Creative Problem Solving – An Application by Children for a Real Life Problem

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Abstract
Research has shown that creativity can be taught (Firestien & Lunken, 1993; Parnes & Noller, 1972; Rose & Lin, 1984; Scott, Leritz & Mumford, 2004), and that creativity training can be effective (Parnes & Noller, 1972; Rose & Lin,1984). How does this research translate to the Indonesian context and in the population of children? This paper presents the design, process and outcome of a Creative Problem Solving (Osborn, 2001) program taught to a group of Indonesian children age six to ten years of age and the children's application of their learning in solving a real life problem – the floods of Jakarta. A nine week long, 30 hour program was developed for children based on the Creative Problem Solving (CPS) model. The children were taught the principles of CPS and various divergent and convergent thinking tools and techniques. The CPS process proved to be an effective means to facilitate collaboration among children to find ideas and reach decisions. Results also show that CPS stretched the children's imagination, participation in different parts of the process was affected by motivation, and that many opportunities occurred for the children to introspect on their cognitive and emotional blocks and leverages in problem solving.

1. Introduction

Research has shown that creativity can be taught and that creativity training can be effective (Firestien & Lunken, 1993; Parnes & Noller, 1972; Rose & Lin, 1984; Scott, Leritz & Mumford, 2004a; Scott et al, 2004b). However, how does this research translate to the Indonesian context and in the population of children? This paper presents the design, process and outcome of a Creative Problem Solving (Osborn, 2001) program ("the program") taught to a group of Indonesian children age six to ten years of age and the children's application of their learning in solving a real life problem – the floods of Jakarta that inundated the city in the year 2007. The program was designed to incorporate the various factors that lead to effectiveness as discussed in the Literature Review section below.

2. Literature Review

The Creative Problem Solving (CPS) model (Isaksen, Dorval & Treffinger, 1994; Osborn, 2001; Puccio, Murdock and Mance, 2007) was chosen as a method to teach creative thinking. In a meta-analysis of 70 studies, Scott et al (2004a) showed that some approaches are more effective than others, specifically approaches that "focus on the development of cognitive skills and the heuristics involved in skill application" (Scott et al, 2004a; p.361), of which CPS is an example. Specifically, Scott et al (2004b) reported that more effective programs focused on the development of creative problem-solving skills, employed instructions that had an emphasis on problem analysis and involved the teaching of problem-solving techniques by way of lecture and realistic exercises.

Torrance (1987), cited his collation of 142 studies in teaching creative thinking to children conducted in 1972, which were categorized into 9 types of creativity training for children (one category of which was programs which emphasized CPS), which concluded that training programs based on CPS "achieved some degree of success" (p.192). The only other category that matched or slightly surpassed CPS based programs on its success rate was 'other disciplined procedures', that is, disciplined procedures other than CPS based programs (e.g. general semantics, creative dramatics and remediation, creative research). Torrance reported success rates of over 90% for both types of training. Torrance summarized his findings as follows:

1. It is possible to teach children to think creatively.
2. Most successful approaches in teaching creative thinking to children are those that involve both cognitive and emotional functioning, provide adequate structure and motivation, and give opportunities for involvement, practice, and interaction with teachers and other children.
3. Deliberate teaching of creative thinking seem to be the factor that account for and predict the greatest differences in creative functioning of children.

Torrance (1987) reported similar findings when he replicated his study 11 years later in 1983. His conclusion in his later study was that "the percentage of successes (of CPS based teaching programs) continues to be higher than for other categories of experimental intervention." (p.205). These findings were later confirmed by the Scott et al (2004b) who concluded in their study that creativity training had noteworthy effects on divergent thinking, problem solving, performance, and attitudinal criteria. Furthermore, the authors noted that training was effective in different populations and settings, from young to old people, gifted and non-gifted students, to school and organizational settings.

Lastly, Torrance (1987) acknowledged that "being able to think creatively" is not the same as "thinking creatively" (p.190). Believing that everyone is able to think creatively, especially with the teaching of creative thinking skills, the program was conceived as an opportunity to both heighten children's ability to think creatively and for children to think creatively.

3. The Creative Problem Solving Program

A ten week long, 30 hour program was developed for children based on the CPS model. CPS is a structured problem solving methodology that was introduced by Alex Osborn in his book "Applied Imagination" in 1953. CPS has since undergone refinements and developments based mainly on the work of the Creative Education Foundation and the International Center for Studies in Creativity at Buffalo State College.

Although CPS is found in varying models, two distinguishing features of CPS remain: (1) the three stages of problem definition, generation of ideas and formulating a plan of action, and (2) the balance between divergent and convergent thinking (Puccio, Firestien, Coyle & Masucci, 2006). Generally, CPS includes three stages and six steps. Within the CPS process, there are a variety of divergent and convergent techniques and tools (Millar, Vehar and Firestien, 2001). An overview of CPS and the time plan of the program are presented in Appendix 1. Torrance (1987) referred to the strong elements of the emotional and irrational thinking processes in creative thinking, and opined that "A part of the business of teaching children to think creatively is teaching them to understand and consciously to use these emotional, irrational

processes and to formulate and apply criteria for evaluating alternative solutions." (p.190). That is, creative thinking involves both divergent and convergent thinking and a separation and balance of divergent and convergent thinking are desirable.

To note is that the CPS is not a linear process and is reiterative depending on the need of at each step of problem solving. This feature of CPS is exemplified in Week 4 of the program when the children had honed in on a very specific problem and needed to return to gather more data in relation to that specific problem per se. The children were taught the principles of CPS, namely, the balance of divergent and convergent thinking and the three stages in problem solving – exploring the problem, generating ideas and formulating an action plan. They were also taught the rules of divergent and convergent thinking (Appendix 2) and various divergent and convergent thinking tools and techniques (Brainstorming, Brainwriting, Forced Connections, Hit, Cluster, Restatement, Card Sort, PPCO[1]). Teaching and application were interwoven throughout the program such that children learnt small chunks of creativity contents and immediately applied them to the problem at hand. A review of the creative problem solving process took place at the beginning and end of each meeting to raise children's awareness of the process in which they were entrenched.

4. The Program Outline & Outcome

This section gives an overview of the program in terms of the CPS stages, steps and outcome of each step of the program. The overview is presented in Table 1 below. Based on an estimate in how long each CPS step would take, the program was designed to run weekly over a period of three months, each session lasting approximately three hours. The length of the program was to be up to students' motivation and development of their thinking during the problem solving process. Thus, the teaching plans for each session were developed on an 'as we go' basis, following a cycle as depicted in Appendix 3. The teaching activities that took place are outlined in Table 1 and described on a per session basis in detail in Appendix 4. Details of the results in the program are provided in Appendix 5.

There were two aspects to this program. The children were learning about the flood problem in Jakarta as content in addition to learning the process of CPS. Although it was not the aim for the children to be able to independently use CPS at the end of the program, the aim of the program in terms of process learning was for the children to at least be aware of the specific tools and techniques used so they can use them independently and to be aware of the 3 stages of CPS. To achieve these process objectives, children were given an overview of CPS in the first session and each meeting with the children began with a discussion recalling the process that occurred in the previous session and asking the children where they thought they were in the process that was about to take place. This was the *meta-cognitive part* of the teaching of the process. Please see Appendix 6 for the process aid used with the children.

To note about the program is the incorporation of different learning activities and modes of learning, especially during the first stage of Exploring the Challenge to help children learn about the floods and its impact on people and the surroundings (e.g. role play in Activity 2.3,

[1] Miller, B., Vehar, J. & Firestien, R. (2001). *Creativity unbound: an introduction to creative process.*. (3rd ed.). NY: Innovation Resources.

site observation in Activity 4.2) and in the idea generation phase (e.g. drama in Activity 6.3). Throughout the process, there was a significant emphasis on the use of visual media as an aid to help children visualize their understanding of the problem and ideas for solving the problem (e.g Activities 1.3, 4.3, 8.1, 8.2, 8.3). The results presented in Appendix 5 show that the solutions generated by the children were various, some realistic, some 'fantastic'. This was deliberately allowed and encouraged to keep alive the children's imagination, especially as the children were very keen on their imaginative ideas.

Table 1 Overview of Program and Results
Activity (group activities unless indicated – I = individual activity)

	CPS Stage	**CPS Step**	**Phase of Thinking** Divergent (D)/ Convergent (C)		**Outcome of session**
Session 1	Explore the Challenge	Identify the Goal, Wish or Challenge	state a variety of goals, wishes or challenges.	D	The children generated 5 groups of problems related to floods in Jakarta. The children chose a group of problems they were most interested in to solve: How to move around in floods? and were equipped with ideas on how to gather information for the problem during the week before the following session.
Activity 1.1 Group Discussion (1) How floods in Jakarta impacted students and (2) observations of the floods.					
Activity 1.2 Interview with flood victim					
Activity 1.3 (I) Observation of images & Creation of pictures of intriguing aspects of floods.					
Activity 1.4 Group Discussion (1) Causes of flood and (2) could floods have been prevented?					
Activity 1.5 Presentation of Activity1.3.					
Activity 1.6 Group Discussion Positive aspects of floods.					
	Explore the Challenge	Identify the Goal, Wish or Challenge	choose a goal, wish or challenge where you have ownership, motivation and a need for imagination	C	
Activity 1.7 Techniques: Hit, Cluster, Restatement - Groupings of intriguing aspects of flood. **Technique: Card Sort** – ranking of intriguing aspects of floods in terms of students' levels of interest in problem.					
Activity 1.8 Technique: Brainstorming - how to find out more about the problem students were interested in.					
Session 2	Explore the Challenge	Gather Data (1)	explore all the data around the goal, wish or challenge	D	A demonstration of students' understanding of the problem *How to move around in floods,* by way of data gathered for the obstacles and difficulties in moving around in floods and what might be useful in helping people and things move around in floods**.**
Activity 2.1 Experience Walking In Flood Water – walking in a bucket of soiled water.					
Activity 2.2 Talk by flood victim with Q&A					
Activity 2.3 (I) Imagine & role play being someone else in the flood – why and how the person would be moving around in a flood.					
Activity 2.4 Group Discussion Using the scenarios enacted in Activity 2.3 1. What obstacles or difficulties are there in moving around during floods? 2. What can be useful in helping people and things move around during floods?					
Session 3	Explore the Challenge	Gather Data (1)	identify all the relevant data	C	**Outcome of session:** The students had broken down the original challenge of *How to move around in floods?* to 17 groups of sub-problems. The students selected one aspect of the original challenge i.e. one sub-problem, to work on:
Activity 3.1 Selecting relevant data to the problem of *How to move around in floods?*					
	Explore the Challenge	Clarify the Problem	state the problem in as many ways as possible	D	
Activity 3.2 Techniques: Hit, Cluster, Restatement of selected data from Activity 3.1. Cluster headings were turned into problem statements. For example: Cluster heading 'Use water transportation' was turned into problem statement of 'How to use water transportation to get us around?'					
	Explore the	Clarify the Problem	choose a problem statement to work on	C	

	Challenge				How to eliminate traps on the roads of Jakarta?
Activity 3.3 Technique: Card Sort problems generated in Activity 3.2 according to students' preference and motivation,					
Assignment (I) **Techniques: Brainstorming, Brainwriting and Forced Connections** Find pictures and ideas for the problem of How to eliminate traps on the roads of Jakarta? as homework.					Students were taught divergent thinking techniques and practiced as homework.
Session 4	Explore the Challenge	Gather Data (2)	explore all the data around the goal, wish or challenge	D	A clay model of a typical Jakarta road with 'traps' observed by the students. This would provide a visual reminder to the students of their observations and the problem they need to generate ideas for to solve: *How to eliminate traps on the roads of Jakarta?*
Activity 4.1 (I) Review Forced Connection technique Students guessed how ideas generated by others were inspired by pictures.					
Activity 4.2 Real life observation of roads for 'traps'.					
	Explore the Challenge	Gather Data (2)	identify all the relevant data	C	
Activity 4.3 Creation of a clay model of the roads and traps observed in Activity 4.2					
Sessions 5 & 6	Generate Ideas	Generate Ideas	think up a wide variety of ideas to solve the problem	D	Many ideas are generated for *How to eliminate electric cables as traps on the roads of Jakarta.*
Activity 5.1 (I) Review traps found in roads in Jakarta. Students generated problem statements: *How to eliminate (trap)?*					
Activity 5.2 Warm up for idea generation, **Brainstormed** on a 'fun' but unrelated problem. (see divergent thinking rules Appendix 2)					
Activity 5.3 Technique: Brainwriting with Forced Connections - How to make sure people are not trapped by electric cables during flood?					
Activity 5.4 Technique: Analogy - How to eliminate electric cables as traps?					
Activity 6.1 Part 1 (I) Technique: Visual Connection –Figure 6.1.1: observation of various interesting objects and listing observed features					
Activity 6.1 Part 2 Technique: Visual Connection – generate ideas for How to eliminate traps? based on observations made in Activity 6.1 Part 1					
	Generate Ideas	Generate Ideas	choose the most promising idea	C	A selection of ideas to eliminate the different types of traps found in Jakarta roads using several techniques of divergent thinking and chosen ideas using several techniques of convergent thinking. Children also learned the process of using each technique.
Activity 6.2 Technique: Hit Selection of ideas generated for How to eliminate traps? In Activities 5.3, 5.4 & 6.1 (criteria: intriguing ideas)					
	Generate Ideas	Generate Ideas	think up a wide variety of ideas to solve the problem	D	
Activity 6.3 Technique: Improvisation (Figure 6.3.1) : Trapped in a flood					
	Generate Ideas	Generate Ideas	choose the most promising idea	C	
Activity 6.4 Technique: Hit – selection of ideas generated for How to eliminate traps? in Activity 6.3					
Session 7	Generate Ideas	Generate Ideas	choose the most promising idea	C	An action plan to: 1. Design and build a model of a vehicle that would help lift people out of floods. 2. To make an information booklet on how people can help themselves during flood. *3.* Write a proposal to the local government,
Activity 7.1 Technique: Clustering, Restatement – ideas selected in Activities 6.2 and 6.4 Clusters labeled with statement starter: "What we see ourselves doing is…(action word). " **Selection of what action(s) to take.**					
	Select & Strengthen Solutions	Prepare for Action	evaluate and refine the ideas you selected	D	
Activity 7.2 Group Discussion Selected action: challenges and concerns and how students might overcome them.					
	Select & Strengthen Solutions	Prepare for Action	select the most promising solution(s)	C	
Activity 7.3 Final decision regarding which action or actions students wanted to take**.**					

	Select & Strengthen Solutions	Plan for Action	list assisters/resisters and actions for implementation	D	specifically, the Governor of Jakarta that would include the ideas generated for *How to eliminate traps on the roads of Jakarta?* Given the time constraints, the teacher offered to write the proposal and the students were divided into two groups by their choice of action steps. One group was tasked to create an information booklet and another in designing and building a model of a vehicle that would help lift people out of floods.
Activity 7.4 Group Discussion Possible obstructions to actions students intended to take.					
	Select & Strengthen Solutions	Plan for Action	form a specific plan of action	C	
Activity 7.5 Formulation of Action Plan					
Sessions 8 – 11	Creation and Implementation of plan of action				
Abandoning the Idea of Creating an Information Booklet After taking the beginning steps of creating an information booklet, the group working on this task asked the teacher for permission to join the group designing the vehicle to help lift people out of floods.					
Design and Build a Model of a Vehicle to Help Lift People Out of Floods **Activity 8.1 (I) Parts of the Vehicle:** Decide parts of vehicle, Design individual parts to vehicle, **Technique: PPCO** design of parts of vehicle					The students named their vehicle Monster Truck Aeroplane or MTA for short. Initial designs of different parts of the MTA.
Activity 8.2 Drawing of MTA The students collaborated on a drawn design of the Monster Truck Aeroplane.					1. A drawing of the design of the MTA. 2. A model of the MTA. 3. A letter and proposal to the Governor of Jakarta.
Activity 8.3 Building a Model of MTA The students used art and junk materials to build a model based on their agreed design.					

5. Discussion

The application of the CPS model with a group of children to a real life problem in Jakarta, Indonesia has substantiated what the literature purports regarding the deliberate teaching of creative thinking and has also enabled insights to be gained with regard to how CPS might contribute to or complement a child's mainstream education here in Indonesia. This section will discuss this in relation to the results presented in the Results section. Specifically, this section will discuss the following benefits of using CPS in group problem-solving with children:

1. The facilitation of the collaboration of the children involved in the program.
2. The leverage of tapping into intrinsic motivation.
3. The teaching and practice of process skills.
4. A focus on problem finding and applied imagination.

5.1 The facilitation of the collaboration of the children involved in the program.

Many arguments and literature have been published about the need for teamwork for children to develop this ability to be prepared for entry to the workplace (Partnership for 21st Century Skills, 2008). This section will discuss how the use of CPS brought together a team of children to truly collaborate to solve on a real life problem. Collaboration within teams and amongst team members mean that meaningful communication has taken place within a team or group to enable the harnessing of individual perspectives and strengths, to arrive at consensual decisions (Johnson and Johnson, 2003). CPS facilitates collaboration in that each member must contribute to each step of the process, albeit to different extents. During the generative thinking activities, group members are required to defer judgment to truly listen and be open-minded to what they or others have to offer to the problem solving process; and during the evaluative and decision making phases, group members are facilitated to arrive at consensus decisions before moving to the next phase in the CPS process (Isaksen, Dorval and Treffinger, 1994; Miller, Vehar and Firestien, 2001). This section will focus on how such collaboration has effectively pooled the knowledge of each child into collective knowledge, brought together a diversity of perspectives, and triggered debates and negotiations among the children to arrive at decisions and conclusions to meet the goals of the group.

5.1.1 Pooling of individual knowledge to collective knowledge

The CPS process includes a data-gathering step, and this step is revisited whenever the need arises. This step is a natural step in the process where the children were able to contribute their own pieces of information and knowledge. For example, in Activity 1.3, the children related to the flood situation differently based on their own experiences. Not only are we influenced by our experiences in what we know but our experiences can also influence what we pay attention to. In Activity 1.2 and 1.3, the children directed their interests and questions based on their own experience of the floods (Activity 1), and in Activity 4.2, the children observed the surrounding environment for traps and were able to compile individual observations into an expansive list of group observations. Not only is such collective knowledge valuable during the data gathering stage in terms of acquisition of knowledge for knowledge's sake, but it is also helpful in the idea generation and decision making stages when children's idea space is expanded and decision making can be made on a more informed basis (e.g the idea generation activities in Sessions 5 and 6 were mostly based on real traps the children had observed in their surroundings). Collaboration also meant that each child was able to bring forth the knowledge he had and benefit from the knowledge of others, for example, some children brought their knowledge of science in the

analogical idea generation activity in Activity 5.4. Pooling of knowledge was valuable when an idea was too complex for the whole group to handle at the same time, take Activity 8.1 for example, when each child was assigned to be an 'expert' for one part of the machine the group wanted to design and create a model for, before coming back together as a group to synthesize the different parts into one whole. In this way, the children operated as 'multi-functional' teams in pooling their pieces of knowledge for one common goal.

5.1.2 Drawing on a diversity of perspectives

The ability to look at situations and problems from multiple perspectives is a pertinent creative thinking skill (Torrance and Safter, 1979; Torrance and Safter, 1999). Collaboration in a team enables individuals to learn how to take different perspectives on a problem simply by allowing the perspectives of individual group members to emerge and to be shared. Keeping open-minded and deferring judgment is a quintessential skill in creative problem solving (Isaksen et al, 1994; Torrance and Safter, 1999; Osborn, 2001). Thus, in drawing upon different perspectives of individual group members, collaborative efforts such as those that occur during the CPS process not only develop perspective taking skills but also deferring judgment skills.

In terms of the different perspectives taken on the content of the problem, we saw how the initiation of a positive perspective on the flood problem opened up the thinking in the group of children in Activity 1.6. The perspective of 'fun in water' opened up many positive angles for thinking about floods in Jakarta. In the idea generation activities (Activity 5.3, 5.4, 6.1 and 6.3) and implementation activities (Activity 7.5, 8.1, 8.2 and 8.3), we saw a diversity of perspectives at work in bringing richness to the output of the CPS process. Brainwriting in Activity 5.3 is an idea generation technique that allows group members to share ideas and to be inspired by the ideas generated by peers in the group. In this activity, the children were able to generate a substantial amount of ideas which is a direct result of sharing perspectives. The children were not only able to inspire one another to build on each others' idea but also able to diversify the categories of ideas generated, thus resulting in flexibility at the group level of ideas generated. This diversity in thought is also evidenced by the responses of the children in Activity 6.3 (Role Play), in which none of the responses given to the same scene were identical. Taken together, the diversity in perspectives of the children's responses to stimuli in the generative thinking activities meant that a large number of ideas were generated (more than 100 ideas!).

In Activity 8.1, where each child was assigned to be an 'expert' for one part of the imagined vehicle the children wanted to create a model for – the Monster Truck Aeroplane, they came together after individualized tasks of working on the separate parts of the model. When each child presented his or her thinking on a part of the model, the forum was opened for peers to comment for improvements to the design to be made. Again, this resulted in an overall 'improved' design that incorporated each and every child's perspective. This is not to say that all comments or feedback were incorporated, resulting in a 'compromised' design based on the 'group mind' (Johnson and Johnson, 2003; pp.269-271). Rather, all feedback was heavily debated. What is important to note here is that it was not the teacher who stepped in to comment or grade the designs of each part, but the teacher facilitated the emergence of the children's own opinions and comments on their peers' thinking to arrive at a solution. Thus, a diversity of perspective was not only important for data gathering and the generation of ideas but also for decision making. This is discussed further in the section *Debates and negotiations for consensual decision making.*

5.1.3 Debates and negotiations for consensual decision making

The arguments for effectiveness of group decision making over individual decision making have been put forth by Johnson and Johnson (2003, pp.278-329). In explaining why group decisions are superior to individual decisions, Johnson and Johnson (2003) wrote: "in groups there is process gain; the interaction among group members results in ideas, insights, and strategies that no one member had previously thought of." (p.279). The authors argued that although group decision-making requires more time, they are worth pursuing. The CPS process is such that after a generative thinking phase, it is followed by a selective and evaluative thinking phase. It is during this convergent phase that group members need to make decisions on a consensual basis based on a diversity of perspectives. This section will examine how this was achieved by the children in the program. The children were met with the challenges of consensual decision making throughout the CPS process (Activities 1.7, 3.1, 3.3, 4.3, 6.2, 6.4, 7.1, 7.3, 7.5, 8.1, 8.2 and 8.3) – 11 out of the total of 35 activities involved group decision-making. Many of the convergent activities employed the use of CPS tools and techniques, namely: Hit, Cluster, Restatement, Card Sort, PPCO. In terms of the broad process, the children first had to decide together on which problem they wanted to solve together, then they had to decide which ideas they wanted to carry forward into the planning stage for implementation. During the planning stage, much of the decision making was for the division of tasks and how to implement the selected ideas. These will now be discussed in more detail.

Motivation is a driving force that needs to be present in any problem solving process (Miller et al, 2001). In choosing a problem to work on, the children were first asked to direct their attention to what interested them most from what they had learned about the floods in Jakarta. The children's responses were compiled in Activity 1.7. In drawing out the children's interests, the children's first real encounter with group decision making was when they were asked to select the problem that interested them the most. The technique used was Hit, which simply involved children to give a vote to the problem they were most interested in. The problem of *How to move around during a flood?* received the most votes. It appeared that the discussion method had helped the children to find their own point of convergence.

In Activity 3.1 and Activity 7.1, the convergent thinking required was much more challenging. The children used the techniques Cluster and Restatement to group the many problems or ideas they had generated in an open-ended way. As can be expected from such a procedure, the discussion and debate can lead to a myriad of options that the children would need to juggle with. As presented in the Results section, the children came up with 17 sub-problems for the problem *How to move around in a flood*? (Session 3), and in Session 7, 15 groups of action ideas were generated after a vigorous process of selection and clustering of the many ideas generated. Although the teacher played a role in facilitating the process and stepping in if necessary, the children were required to be both critical and 'inducible' (Johnson and Johnson, 2003; p.237) at the same time, *inducibility* being defined by Johnson and Johnson (2003) as the openness to influence. We found that although discussions and debates occurred among children during the convergent thinking phases, the children were more open to listen to others and go along with others' opinions if the discussion or matter was intellectual such as the Cluster and Restatement activities afore-described. The children were more opinionated and less susceptible to be influenced when a decision would impact them directly such as when they had to make choices that would determine

what they would be working on for the next steps in the process. This is exemplified by the children's behaviour and interaction during Activity 7.3 when they were faced with a myriad of possible actions they could take (15 categories) and had to decide which action steps they wanted to prioritize. This discussion lasted for more than an hour and the teacher played a bigger role in guiding the discussion as the children were more interested in the imaginative and inventive action idea (design and make a vehicle that lifts people out of water – the Monster Truck Aeroplane) than the realistic ones (initiate an educational campaign for people not to litter the river and to make an informational booklet on how people can help themselves during a flood).

Overall, as pointed out by Johnson and Johnson (2003), the convergent phases tended to be time consuming but the end results were worth the time. The CPS process had provided a structure for the children to operate together. The separation and balance of divergent and convergent thinking and the rules for divergent and convergent thinking had been well applied that had resulted in a problem solving process that was respectful and helped the children develop listening and communication skills. Such are the ground rules and process of CPS that it calls for open-mindedness, a diversity of perspectives and consensual decision making, that as a result, the process creates a spirit of collaboration instead of competition.

5.2 The leverage of tapping into intrinsic motivation.

Much had been written about the role of intrinsic motivation in creative endeavors (Torrance, 1979; Woodman and Schoenfeldt's, 1993; Amabile, 1996; Torrance and Safter, 2005) and in his synthesis and summary of the research conducted in creative personality traits, Davis (2004) concluded that one trait characteristic of creative people is that they have high levels of energy. That is, creative people are highly motivated and passionate about what they do. During the program, we have seen intrinsic motivation brought to the fore in the children in two ways, by: allowing freedom of choice in all decision making, and allowing children apply and express themselves according to their strengths and interests.

5.2.1 Freedom of choice

Deci's (1995) theory of motivation postulates that intrinsic motivation is heightened from a sense of integrated self, which results from the extent of freedom afforded to an individual. According to Deci (1995), when people feel free to choose in their own actions, i.e. they are autonomous, "they embrace the activity with a sense of interest and commitment. Their actions emanate from their true sense of self, so they are being authentic."

Given that intrinsic motivation is a powerful force that can be tapped into, a practical teaching strategy to tap into children's intrinsic motivation is to offer genuine choices during the learning process and leave the decision making to the children. Guidelines to the convergent or decision making phases of CPS require selections to be made based on several criteria, one of which is motivation and arousal of interest, that is: how motivated and interested the decision makers are in the choices generated (Miller et al, 2001). As we have seen, the CPS process offers opportunities for autonomous decision making during all convergent thinking phases and as we have discussed in the section *Debates and negotiations for consensual decision making*, the group of children independently selected the problems and ideas they wanted to bring forward in the process. They were asked what interested them (Activity 1.7), what their favourite problem was (Activity 3.3), to choose their favorite ideas (Activity 6.2), what action they wanted to take (Activity 7.1 and 7.3).

As a result of Activity 7.3, three action steps were selected by the children. However, initially, the children were really passionate only about one action idea – that to design and make a model of something that could lift people out of water. The action ideas of starting an educational campaign and creating an information booklet received less enthusiasm and were encouraged by the teacher. As it turned out, the group that started work on the information booklet lost interest in the work and asked the teacher if they could join the group that had already started work with the model (which they named Monster Truck Aeroplane). Permission was given and the children worked with a very high level of energy in conceptualizing, designing and creating the model of the object that could lift people out of water. As a result, the children were able to bring the project to completion despite the long duration of 11 weeks. The last two weeks of the project were added in order to bring the program to completion. Participation was voluntary but high among the children who were keen to finish off the Monster Truck Aeroplane.

5.2.2 Each to their own ability and preferences

Puccio's (2002) Foursight™ profiles preferences for different stages in the creative problem solving process (problem clarification, idea generation, solution plan development and implementation). Gardner's Multiple Intelligence Theory (2006) postulates unique individual profiles of strengths in how one thinks or problem solves. Such preferences were found throughout the process whereby we saw each child exhibiting unique profiles in preferences or styles in problem solving. The different preferences were managed by way of the teacher setting minimum expectations for the children (that is, at each step, what the minimum output or effort expected by the teacher from each child was). Minimum expectations were set to ensure each child made genuine attempts in all activities but beyond the minimum expectations, all efforts were determined by each child's interests and motivation.

The children demonstrated different levels of interests at different stages of the process. Most notably was that all the children were engaged in the stages of problem clarification (Activities 1.1 to 4.3) and idea generation (Activities 5.1 to 6.4) with very high levels of interests and motivation. The children's engagement with the process dipped for the solution planning stage from Activities 7.1 to 7.4, during which time the teacher found it challenging to involve the children in activities and discussions. The process almost faltered during the solution development stage as only one child was exhibiting interest. However, after the group had developed the solution plan with much teacher coaxing, the children were found to be with high energy levels again during the implementation stage (Activities 7.5 to 8.3).

Besides different preferences for the different stages of CPS, the children were also observed to have different preferences for the two different phases of thinking in the CPS process. We found that most but not all children were comfortable with the divergent phases of the process and only a minority of the children enjoyed the convergent phases. We also observed that children reacted differently to various divergent thinking tools and techniques. Some children were more comfortable with techniques that were 'down to earth' such as Brainstorming. Some children were found to prefer divergent thinking tools that led their imagination to absurd ideas, such as in Activity 5.3 (Forced Connections), Activity 5.4 (Analogy) and Activity 6.1 (Visual Connection). The observation of children's liking for convergent thinking was especially apparent in the long drawn out convergent thinking activities, notably Activities 3.3 and 7.1, when towards the end only a minority of the children displayed continued interest. In this regard, the combination of

children with different extents of preferences for divergent and convergent thinking had enabled the alternating divergent and convergent phases of CPS to be well navigated by the group of children as a whole.

Lastly, CPS is essentially a highly verbal process. In order to reduce the focus on verbal activities given that the group of children included some younger children who were still learning to read and write, and in acknowledgement that some children may prefer to think or problem solve in modes other than verbally, the program was designed to include non-verbal activities. Non-verbal activities included visual activities (Activities 1.3, 2.3, 4.2, 4.3) and kinesthetic activities (Activities 4.2 and 6.3). On the whole, all children were highly motivated in the visual activities and thus the inclusion of the visual activities played an important role in sustaining children's interests in the long CPS process.

In summary, CPS as a process provides opportunities for decision making and individual expression in a variety of ways, affording children with different preferences in thinking different levels of engagement throughout the process. The freedom of choice in one's course of action is believed to have created a sense of autonomy in the children during the CPS process. The freedom to apply one's strengths and preferences or styles in problem solving is observed to have facilitated the group of children to navigate the long duration of the program with continued high levels of interests. Both are thought to have contributed to sustaining high levels of intrinsic motivation in the children which brought the program to a successful outcome.

5.3 The Deliberate Teaching of Process Skills

Process is a sequence of actions or events, i.e how something gets done. In solving problems, the inability of identifying the right problem and jumping to conclusion will not give the desired results. The teaching of process via the CPS model in addition to contents has several benefits. Firstly, the students gained an understanding and experience the process of CPS in 3 simple stages i.e. exploring the problem, generating ideas and formulating a plan of action. Secondly, students learned about divergent and convergent thinking and how the two types of thinking are applied in the 3 stages of CPS. The students in the program understood an important principle that exploring ideas (divergent thinking) should be separated from idea evaluation and selection (convergent thinking). The students were also taught the rules of divergent and convergent thinking, which aids effective divergent and convergent thinking. Take for example, the training of critical thinking (convergent thinking). Critical judgment is essential for solving problems. The hazard comes in judging too soon or choosing among options that are too limited. In school, most of us are taught that the faster we reach an answer, the smarter we are. In fact, the most successful problem solvers put in time for diverging before they enjoy the resolution that converging brings. (2001 Miller, Vehar, Firestien). Having gone through the whole CPS process, the students were aware that in each stage, they had to separate but balance divergent and convergent thinking. Thirdly, the children were taught various divergent and convergent tools and techniques so they could use them independently.

5.4 Focus on Problem Finding and Applied Imagination.

5.4.1 Problem Finding

Finding the right problem is just as important as the ability to solve a problem. The inability to explore a problem may result in solving the wrong problem. Finding the right problem also

requires the ability to break a complex problem into manageable sub-problems. Runco (2007) recommended that problem finding be included in school curriculum, arguing that problem discovery is an important skill. CPS as a creative process includes this stage for problem solving, as we've seen in the program when the students spent several sessions understanding the problem, exploring different perspectives of the flood problem including positive aspects of the flood that might contradict their original thinking (Activity 1.6). In exploring the flood problem, the children found many related problems. The big and complex problem of floods in Jakarta was broken down into 5 categories, one of these categories which were further broken down by the children to 17 sub-problems, which culminated in Activity 3.3 when they decided that the problem they could attempt to tackle was '*How to eliminate traps on the roads in Jakarta*?'.

This CPS program has given experience to the children that they are able to contribute great ideas by breaking a complex problem of solving flood problems in Jakarta into a sub-problem that they are comfortable enough and motivated to work on. By doing this, children can be more encouraged to contribute their ideas for real life problems in their surroundings as well as other problems that might seem too complex for children but made more possible through the CPS process.

5.4.2 Applied Imagination

Creativity is more than just imagination – it needs to be coupled with intent and effort. However, it is unarguable that creativity requires imagination. Imagination, the ability to visualize, foresee, and to generate ideas, is what makes the human brain unique.

Although many educators believe that our changed environment should call for more training in creativity, our educational programs have tended to stifle imagination (Osborn, 2001). Osborn (2001) wrote that our thinking mind is mainly two fold: (1) a judicial mind which analyzes, compares and chooses; (2) a creative mind which visualizes, foresees, and generate ideas. Both judicial and creative efforts are alike in that both call for analysis and synthesis. The research conducted by Dr. E. Paul Torrance has confirmed the fact that imagination tends to contract as knowledge and judgment expand (cited in Osborn, 2001; p.40). Thus, we argue that imagination needs deliberate sustenance and nurturing in schools. If one of the goals of education is to create leaders with visions and ideas, the development of imagination skills should receive more attention, and deliberately planned into the curriculum. The implementation of a CPS program at schools is a step toward implementing applied imagination which develops creative thinking.

The use of imagination in problem solving was a deliberate intention of this CPS program. There were many exercises of applied imagination woven throughout the program. When the children diverged for ideas, they were instructed to delay judgment, which created a safe environment for wild ideas in their imagination. During the stage of generating ideas, the teacher introduced several techniques that required imagination from the children. In Activity 5.3, the children used Forced Connection technique to stretch their imagination to find ideas. The same exercise happened in Activity 5.4, (Analogy) where, for example, children imagined the cable as a worm, and again in Activity 6.1, where the children applied visual connections from toys or other interesting objects to the problem. In activity 2.3, the children practiced vicarious imagination where they put themselves into other people's perspective (e.g. one student imagined herself as a mother who had to save her baby (see Appendix 5; figure 2.3). The ability of putting ourselves in other people's perspective is a very important skill for solving problems. The creation of the Monster Truck

Vehicle (a combination of the ideas of an aeroplane and monster truck) was yet another outcome of the children's imagination

What is pertinent to point out here is that deliberate efforts were made to design processes to trigger the children's imagination in different ways. Not only were children applying their imagination during divergent thinking phases, they were also encouraged to apply their imagination during convergent phases – to imagine a future without floods in Jakarta, and what the new solutions could be.

6. Conclusion

CPS proved to be an effective means to facilitate collaboration among children to find ideas and reach decisions. The process also empowered children to push their imaginative and critical thinking as teachers acted as facilitator of the process. The children had different levels of enjoyment at different parts of the process, which affected their motivation individually but benefited the group as a whole as the diversity of individual strengths and preferences enabled the group to successfully navigate the entire CPS process. Citing theory and research, Treffinger and Isaksen (2005) asserted the following:

1. Creative potentials exist among all people.
2. Creativity can be expressed among all people in an extremely broad array of areas or subjects, perhaps in a nearly infinite number of ways.
3. Creativity is usually approached or manifested according to the interests, preferences, or styles of individuals.
4. People can function creatively, while being productive to different levels or degrees of accomplishment or significance. (p.343)

The CPS program described in this paper confirms the aforementioned assertions. As Treffinger and Isaksen (2005) suggested: Through personal assessment and deliberate intervention, in the form of training or instruction, individuals can make better use of their creative styles, enhance their level of creative accomplishment, and thus realize more fully their creative potential (p.343). Similar programs in the future should give children time to reflect on themselves in how they are creative and to really master the CPS process in order to be in control of it or parts of it as required by problem solving situations. Lastly, Treffinger and Isaksen (2005) suggested that school curriculum contents can be made more challenging and stimulating by providing instructions for CPS tools to students to facilitate complex learning and problem solving and to extend student thinking to higher levels. This may be especially true in the Indonesian context, where the more commonly use of didactic teaching methods can be balanced out by the employment of whole or parts of programs such as CPS. Furthermore, CPS invokes the deployment of one's imagination which is sorely lacking in formal education. The results of the program is proof that CPS can be taught to children in the Indonesian context and this should be encouraging for the further and wider efforts in digging into children's higher levels of thinking and their imagination.

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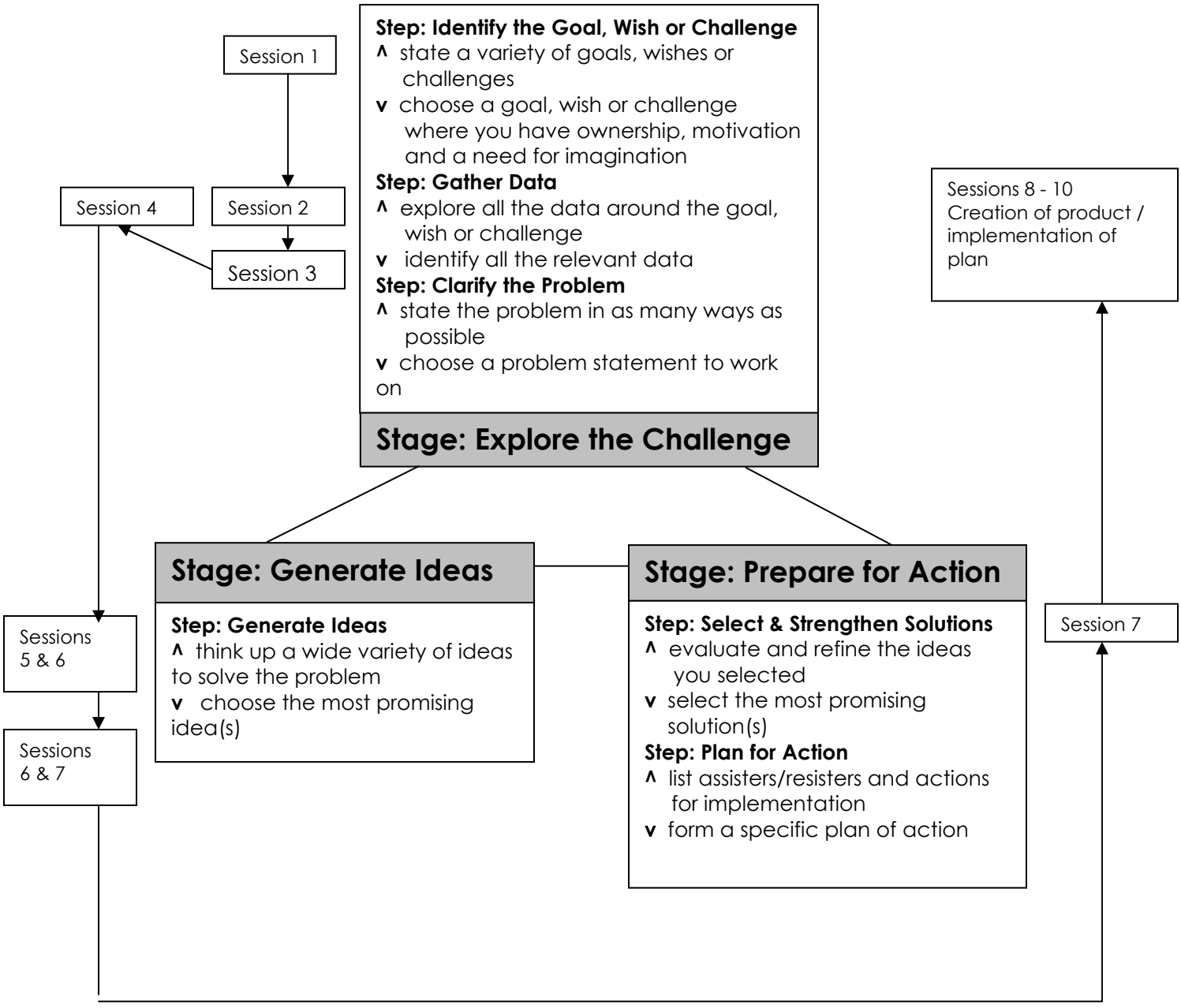
APPENDIX 1 : **An Overview of Creative Problem Solving (CPS) and the Time Plan of the Program**

Adapted from Miller, B., Vehar, J. & Firestien, R. (2001). *Facilitation: a door to creative leadership.* (3rd ed.). NY: Innovation Resources.



^ diverge = **generate** variety of problem statements / ideas / actions
v converge = **evaluate and select** from the variety of problem statements / ideas / actions generated

APPENDIX 2 : Divergent and Convergent Thinking Rules

Divergent thinking rules

1. **Defer judgment:** Allow ideas to flow. Do don't judge ideas yet – ideas will be judged later.
2. **Go for quantity:** Push your thinking to get as many ideas as possible. The ideas we immediately think of are ideas we already know so think beyond the ideas that immediately come to mind.
3. **Build on others' ideas:** Be inspired by others' ideas and use them as building blocks for further ideas. If thinking up ideas alone, take your own ideas and add to them or modify them to see where you end up.
4. **Unusual ideas are ok**: Wild ideas can be tamed. If you come up with an unusual idea, that's ok. Unusual ideas often contain essences that can be extracted that provide good solutions.

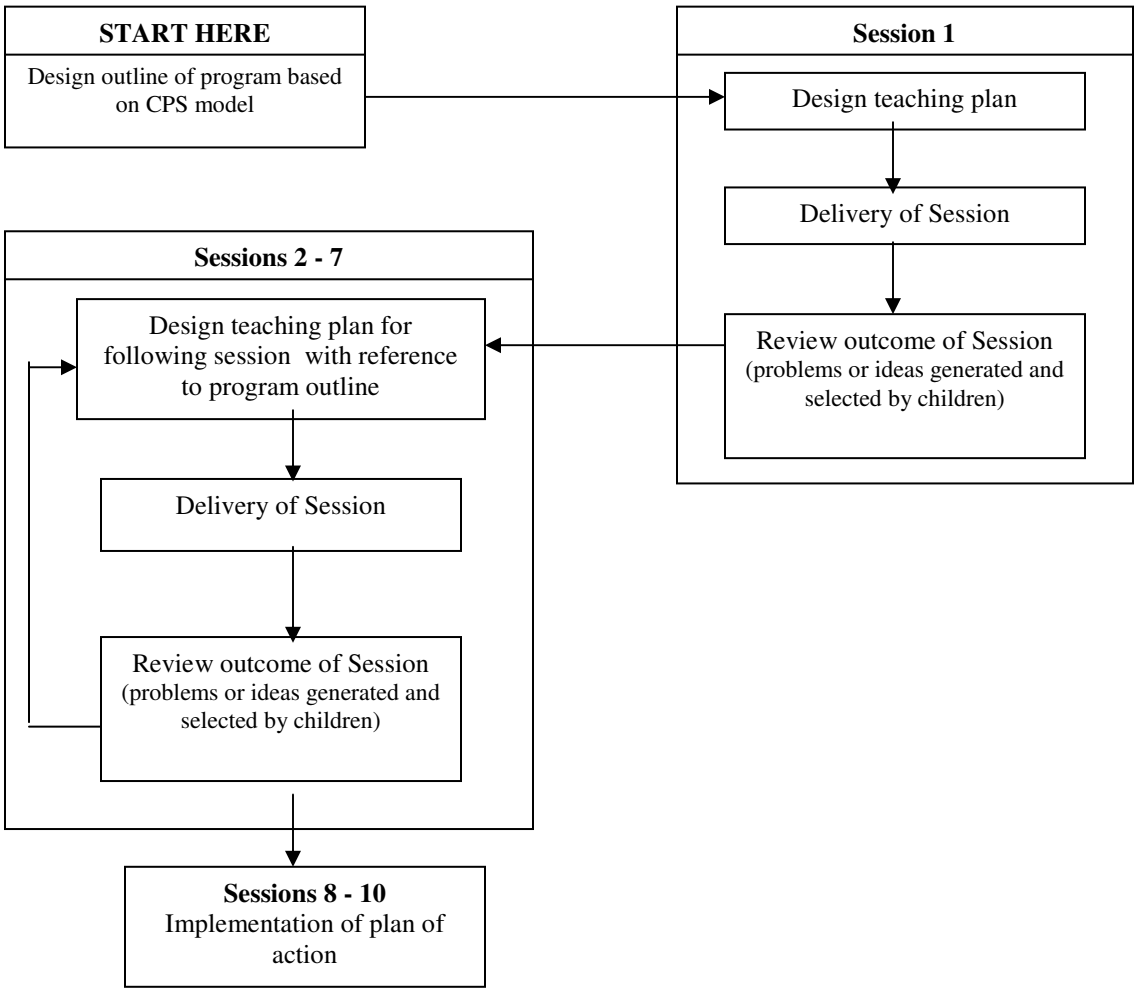
Rules for Convergent Thinking

1. **Be affirmative**: be positive about the idea.
2. **Be deliberate**: think through the idea before saying no.
3. **Check your objectives**: check back to your original objective.
4. **Improve ideas**: remember that ideas still need to be refined.
5. **Consider novelty**: be brave with new ideas.

Reference:

Miller, B., Vehar, J. & Firestien, R. (2001). *Creativity unbound: an introduction to creative process.*. (3rd ed.). NY: Innovation Resources.

APPENDIX 3 : Design Process of the CPS Program



APPENDIX 4 : Details of CPS Program and Teaching Activities

Each session description will start with a table giving the CPS stage and step, and the phase of thinking covered in the session. All activities are ***group activities*** unless otherwise indicated.

Session 1			
CPS Stage	**CPS Step**	**Phase of Thinking**	
Explore the Challenge	Identify the Goal, Wish or Challenge	state a variety of goals, wishes or challenges	Divergent
		choose a goal, wish or challenge where you have ownership, motivation and a need for imagination	Convergent

Phase of Thinking: state a variety of goals, wishes or challenges (divergent thinking)

Activity 1.1 : Discussion with children on how floods in Jakarta impacted them and their observations of the happenings during the floods.

Activity 1.2 : Children interviewed flood victims (flood victims invited to the session).

Activity 1.3 (Individual activity) : Children observed images of floods in Jakarta prepared by teachers (images from newspapers, magazines etc). After their observations, children drew pictures of what have intrigued them so far (including from Activities 1.1 and 1.2). Children then elaborated on their drawings by referring to the images provided.

Activity 1.4 : Discussion with children on causes of flood and whether they thought the floods could have been prevented.

Activity 1.5 : Children presented their pictures from Activity 1.3.

Activity 1.6 : Discussion with children on whether they thought anything positive could have been gained from the floods.

Phase of Thinking: choose a goal, wish or challenge where you have ownership, motivation and a need for imagination (converge)

Activity 1.7 : Children were asked what intrigued them most about the floods and what happened afterwards. The responses were grouped and given big headings. (Technique: Hit, Cluster, Restatement). Children then ranked the problems from the problem they were most interested in to the problem they were least interested in. (Technique: Card Sort)

Activity 1.8 : The children were asked how they could find out more about the problem they were interested in (Technique: Brainstorming) and were assigned to gather information about the problem for the following session at home.

Session 2			
CPS Stage	**CPS Step**	**Phase of Thinking**	
Explore the Challenge	Gather Data (1)	explore all the data around the goal, wish or challenge	Divergent

Phase of Thinking: explore all the data around the goal, wish or challenge floods and the problems they cause to people affected (diverge)

Process Recap: Recap with students on which stage and step they were in CPS. Students were then told by the teacher the aim of the session which was to find out more about the problem they had decided to work on from the previous session. Children were asked if they remembered what the chosen problem was. (*How to move around in floods?)*

Activity 2.1: A big bucket of soil water was placed in the classroom. The water contained stones, twigs and trash to emulate flood water in the city. Students were asked to put their feet inside and try to walk in it. The aim was to help the children experience what it would be like to be inside flood water.

Activity 2.2: A talk was given by a flood victim followed by a Q&A session.

Activity 2.3 (Individual activity) : Students were each given a picture of a person or a group of people (e.g President of Indonesia, aid workers, drivers, mothers etc) and asked to imagine that they were the person in the picture. Students were then asked: If they were to move around during flood in Jakarta, why would they be moving around? Where would they be moving to? What will they be moving with them? Who else will they need to move with them? How? Students shared their responses by role playing their character.

Activity 2.4 : Using the scenarios enacted by students in Activity 2.3, a discussion was held with students with the following questions guiding the discussion:

- What obstacles or difficulties are there in moving around during floods?
- What can be useful in helping people and things move around during floods?

Teacher wrote down students' responses on pieces of paper and posted them on big sheets of flip chart paper.

Session 3			
CPS Stage	**CPS Step**	**Phase of Thinking**	
Explore the Challenge	Gather Data (1)	identify all the relevant data	Convergent
	Clarify the Problem	state the problem in as many ways as possible	Divergent
		choose a problem statement to work on	Convergent

Process Recap: Recap with students on which stage and step they were in CPS. Students were told the session would entail deciding on the important pieces of information gathered from the previous session about moving around during flood times. Students were briefed on the aim of the session, which was to break their chosen problem of *How to move around in floods?* into smaller problems so they could start finding solutions to the problem of 'moving around in floods'. The students were asked if they remembered what they did in the previous session as a warm up.

Phase of Thinking: identify all the relevant data (Convergent)

Activity 3.1 : With teachers' help, students evaluated and chose the data (generated in Activity 2.4) that were relevant to the problem of *How to move around in floods?*

Phase of Thinking: state the problem in as many ways as possible (Divergent)

Activity 3.2 : Students turned the selected data from Activity 3.1 regarding obstacles and useful things into clusters and labeled each cluster with big headings. (Techniques: Hit, Cluster, Restatement). Based on the cluster headings, the students turned the headings into problem statements.

Phase of Thinking: choose a problem statement to work on (Convergent)

Activity 3.3 : The students were reminded of the rules for convergent thinking. The problem statements generated from Activity 3.2 were sorted according to the students' preference and motivation, from the sub-problem they were most interested to work on to the sub-problem they were least interested to work on. (Technique: Card Sort).

Activity 3.4 : Assignment (individual activity):

The students were taught the divergent thinking techniques of Brainstorming, Brainwriting and Forced Connections. The Students were then asked to generate 15 ideas for the problem of *How to eliminate traps on the roads of Jakarta?* as homework.

Session 4			
CPS Stage	**CPS Step**	**Phase of Thinking**	
Explore the Challenge	Gather Data (2)	explore all the data around the goal, wish or challenge	Divergent
		identify all the relevant data	Convergent

Process Recap : Recap with students on which stage and step they were in CPS. They had broken down the big problem or original challenge of *How to move around in floods?* into 17 sub-problems; one of which, *How to eliminate traps on the roads of Jakarta?*, they had chosen to bring forward into the next step in the CPS process. The students were told that the aim of the session was to generate ideas for their selected problem. However, before students could move forward to generate ideas, they were told they would have to move back in the CPS process in order to gather data for their selected problem of *How to eliminate traps on the roads of Jakarta?* – they needed to find out more about the 'traps' found on a typical Jakarta road.

Phase of Thinking: explore all the data around the goal, wish or challenge - the traps found in floods when moving around (diverge)

Activity 4.1 (Individual activity): Students were asked to stick the picture they had used for their homework (Activity 3.4) on the wall of the classroom and write the ideas they had generated based on the picture (Technique: Forced Connections) on strips of paper. Each student was asked to randomly select one of the ideas posted and try to guess which picture inspired it. Students then took turns to share their guess and reasons for their guess.

Activity 4.2 : Students were taken outside on to the road to observe for 'traps'. The students were split into 2 groups and each group was tasked to intensively observe one small area. Their observations were written down.

Phase of Thinking: identify all the relevant data - the traps found in floods when moving around (converge)

Activity 4.3 : The students were asked to create a clay model of the road they observed with all the traps they had observed.

Sessions 5 & 6			
CPS Stage	**CPS Step**	**Phase of Thinking**	
Generate Ideas	**Generate Ideas**	**think up a wide variety of ideas to solve the problem**	Divergent
		choose the most promising idea	Convergent

Session 5 →Process Recap:
Recap with students on which stage and step they were in CPS. They had just finished doing data gathering for their selected problem of *How to eliminate traps on the roads of Jakarta?* The aim of the session was to generate ideas for solving the problem now the problem was better understood.
Phase of Thinking: think up a wide variety of ideas to solve the problem I (diverge)
Activity 5.1 (Individual activity) : Students were asked to write on a piece of paper the traps they remember from the clay model created in the previous session. They were then asked to substitute the traps they found into the following problem statement: *How to eliminate (trap)?*
Activity 5.2 : To warm up for idea generation, students Brainstormed on a 'fun' but unrelated problem. Students were reminded of the divergent thinking rules.
Activity 5.3 : Starting with one trap or problem statement, students generated ideas to eliminate the electric cables as a trap by the techniques of Brainwriting with Forced Connections.
Activity 5.4 : The students chose another problem or trap and generated ideas to eliminate electric cables as a trap by way of using analogy to find ideas.
Session 6
Activity 6.1 Part 1 Various interesting objects and toys were placed on each table in the classroom before the students arrived. When the students arrived, they were asked to play around with the toys and objects and to observe what was interesting about the objects. The students were asked to write down at least 5 observations on a piece of paper.
Process Recap: Recap with students on which stage and step they were in CPS. They had started to generate ideas for the problem of *How to eliminate traps on the roads of Jakarta?* by focusing on individual types of traps. The students were told the aim of the session was to continue to generate ideas for the problem with different idea generation techniques.
Activity 6.1 Part 2 A piece of flip chart paper with the different kinds of traps listed was posted on a wall. Students were asked to select a trap to work on. They were then asked to relate each observation they had made from Activity 6.1 Part 1 to a new idea of how the trap they have selected can be eliminated**.**
Phase of Thinking: choose the most promising idea I (converge)
Activity 6.2 : Students were asked to post their ideas up on a wall in the classroom. They were given
small round stickers and asked to select ideas generated in Session 5 and Activity 6.1 that they liked and ideas that intrigued them by sticking their stickers on their chosen ideas. (Technique: Hit)
Phase of Thinking: think up a wide variety of ideas to solve the problem II (diverge)
Activity 6.3 : Students were asked to each pick one of the remaining traps that had not yet had ideas generated for their elimination. Students took turns to act out being trapped by the trap in floods, and were instructed to scream during the enactment "Oh, I wish…" The viewing students were to complete on a piece of paper "Oh, I wish…" by filling in what it is they would wish for in that situation. (Activity 6.3 seemed to have inspired the students to think of how to avoid the traps rather then how to eliminate the traps – which led to ideas like the Monster Truck Aeroplane)
Phase of Thinking: choose the most promising idea II (converge)
Activity 6.4 : The ideas generated in Activity 6.3 were posted on a classroom wall and students were asked to select the ideas that they liked or intrigued them by sticking small round stickers on their chosen ideas. (Technique: Hit)
Outcome of session: A selection of ideas to eliminate the different types of traps found in Jakarta roads.

Session 7			
CPS Stage	**CPS Step**	**Phase of Thinking**	
Generate Ideas	Generate Ideas	choose the most promising idea	Convergent
Prepare for Action	Select & Strengthen Solutions	evaluate and refine the ideas you selected	Divergent
		select the most promising solution(s)	Convergent
	Plan for Action	list assisters/resisters and actions	Divergent

		for implementation	
		form a specific plan of action	Convergent

Process Recap: Recap with students on which stage and step they were in CPS. They had chosen some ideas they had generated for elimination of various traps found on Jakarta roads. The aim of the session was to evaluate the chosen ideas further so a plan could be made based on the ideas.

Phase of Thinking: choose the most promising idea II (converge)

Activity 7.1: The students clustered the ideas they had chosen from session 6. The students were then asked to read one cluster of ideas and share why they thought the ideas belong as a cluster. They were then asked to think of an action word related to the cluster and create a statement starting with the phase: What we see ourselves doing is…(action word). This was repeat for all the clusters until all the clusters had action statements that read *What we see ourselves doing is.*...From the many action statements generated, the students were asked which action or actions they wanted to take to solve the problem of *How to eliminate traps on the roads of Jakarta?*

Phase of Thinking: evaluate and refine the ideas you selected (diverge)

Activity 7.2 : A discussion was held on the students' decision from Activity 7.1. Specifically, the students were asked about the challenges they might encounter and their concerns and how they might overcome them. These were noted and listed down by the teacher.

Phase of Thinking: select the most promising solution(s) (converge)

Activity 7.3 : Based on the discussion held in Activity 7.2, students were asked to make a final decision regarding which action or actions they wanted to take.

Phase of Thinking: list assisters/resisters and actions for implementation (diverge)

Activity 7.4 : Based on their final decision from Activity 7.3, students discussed what might help or obstruct the actions they intended to take. These were noted and listed down by the teacher.

Phase of Thinking: form a specific plan of action (converge)

Activity 7.5 : Students wrote on small pieces of paper all the possible things they might need to do in order to carry out the actions they had decided upon. They were then asked to arrange the different action steps into a logical order and to assign the tasks among them.

Sessions 8 – 11	Creation and Implementation of plan of action

Abandoning the Idea of Creating an Information Booklet

After taking the beginning steps of creating an information booklet, the group working on this task asked the teacher for permission to join the group designing the vehicle to help lift people out of floods.

Design and Build a Model of a Vehicle to Help Lift People Out of Floods

Activity 8.1 (individual activity) : The students were asked to generate ideas for the characteristics or parts the vehicle might have. The students then decided on the parts they wanted to include in their design. Each student was assigned to design one aspect of the vehicle. After designing the assigned part, each student was asked to evaluate their own design using the tool PPCO. They were first to list the pluses of their design, then the concerns they have about their design and how they might overcome their concerns. The students were asked to incorporate their improvement ideas in their design. After reviewing each others' parts, the students named their vehicle Monster Truck Aeroplane or MTA for short.

Activity 8.2 : The students collaborated on a drawn design of the MTA.

Activity 8.3 : The students used art and junk materials to build a model based on their agreed design.

Letter to Local Governor : The teacher wrote a letter of proposal to the Governor of Jakarta on the outcome of the CPS process. This was read and signed by the students and sent to the local government.

APPENDIX 5 : Details of Results

The results presented in this section are representative of the thinking and collaboration that a process such as CPS can draw out from a group.

Session 1

Activity 1.1 : Each child shared how the flood had impacted their family and friends. As we can see from the following extract of the discussion that took place, the experiences of the children were varied and had affected the children in different ways, thus resulting in a variety of foci of the impact of the floods.

Kim: We had black outs for so long that we could not sleep.

Jason: My family had to move things up so they wouldn't get wet when the flood got into our house.

Matthew: I couldn't go to many places because of the flood.

Activity 1.2 : One teacher happened to be a victim of the flood. His house and the neighborhood were heavily flooded, and he was completely shut out from the outside world for several days without electricity, telephone connection, and money because the ATM machine was also damaged by the floods. As the teacher shared his experience, the children tried to put their perspective in their teacher's experience and asked questions like, "Where would you sleep then?", "How did you come to the studio?"

Activity 1.3 : After the children had gathered background knowledge on the flood from discussions, interview, and visuals, they were asked to draw pictures on what intrigued them most about the floods. The pictures that the children drew show that each of them had a different perspective on what intrigued them most and they were able to represent their thinking into their drawings. For example: Matthew understood the relationship between height of a location and the severity of the impact from the floods – floods impacted locations at lower elevations. Jason took a very different perspective by drawing a situation where the supermarket was closed because all goods were sold out.

Activity 1.4-1.5 : When the children were asked by the teacher, "What causes floods?", the children came up with many causes, at times, confounding cause and effect. Some of the explanations for the floods included heavy rain, people throwing rubbish, people cutting down trees and traffic jams. When the children were asked to clarify how traffic jams could cause floods, the children reflected and responded that it should be the other way around – that it was the floods that caused traffic jams.

Activity 1.6 : In answer to the teacher's question of what might be positive outcomes of the flood, the children took to the question as a matter of course without hesitation. They were able to look at the problem in another way. Their responses included: many people were willing to help one another, the playground became more fun, the children had fun playing toy boats in the flood water, free swimming opportunities. The children were found to enjoy the discussion.

Activity 1.7 : The children were asked what interested them most about the flood. They came up with many answers. With teachers' help in extracting from the above discussion the aspects that interested the children, the children categorized the ideas and grouped them into 5 categories. The categories were given headings in the form of problem statements. The students then voted by hitting (selecting) the category that they were most interested in.

The 5 categories were:

1. How to prevent people getting hurt during flood?
2. How to reduce litter?
3. How to deal with trash after the flood?
4. How to do activities without electricity?
5. How to move around in floods?

Outcome of Session 1: The problem 'How to move around in floods?' received the most votes. The students were asked to gather information for the problem they wanted to work on, anything related to flood and move around. The teacher gave several suggestions on where to look for information.

Session 2

Activity 2.1 : Most children were curious what it was like to put their feet inside the bucket that contained dirty water with stones, twigs and trash – most probably because they had never experienced it before. As we can see, the children were rather descriptive of the experience.

Patrick: I felt cold, icy, rough, fun, sandy, soily.

Jason: I felt cold, wet, dirty, soil, fun, trash, and yucky

Activity 2.2 : The teacher shared a story of her friend, Adi, who had to move around during the floods which put him in a misery because his baby was just 3-days old, and his wife was not feeling very well after delivering a baby. The children asked how Adi saved his baby and his wife when the water level was up to Adi's chest. They were also intrigued in how Adi could bring his baby to safety, as there were no boats. The children were inspired by the story and some of them shared other stories of their friends' families who also had problems moving around during the floods.

Activity 2.3 : To explore the problem of *How to move around in a flood?*, the children were given images of different people and asked to imagine themselves being the person in the image they were given. Some of the roles included the president's bodyguard, a woman who tried to save her baby, an aid worker who had to distribute food to the victim. To guide the children's thinking, each child was asked to answer five questions. We will look at how one student, Tiffany (age 10), imagined her role as a mother who needed to save her baby (figure 2.3). By going through these questions with reference to different people, the children found out the diverse range of difficulties faced by people in different situations and backgrounds.

1. Why do you need to move around?
   - To save baby, to get enough food, to find a better shelter, to find transportation, to find clothing, to get out of the danger
2. What do you need to move around?
   - People, farm animals, transportation, food, clothing, energy
3. Who will be moving around with you?
   - Family, pets, farm animals, neighbor, friends, cousin
4. Where will you move to?
   - A save place, a hospital, hotels, to family's house, tall building, high place, factory.
5. How will you move around?
   - By helicopter, rubber boat, walking, swimming, truck, barrels.

Activity 2.4 : For the brainstorming session, the teacher had set an idea quota for the group of children. That is, as a group, the children had to generate a minimum of 30 ideas. The children were fluent in coming up with ideas and reached the quota set by the teacher. During the process, the teacher constantly reminded the students to suspend judgment on their own and their peers' ideas. From the students' answers, we find spontaneous and unexpected ideas that might not be regarded as realistic. What was more important for this activity was to warm children up in the practice of suspending judgment for the upcoming idea generation activities required for the problem solving process. In this regard, the activity was successful in that the children learned to suspend judgment, and it worked in keeping the children's ideas flowing.

Outcome of Session 2 : The students explored the problem of 'How to move around during a flood? from different point of views. Through the process, they acquired and demonstrated understanding of the problem. It is worth pointing out that the teacher had a big role in guiding the children step by step through the thinking process. Given appropriate stimulation during the process, the children were able to dig deeper into the problem.

Session 3

Activity 3.1 & 3.2 : The children systematically went through the ideas generated in Activity 2.4 and clustered or grouped them with the mandate to 'group ideas that belong together'. There was no one right way to do this and the children had to think hard for how to group the vast array of ideas. The next step was to give headings to the groups of ideas which were then turned into problem statements. The children were given examples on how to turn a heading into a question and were provided with the following question statement starters as a guide: How to …..? How might we …..? In what ways might we ….? For example:

Group of ideas with heading:	Turned into the problem statement:
invent a new thing	How to invent a new thing that is helpful in flood?
get trash away	How to get trash away?
use simple machine	How to use simple machine to help us in the flood?

From the 17 groups of ideas, resulted 17 questions or sub-problems of the problem under exploration (How to move around during a flood?). The 17 problems were:

1. How to make sure there are no traps on the road ?
2. How to use water transportation to get us around?
3. How to access toll land transportation?
4. How to protect ourselves?
5. How to use simple machine?
6. How to find floating things?
7. How to move to dry places?
8. How might we prepare what we need?
9. How to keep things in a safe place?
10. How to get trash away?
11. How to get things that float?
12. How to watch out for danger?
13. How to get rid of the water?
14. How to move to high places?
15. How to access flying transportation?
16. How can we access animals that can help us?
17. How to call the emergency services?

Activity 3.3

The teacher guided the children to sort the 17 sub-problems from their most favorite to the least favorite problem to solve using the technique 'Card Sort'. The top 3 ranking problems were:

1. How to make sure there are no traps on the roads?
2. How to use water transportation to get us around?
3. How to access tall land transportation?

Outcome of Session 3: The children had broken down the original challenge of 'How to move around during floods?' into 17 sub-problems and they had converged on 3 of these problems as problems they were interested to solve. The children were allowed to form groups to work on one of the 3 problems. All children wanted to work on the first problem 'How to make sure there are no traps on the road?'

Figure 4.2.1 The traps observed by the children

Exposed pipes
Broken steps
Slopes leading down driveways
Broken pieces of concrete
Loose bricks
Prickly plants
Trees
Potholes
Loose rocks & stones
Drains between houses
Uneven road surface
Plants & weeds
Sign posts
Hedges
Rivers
Electric cables
Broken bridge
Slippery slope/mud by river
Stairs
Trash
Concrete

Session 4

Activity 4.2: The students worked in small groups to observe for possible traps in the streets that might trap people during a flood when they move around. Figure 4.2.1 shows the results of the observations.

Activity 4.3 : The children were excited at the opportunity to work with clay. However, to begin the clay model project, they needed to formulate a plan in how to work as a group to create one model of the surroundings with all the traps observed. Students were paired to work on different parts of the clay model and the allocation was based on children's preferences. The children were mainly able to work independently to complete their parts although from time to time, the teachers had to remind them to work according to the plan. Some children needed the teacher's help to review the plan and think through to transfer the idea in the drawing into the clay model.

Outcome of Session 4: The children created a representative clay model of a typical Jakarta road with 'traps' according to their observations. This acted as a visual reminder when they need to generate ideas for the following activities in the problem solving process.

Session 5: Generate Ideas

Activity 5.3 →Technique: Brainwriting with Forced Connection

This is a silent way of diverging or idea finding. When the children needed inspiration, they would use a picture to see inspiration. The children seemed comfortable with the technique and were able to come up with 101 ideas for the problem of *How to eliminate electric cables as traps found in the road?* (or *How to make sure people are not trapped by electric cables during floods?*). From the ideas generated, it appears that the children thought through the problems and were able to suspend judgment. They had unusual ideas such as; allow my pet to eat the cable, use a lion to cut the electric cable, use a volcano to burn the electric cables, use balloons so we are floating, ship it to Nepal, we surf, etc.

Activity 5.4 →Technique: Analogy

The teacher used analogy as a technique to push the children to think up more ideas for the problem of *How to make sure people are not trapped by electric cables during floods?*. Due to their physical resemblance, the cable was imagined as a worm. To get going, the children discussed what they knew about worms, such as their shape, and related this observation back to the original problem. An example is when one student came up with the observation that worms, like snakes, can be poisonous. When the teacher challenged this line of thinking on how the poison could help to make sure people are not trapped by electric cables during floods, Jason said that the poison is akin to the electricity of the cable, and cutting off the electricity would mean the cable cannot electrocute people. It was also obvious during the conversation that children's personal interests influenced the ideas generated. Matthew, who likes science, thought of the ideas of *less gravity*. Again, the teacher related it back to how *less gravity* could solve the problem of eliminating traps in the roads of Jakarta. The students came up with an idea that with less gravity, the cable can float so that it could not electrocute people. The children also tried to be flexible and moved to different categories of ideas. After they talked about the idea of *less gravity*, their conversation moved to a different topic - using vehicles so people don't have to step on the cables which inspired ideas such as using vehicles with big wheels, surfing, or making a bridge. The discussion was dynamic, resulting in many ideas.

Outcome of Session 5: The students generated ideas for the problem statement of How to eliminate electric cables as traps during floods?, and generated lots of ideas using brain writing and analogy techniques. They have also chosen answers that they liked in each technique.

Session 6: think up a wide variety of ideas to solve problem

Activity 6.1 →Technique: Visual Connection

Various interesting objects and toys were placed on each table in the classroom. The students were asked to pick an object, play around with the toy or object and make an observation on what was interesting about the object. The students were then asked to write down at least 5 observations, and from these observations, were to generate new ideas of how traps in roads can be eliminated. After generating ideas, the students were asked to select the ideas they liked.

Activity 6.2: From the myriad of ideas generated, the children had to choose their 5 most favorite ideas to solve the problem of eliminating traps (electric cables) on the roads of Jakarta. The technique Hit was used for the children to make their selections.

Activity 6.3 & 6.4 →Technique: Role Play

Role play was fun for the children but at the same time challenging, because the children were still reticent to act in front of their friends. They were asked to choose a trap, and act out how the trap could become a problem if they were to move around during a flood. For example, Tiffany's selected trap was a river, she acted out her legs being stuck in it during a flood. Bennett's chosen trap was a sign post, he acted that he had bumped into it and fell down in the flood water. Inspired by these enactments, the children who were the audience had to complete the statement 'I wish…' When all the children had had their turn, they were asked to post their ideas up on a wall in the classroom and given small round stickers to select the ideas that they liked or the ideas that intrigued them most. (Technique: Hit).

Outcome of Session 6 : The children derived various ideas from several techniques of divergent thinking and they had chosen ideas that they liked to work on using several techniques of convergent thinking. The children not only got the ideas for the problem they worked on but they also learned the process of how to use each technique that was introduced to the process.

Session 7: Select & Strengthen Solutions

Activity 7.1 : Now the children had a collection of selected ideas from variety of techniques that they had gone through. The next task for them was to cluster the ideas. The teacher guided the children with some specific instructions in this activity as compared to previous clustering activities because of the sheer volume of ideas. The children were instructed to take one idea, and then to find if there were any other ideas that could go to the same cluster. Ideas that could not be grouped to existing clusters were used to form new categories. An ability to highlight the essence of the ideas was very important in this activity. The process was intense and the children thought hard, especially when clusters of ideas had to be reconfigured. When all the clusters were formed (15 in total), the children had to make an action statement for each group of ideas with the beginning phrase "What we see our self doing is ……. (action word)". Below are action statements generated by the children :

What we see ourselves doing is……..

1. Use flying transportation. 2. Use animals that can help. 3. Use human to help. 4. Cover the cables with things that do not pass on electricity. 5. Ruin the cables so they could not hurt us. 6. Calling for help. 7. Get rid of the (pot)holes. 8. Fix the broken bridge.	9. Help ourselves and others. 10. Tell people not to throw rubbish in the river. 11. Making information guide 12. Design and make model 13. Arrange transportation that can lift us out of the water 14. Get rid of sign posts 15. Put a fence on the electric cables

Plan for Action: Activity 7.2, 7.3, 7.4 & 7.5

From a group discussion based on the various clusters of action statements, the group of children led by the teacher decided that there were various options to act on, things that the children could possibly do:

1. Urge the local government to take action on the following:
    a. Fix exposed electric cables so they can't hurt people.
    b. Ensure there are reliable emergency services people can call for help.
    c. Replace current signposts with sign posts that are soft or can bend so when people crash into them they do not pose a danger.
    d. Fix the potholes in the roads.
    e. Safeguard people from electric cables either by fencing them off or covering the cables with materials that do not conduct electricity.
    f. Fix the broken bridge.
    g. Make an information guide for people on how to keep safe during floods.
    h. Start an education campaign to tell people not to throw rubbish into the river.
2. Help themselves and others in need during floods.
3. Make use of animals as guides when people move around during floods.
4. Design and make a model of a machine that can help people move around or lift people to safety from the floods.

Given that so many useful ideas have been generated that would unlikely be taken further in actions steps by the children, the teacher suggested that the children should send some of the ideas in the form of a proposal to the Governor of Jakarta, with a copy sent to the President of Indonesia. The government might have the money and resources and expertise to really make use of the children's ideas. In terms of concrete action, the teacher helped the children to formulate the above into possible actions that they could immediately act upon:

1. To start an educational campaign to encourage people not to throw rubbish in the river.
2. To make an information booklet on how people can help themselves during a flood.
3. To design and make a model of a vehicle that can lift people out of the water.

Given the time constraints, the teacher offered to prepare the proposal to be sent to the Governor. The children were left with three choices and on the outset, all were interested in designing and making a model of a vehicle that can lift people out of water. The teacher encouraged the children to consider the other action steps too, and in the end, three children (Tiffany, Patrick, and Matthew) responded to the teacher's encouragement and opted to create an information booklet on how people can help themselves during a flood. They decided to make an information booklet to guide people what to do during flood. Dea, Jason, Sam, Ruth, Bennett, and Benita were in the group that was to work on a transportation model to lift people during flood. Only a brief discussion on the anticipated obstacles of the chosen action steps took place as the convergent thinking process during this session was long and hard work and the children were tired by this time. The teacher asked the children the actions they needed to take and led them to formulate an action plan.

Outcome of Session 7 : The children divided into 2 groups to work on 2 tasks: 1) make an informational booklet on how people can help themselves during flood. 2) make a transportation model to lift people during flood.

Session 8-10: Take action

Creation of an Informational Booklet on How People Can Help Themselves

As this group of children proceeded to work on the task, they were distracted by the other group of children who were designing and building a model of a vehicle. This resulted in the older child Tiffany (age 10) who was constantly found to remind the younger children Patrick (age 7) and Matthew (age 8) to focus on their task. In the end, the experience was so frustrating for all three children that they asked for permission to join the group designing the vehicle and were given permission to do so.

Design and Build a Model of a Vehicle to Help Lift People Out of Floods.

The Concept of the Vehicle : The children began to conceptualize the vehicle by diverging on ideas first for machines that would lift people so they would not be trapped during a flood. Some ideas that the children conceived were: aeroplane, tractor, spaceship, jeep, and monster truck. Monster truck and aeroplane received the most votes, so the children decided to combine the two ideas – to design and build a model of a monster truck that could fly. The children called it Monster Truck Aeroplane or MTA for short.

Activity 8.1 : How would the children design the MTA? The teacher asked what the MTA should have so the MTA could function well. The teacher reminded that the purpose of the MTA was to put people from danger during the flood. The children were excited and every child wanted to draw at the same time. Then the teacher had an idea to solve this by assigning each child to be in charge of certain part of the MTA. The children talked about what functions the machine should have. They then went on to explore what kind of things would need to be lifted from a flood. The ideas they came up with included, among other ideas, food, drink, coca-cola, tools, garage, vacuum cleaner, people. Following this, the children considered the parts that the MTA should have. After the group came to an agreement on the various parts the MTA should have, they were allocated one part of the MTA each to design, for example: Jason designed the stairs, Dea designed the windows, Samuel designed the engines. Before designing their assigned parts, the children discussed pertinent characteristics of the parts, for example, water should be prevented from reaching the engine, whether there are any other power sources to move the MTA?

After the first design of the parts of the MTA were completed, the teacher asked the children to evaluate their own work by way of PPCO as a tool. An example is as follows: Ruth, the engine designer, thought that the plus of her engine were that it could help people, it could fly, and it had a ladder. Her engine had potentials where it might be a great aeroplane, it might help all people, and it might carry heavy things. She thought of several concerns and also ways to overcome them: To overcome concern of how to make it fast, she would put an engine, to overcome how to make it stop, she would use a rubber band, and to overcome how to make it stronger, she would use bricks.

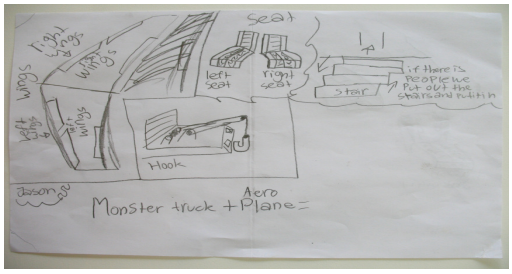


Figure 8.1: sample of individual part of MTA

Activity 8.2 & 8.3 : When synthesizing the designs of individual parts into the design of a whole MTA, much debates and discussions followed by voting or consensual agreement went on in deciding the final design of the MTA. The teacher tried to get the children to imagine the real situation, and brought the children to think of possible problems and how they could solve them. The teacher asked questions like : How many hooks are needed on the MTA to lift goods or people? On which side? How many people be loaded into the MTA? How do people get in? By stairs or by a suspended hook? Where is the opening? etc.

The child who designed a particular part of the MTA (the part expert) would propose an idea, and the teacher asked the group questions in order to challenge them to agree or share the concerns other members of the group might have. During the process, the teacher taught the principle of PPCO (Plus Potential Concern Overcome). Most of the children were very active in giving comments and suggestions, and raising concerns. For example:

- Jason, the door expert proposed that there should be 2 doors on each side of the MTA. Bennett had a concern that there would be human traffic jam with only 2 doors. However, other kids thought that 6 doors would be too many. The teacher commented that those who did not agree needed to give ideas that could alleviate the concern and give solutions. Tiffani arrived at a solution acceptable to the group by suggested the MTA could have just 2 doors on each side of the MTA but of wider width than a standard door.
- Tiffany raised the concern of how to prevent people falling off the open space. Bennett suggested a flap door that could swing open and close. Then Tiffany strengthened the idea by suggesting a transparent door. The children also discussed the mechanism of how the door could be opened and closed.
- Samuel was worried that there would not be enough space inside and he suggested to have reclining seats that could turn into beds. The teacher asked if everyone agreed to the idea, and everyone like it so they put this idea into the design.

Some children (Ruth and Bennita) were not very active in the early discussion. The teacher noticed and tried to involve them in the discussion by asking their opinion as one of the experts. Once they gained confidence, Ruth contributed important ideas and gave solutions to a problem raised by her team. She gave a solution on the stair design so that it did not block the view by having the stair outside on first floor and inside on second floor.

The design of the MTA was completed through collaborative work with many interactions such as this one. The final design of the MTA was a vehicle that could fly and float on water. The floating ability of the MTA is made possible by way of stabilizers or feet such as those of a helicopter. The MTA consists of two stories, whereby the top storey is for the people rescued from the floods and is used as a temporary hospital. The bottom storey is used for storage of medicine and supplies. The access to the top storey is by way of a staircase that leads from the two wide doors positioned at the front of the MTA. A winch is positioned at the back of the MTA that goes directly to the top storey to airlift injured victims who have been immobilized (see figure 8.2.1). Both the front and back of the MTA are made of windows to enable vision to search for victims. The final design was agreed upon by all children in the group and the model was a creation faithful to the original design. Because the children wanted to create a model that adhered to the design, the creation process also gave rise to many discussions and debates in the choice of materials and ways to realize the design into a model. The MTA model was finished in week 11. The children were very proud when they signed the proposal prepared for the Government of Jakarta.

The Outcome of Session 8 – 11 : The children had gone through a long process to finally arrive at an action plan where they decided to make a model on a transportation vehicle that could fly and lift people out of floods. The teacher decided to send a proposal containing the children's to the Governor as a recommendation to the government to take action. Maybe the ideas from the children can one day become reality and solve the problem of How to move around during floods?

APPENDIX 6 Meta-cognitive / Process Recap Tool

Floods in Jakarta
What can we do about it?

Such a big problem! How do we know where to start?
We can use Creative Problem Solving or CPS (easier to say!)

Week	CPS Stage		CPS Sub step	
	1	Explore the Challenge	1	Identify the Goal, Wish or Challenge
			2	Gather Data
			3	Clarify the Problem
	2	Generate Ideas	4	Generate Ideas
	3	Prepare for Action	5	Select & Strengthen Solutions
			6	Plan for Action

Too difficult to understand? You bet!
Might be easier this way…**CPS in a nutshell**

Completed 2007	What do we do now?
	First…decide on the problem.
	We need to decide which part of the flood problem we're really interested to work on.
	We need to find out more about the problem we're interested in.
	We need to decide what exactly the problem is or what the different parts of the problem we are dealing with.
	Now we have a problem to work on… **Second… think of ideas to solve the problem.**
	We need to find lots of ideas to solve the problem.
	Now we have brilliant ideas to solve the problem… **Last but not least…make a plan on what needs to be done.**
	We need to think about how to make our plan succeed.
	We need to list down all the things that need to be done.
	Take action

Bio

Kayee Man and Fendelina Suryadi founded Credo (Creative Education Indonesia Foundation) in Jakarta, Indonesia, which disseminates and teaches creativity education to educators.

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