposed to do (M: 1.44 SD: 0.72). The participants created 192 concepts in the phases 1, 5 and 9 of the creative technique. The concepts of the phases were grouped according to all three focuses (shown at Table 9 / concepts) of the technique. As a result of the creative process, 125 service ideas were created (group1: 45 ideas, group2: 43 ideas and group3: 37 ideas). These ideas were also grouped according to the three focuses (shown at Table 9 / ideas). An analysis of the database showed that each participant used analogies from all three focuses to create a new service idea. The mean for the time interval between two concepts was 31 seconds for all participants.

Table 9
Results of experiment A: a thinXel-based creativity technique “Analogies”

	group 1			group 2			group 3				
Time interval between two concepts											
Participant	1	2	3	4	5	6	7	8	9	M	SD
mean (M)	00:19	00:26	00:17	00:44	00:29	00:36	00:44	00:44	00:18	00:31	00:12
standard deviation (SD)	00:16	00:35	00:19	00:38	00:30	00:35	00:40	00:38	00:12		

Concepts (results from question 1, 5, 9)

Participant	1	2	3	4	5	6	7	8	9	M	SD
focus process	8	6	17	4	5	5	4	4	10	7,00	4,27
focus problem	12	3	10	4	4	4	4	5	8	6,00	3,20
focus person	13	5	16	4	11	2	3	4	17	8,33	5,92

Ideas (results from question 4, 8, 12)

Participant	1	2	3	4	5	6	7	8	9	M	SD
focus process	6	3	5	4	4	4	1	1	8	4,00	2,24
focus problem	6	6	5	6	7	9	1	2	9	5,67	2,74
focus person	7	4	3	3	2	4	5	2	8	4,22	2,11

Experiment B

To verify our assumption that a facilitator instruction should lead to one activity to generate more benefit from a creativity technique, we designed experiment B as a variation of the creativity technique “Analogies”, which leads to different activities by a facilitator instruction (illustrated in Table 10). We created this situation by a design, which integrates the focuses: Problem, Person and Process into one facilitator instruction. All instructions were more formal than in experiment A and the technique used four phases which each had duration of nine minutes.

Table 10
Experiment B: a creativity technique “Analogies” which produce a high cognitive load

Facilitator instruction	Duration
1. Which attributes (problem, people, and process) do you associate with a Citizens' Advice Bureau?	9 minutes
2. Which institution has the same attribute?	9 minutes
3. Which service idea is offered by this institution?	9 minutes
4. Which new service idea can be adapted to the Citizens' Advice Bureau?	9 minutes

During the experiment B a process oriented communication between the participants could be detected in one group. All participants followed the facilitator instruction. They understand the facilitator instruction (M: 1.67 SD: 1.0), and knew always what they were supposed to do (M: 1.78 SD: 0.83). The participants created in the phase 1 of the creativity technique 148 concepts which grouped according to all three focuses of the technique (shown at Table 11 / concepts). An analysis of the database showed that the participants preferred the focus: process and problem. As a result of this, only four participants used analogies of all three focuses to create new service ideas (shown in

table 11 / ideas). The creative process creates 102 service ideas (group1: 34 ideas, group2: 46 ideas and group3: 22 ideas). The mean for the time interval between two concepts was 32 seconds for all participants.

Table 11
Results of experiment B: a creativity technique “Analogies” which produce a high cognitive load

	group 1			group 2			group 3				
Time interval between two concepts											
Participant	1	2	3	4	5	6	7	8	9	M	SD
mean (M)	00:30	00:45	00:32	00:29	00:12	00:26	00:36	00:40	00:36	00:32	00:09
standard deviation (SD)	00:23	00:47	00:21	00:27	00:11	00:21	00:32	00:36	00:28		
Concepts (results from question 1, 5, 9)											
Participant	1	2	3	4	5	6	7	8	9	M	SD
focus process	8	4	7	7	20	23	0	1	5	8,33	7,97
focus problem	3	3	10	4	7	3	9	7	6	5,78	2,68
focus person	2	1	1	2	8	1	2	2	2	2,33	2,18
Ideas (results from question 4, 8, 12)											
Participant	1	2	3	4	5	6	7	8	9	M	SD
focus process	5	1	7	4	6	8	2	0	2	3,89	2,80
focus problem	12	4	4	0	2	1	5	4	7	4,33	3,57
focus person	1	0	0	6	9	10	0	2	0	3,11	4,11

Experiment C

We design this experiment to verify our assumption, that the participants will lose their attention for the process by using a creativity technique, without any further instructions from the facilitator. The experiment used the same variation of the creativity technique “Analogies” as in experiment B, but reduced the influence of the facilitator. First, the participants were introduced to the creativity technique by using each phase (phases 1-4 in Table 12) as a group for a short time of two minutes. In the second part of the experiment (lasting 28 min), they were invited to use these phases independently to create new ideas without any further instructions from the facilitator.

Table 12
Experiment C: creativity technique “Analogies” which a low influence of the facilitator

Facilitator instruction		Duration
1.	Which attributes (problem, people, and process) do you associate with the Citizens' Advice Bureau?	2 minutes
2.	Which institution has the same attribute?	2 minutes
3.	Which service idea offers this institution?	2 minutes
4.	Which new service idea can be adapted for the Citizens' Advice Bureau?	2 minutes
5.	Use this creativity technique in the presented way, to create new service ideas for a Citizens' Advice Bureau.	28 minutes

During the “Experiment C” private communication between the participants could be detected in two groups. Some participants were followed only the facilitator instruction in the first part of the experiment. In the second part, the participants used only one or two phases of the creativity technique but not the provided creative process. Figure 2 illustrated this for the activities of the participants in group 1. With the beginning of the second part of the experiment (timestamp 00:08:00), participant 3 used only the phase 4 of the technique to create new service ideas. Our observation shows that the participants used the phase 4 as a basis for the use of the generic creativity technique “Brainstorming”, which they all know. The questionnaire shows, that the participants understand the facilitator instruction (M: 1.33 SD: 0.5), and knows always what they should do (M: 1.56 SD: 0.53). Some participants did not create concepts in all three focuses (shown at Table 13 / concepts). Also a preference for analogies of the focus process is shown (shown in table 11 / ideas). Altogether 72 concepts were created in phase 1 of the creativity technique. As a results of the creative process 226 service ideas were created (group1: 74 ideas, group2: 94 ideas and group3: 58 ideas). The mean for the time interval between two concepts was for all participants 36 seconds.

Table 13
results of experiment C : creativity technique “Analogies” which a low influence of the facilitator

	group 1			group 2			group 3				
Time interval between two concepts											
Participant	1	2	3	4	5	6	7	8	9	M	SD
mean (M)	00:34	00:26	00:51	00:50	00:26	00:26	00:25	00:32	00:52	00:36	00:12
standard deviation (SD)	00:59	00:24	00:36	01:06	00:28	00:21	00:21	00:20	00:44		

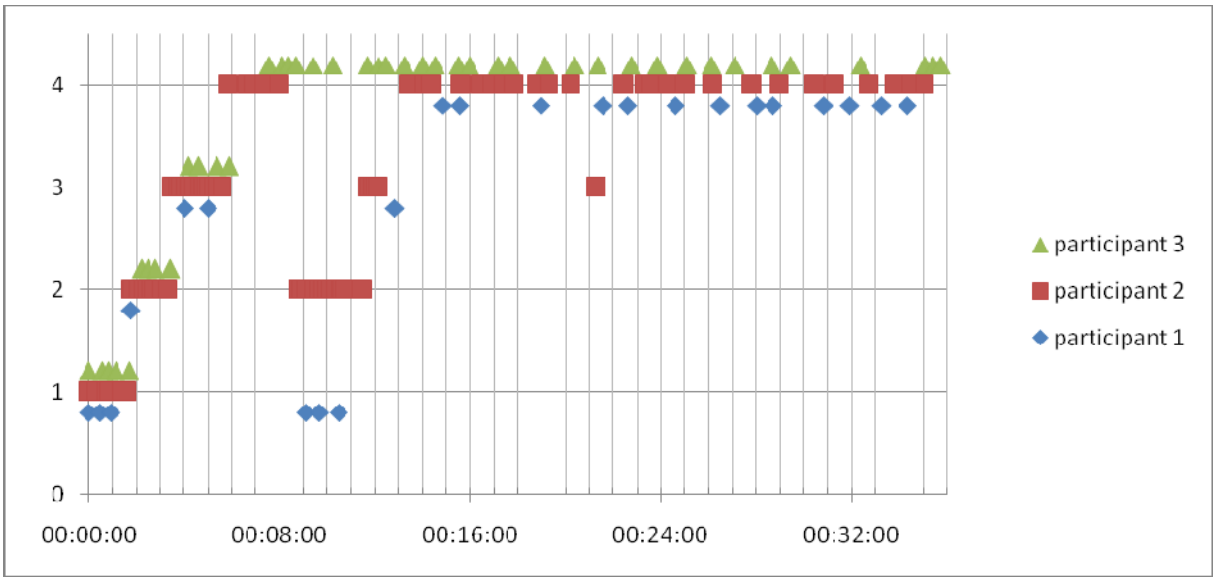
Concepts (results from question 1)

Participant	1	2	3	4	5	6	7	8	9	M	SD
focus process	2	1	2	3	7	5	6	4	1	3,44	2,19
focus problem	4	3	3	2	6	2	4	3	3	3,00	1,73
focus person	0	2	0	2	1	2	2	2	0	1,22	0,97

Ideas (results from question 4)

Participant	1	2	3	4	5	6	7	8	9	M	SD
focus process	11	24	25	19	26	37	7	3	6	17,56	11,45
focus problem	0	2	2	0	1	2	17	3	5	3,56	5,27
focus person	2	5	3	2	1	6	10	7	0	4,00	3,24

Figure 2
Experiment C: the activities of the participants of group1 (x = time, y = phases of the technique)



The results of these experiments validate the hypotheses, which we created with the thinXel approach. The creativity technique “Analogies” creates a benefit by using Analogies to find new ideas. To support the participants in their search for analogies, we used three different focuses under which the situation can be analyzed. The focuses were used in phase 1 of each creativity technique and developed different concepts, which built the basis for the creation of analogies. In an ideal case, the participants would create a well-balance distribution of concepts, for the provided focuses. The results show that only the thinXel-based creativity technique creates a well balance distribution (Table 9 / concepts). This supports our claim that a facilitation instruction should only lead to one activity because the thinXel-based technique in experiment A used one instruction for each of the focuses and forced the participants to write concepts for all focuses. The other techniques used only one instruction to create concepts for all three focuses. In this case the participants concentrated their activities on the focus which allowed them to easily create new concepts. This effect could also be observed in

experiment C, where the participants were introduced to the creativity technique, and were then ordered to use this technique without any further instructions from the facilitator. In this case some participants did not use the provided process. Instead, they used a generic process like the creativity technique “Brainstorming” to create new ideas. The participant only used existing ideas of other participants as stimuli for new ideas. Thereby, experiment C created more ideas than the experiments A and B (exp. A: 125 service ideas, exp. B: 102 service ideas, exp. C: 226 service ideas). A closer analysis of the database shows that most of ideas are extended versions of other ideas, which were created by the participant themselves. The result of the created concepts shows that experiment A used much more concepts for the development of new ideas (exp. A: 192 concepts, exp. B: 148 concepts, exp. C: 72 concepts). This complies to the intend benefit of the creativity technique “Analogies” and support our claim that a thinXel-based technique will increases the efficiency and effectiveness of the creative process.

The personal evaluation showed that all participants thought that they had understood the intention of the facilitator and knew what they should do. Experiment C shows that the participants misunderstood the facilitator instruction. In this case the facilitator lost the control of the creative process and could not intervene in the process, because he did not get negative feedback from the participants. This supports our assumption, that the facilitator will lose the attention of the participants for the process by using a creativity technique, without any further instructions.

We assume that the time interval between two concepts will be increased by a non thinXel-based technique. Our analysis of the database showed that no significant difference exists between experiment A and B, but that the time gap increased with the decrease of the facilitators influence (exp. A: M = 31 seconds SD = 12 seconds, exp. B: M= 32 seconds SD= 09 seconds, exp. C: M= 36 seconds SD= 12 seconds). We could not directly prove our hypotheses that a thinXel-based creativity technique will hold the attention to the process.

However, as a summary of the experiments it can be said that a thinXel-based creative process can generate more benefit from an existing creativity technique and increases the efficiency and effectiveness of the process.

6. Discussion and Conclusions

This paper introduced thinXels as a new approach to design and execute a creative process in a face-to-face or computer-based workshop. A thinXel is defined as an elementary instruction leading to a response which has a well-defined function in the context of the group's goal. It represents a reusable facilitation block and can be sequenced according to formal rules to form more complex modules. We claim that a formal language can be used to define these rules and presented such a formal language for the creative process. The language reproduces a creativity technique as a word of the language. This word represents the algorithm of the technique and can be described as a sequence of thinXels. Therefore the formal language builds a communication medium, which can be used by researchers and users of creative processes. It allows the creation of modules for existing and new creativity techniques. These modules can be used for the development of a GSS, which includes a library of thinXel-based creativity techniques. A thinXel-based creative process allow participants without facilitator experience to execute a creative process in a more efficiently way. Our experiments

show that a thinXel-based creativity technique will hold the attention of the participants to the creative process. The participants can generate more benefit from an existing creativity technique and increases the efficiency and effectiveness of the creative process.

More research is needed in the research field of thinXels. The existing formal language is based on a simple model for the creative process. Over the years many other models have been defined like Osborn's Seven-Step Model for Creative Thinking [12]. Researchers could analyse these models and adapt the formal language by introducing new concept. Also procedures for existing creativity techniques should be designed and categorized. To describe these procedures in a uniform way, a conceptualization must develop. A thinXel-based GSS should be designed to support the creative process by using GSS. We suppose that the thinXel-approach can be used to support other group process like a discussion, a debate or a board meeting. For these processes new formal languages will be need.

Finally, it can be said that companies which will use the thinXel approach to design and execute their group work, will increase the efficiency and effectiveness of their work, without professional facilitators.

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