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A comparison of problems at the grassroots level in India identified by adults and children: Implications for Design and Technology Education

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Abstract

The focus of Design and Technology (D&T) education (Wilson & Harris, 2004) has been on designing and making activities and in developing technological capabilities amongst students. Innovation is an important aspect of D&T that helps in creating new products and artefacts to overcome the limitations of existing ones. Problem solving and problem identification are inherent components of innovation and D&T education. This study aims to compare differences in problems identified by adults and children at the grassroots level in India. In particular, we ask what kind of differences are there in problems identified by adults and school students and what could be the reasons for the differences and its implications for design and technology education? The data of innovations was accessed from the website of the National Innovation Foundation (NIF), India. The innovators, both children and adults, had not received any design brief by an external agency and the range of problems identified by them were from diverse areas. We grouped the problem areas into a number of categories. Contrary to conventional wisdom and literature about children being more creative than adults, we found a greater diversity in the problems tackled by adults. More importantly there were qualitative differences in the kind of problems identified by adults and children. Interestingly a category of problems that children identified was related to human behaviour and students attempted to fix these behaviours through technology.

Key words

Innovation, Creativity, Problem identification, Design and Technology Education, Children, Adults

Motivation for the study

Innovation, has been recognized as the key driver of economic growth (Gallagher, 2012; Rosenberg, 2004) and there is a wealth of research about innovation and how it can be nurtured in individuals and organizations. However, an important question to ask is, what avenues are available for the citizens of a country to practice their capacity for innovation?

People do innovate in their everyday life, but are there also formal support systems whereby innovation is encouraged to take place? In the Indian context, other than industries, there are various design and technology (D&T) educational institutions that encourage students to work on innovative projects. Apart from D&T education at the tertiary level, there exist few opportunities for school students to exercise their creativity, such as science fairs and competitions. Design for Change (DFC) is another initiative that encourages children to identify local problems and provide solutions for them. The National Innovation Foundation (NIF) website (http://nif.org.in/) is one such initiative maintained by the government of India. It was founded in the year 2000 with support from Department of Science and Technology (DST), India and showcases innovations/solutions provided by school students and adults to a range of problems that they themselves have identified or chosen to work on (NIF, 2015). A lot of innovation happening in India at the grassroots level is a result of the work of people who are not formally trained in D&T education. A list of innovations is provided in the 'awards' section of the website; adult innovations are listed in 'Biennial' award function sub-section (NIF, Biennial, 2015) and student innovations are listed in 'IGNITE' award function sub-section (NIF, IGNITE, 2015). Our inquiry was particularly motivated by the question, "What are the problems identified by adults and children independently and what are the differences in the kinds of problems identified by young innovators and those identified by adult innovators." These questions are important from the perspective of design and technology (D&T) education, as one aspect of D&T education involves engaging with authentic problems, where individuals can select their own problems. This study can help understand the limitations in problem identification.

Innovation, problem solving and problem identification

Problem solving is an important aspect of innovation. Often some new product may be created when a problem in an existing state of affairs is solved with a solution that is unique. However, in recent literature on innovation, besides problem solving the ability to 'identify or find problems' is being considered important for creativity and innovations (Runco, 1994). According to Polanyi (1958), "to recognize a problem which can be solved and is worth solving is in fact a discovery in its own right" (p.120). Researchers have found a correlation between problem finding and verbal divergent thinking tests, however, divergent thinking tests may not be a good indicator of real-world creative performance. Okuda, Runco and Berger (1991) have shown that there is a greater correlation between real-world problem identification and creative accomplishment than with performance on tests of divergent thinking. Other researchers have emphasized the link between real-world problem construction with quality and originality of solutions (Reiter-Palmon, Mumford, Connor & Runco, 1997).

In the Indian education scenario from school to graduation, learners are expected to solve problems that are defined by a teacher, or presented in educational materials. It is rare for a student to be asked to identify a problem herself. Students enrolled in design education at graduate and post-graduate level do get an opportunity to work on problems that they themselves select. But here too, the freedom to identify problem is exercised only in a few select projects. Since D&T education does not exist at the school level in India (Ara, Chunawala, & Natarajan, 2013), the scope of learning to identify problems is limited in the school going population, even though to some extent, a few teachers at their individual level may try to encourage students to identify problems in a presented scenario or problem context. In recent years, there has been an emphasis on inquiry-based learning where students do get to work on problems defined by themselves (Friesen & Scott, 2013). But this practice too, may be confined to only a few institutes in India that are not accessible to a vast majority of students. In such a scenario, we wondered about situations where students could choose to identify problems on their own and also suggest solutions to these problems. What differences would there be between adults and children, if both identified problems independently? This was the question that inspired us to commence this study.

Problem situations have been sub-divided into three main types; presented problem situation, discovered problem situation and created problem situation (Getzels, 1979). A 'presented problem situation' refers to those situations when problems are presented to an individual by another agency or person. The regular tests that happen in classrooms where a teacher presents problems to students to solve is a typical example of a 'presented problem'. Discovered problem situation refers to contexts when an individual discovers an existing problem. Such problems can be discovered by people who are practitioners of a field, for example a mechanic discovers a problem in the spark plug which is preventing a car engine from starting. The "created problem situation" is when an individual creates a problem situation when no problem exists. Such problems can be devised by persons who want to experiment and explore unknown situations. Here one can take an example from the history of technology. The Wright brothers had successfully mastered the art of flying an engine-less glider and had performed about a thousand flights without crashing even once. Their decision to add an engine to the plane did not arise from any problem experienced by them in their existing glider. Instead it was an attempt to challenge the limits of what their existing glider could do. We feel that the kinds of problems that are addressed in the NIF website can be classified as either discovered problems or created problem situations.

An advantage of identifying problems oneself could be related to motivation to solve the problem. Deci and Ryan (1985) in their cognitive evaluation theory which is a subset of self-determination theory have emphasized intrinsic motivation. According to them, when people experience themselves as initiators of their own behaviour, they select desired outcomes and find out alternative means to achieve them. Students too may be motivated to approach a problem that they are instrumental in selecting. This view is supported by Vygotsky, who observed in his studies that children's creative writing vastly improved when they were asked to write on topics they felt deeply about rather than on topics that were given to them by the instructor (Vygotsky, 2004). The freedom to choose and identify a problem maybe one of the essential elements in development of creativity. Hence the study of instances where problems are identified by individuals (both children and adults) was undertaken.

Expert-novice differences in problem solving and problem identification

Adult and children responses in design or problem solving can be looked at from the lens of expert-novice differences, with experts having more knowledge and strategies to organize knowledge. According to Yuan et. al. (2014), experts can perform tasks involving problem solving faster and more precisely than novices. However, they mention an "inverseexpertise effect" which suggests a contrary view where novices seem to perform equally or better than experts in solving certain type of problems (Adelson, 1984). In a study on expert-novice differences in problem identification, Dixon found that expert design engineers were able to identify core problems much faster than novices and thus could spend more time solving the problem as compared to novices (Dixon, 2011). Moreover Chi, Feltovich and Glaser (1981) found that there are differences in expert and novices in how they identify problems and sort them into different categories. While experts categorize problems according to basic principles involved, novices categorize them according to literal features of the problem. These studies have focused on how experts and novices solve problems and how they identify problems. However, in our study concerned with the domain of innovation, we feel that it is difficult to label adults or children as experts or novices mainly because this group that innovates is a very limited select group. While the potentiality to innovate may be present in all of us, the act of actually designing and innovating is rare. Our focus in this study was on the types of problems identified by adults and children to work on. We compare the various categories of problems identified by these two groups of innovators in India, who worked independently without any design brief from any external agency.

Data collection

The NIF showcases innovations at two levels. They organize annual competitions among school students wherein innovative solutions are to be presented along with the problem that prompted these innovations. It also showcases innovations by adults at grassroots levels from all across India. Data of both student and adult innovation is available on the NIF website (record collected from 2001 onwards). For the purpose of our study we tabulated the list of innovations for both children (school students) and adult group for 3 years 2015, 2013 and 2012. Data for 2014 for adults was not available on the website and hence we did not include this year in our sample.

Table 1: Number of innovations showcased on the NIF website for the years 2015, 2013 and 2012 (the biennial issue) for adults and students

	By adults (above 18 years) Biennial award		**By school students (below 18 years) IGNITE award**		**Total**
	innovations	innovators	innovations	innovators	
2015	35	46	30	37	
2013	35	42	28	43	
2012	41	44	26	34	
Total Innovations	111		84		195
Total Innovators		132 (117M, 15F)		114 (81M, 33F)	246 (198M, 48F)

The entries in the adult section were mostly from people dwelling in rural areas, (Abrol & Gupta, 2015) while the entries in the student sample belonged to all sections of society. In both the cases, students and adults, and totally too, the number of innovators is larger than the innovations as more than one person may have collaborated on an innovation.

We find the total innovators to be higher in the adult population as compared to the student population. This statistic (Table 1) we find counter-intuitive as there is a common perception as well as studies to support the view that children are more creative than adults and that this creativity tends to reduce with age (McGarvey, 1992, 2001). These views will be explored later in the discussion section. Of the total number of innovators, there were 198 males and 48 females. Why there were so few female innovators requires a separate investigation. But an interesting point to note is that while there were less student innovators, the number of adult female innovators was less than half the number of student female innovators (Table 2).

Table 2: Female innovators for adult and student groups

Female innovators	**adults (above 18 years) Biennial award**	**school students (below 18 years) IGNITE award**
2015	9	12
2013	4	13
2012	2	08
Total	15	33

An interesting result that has emerged from the data in Table 2 is that while more innovations were listed by adults than students in total, there were more 'female student' innovators than 'female adult' innovators. Even this result requires further investigation.

Since there could be many possible reasons for this difference between the number of adult and children innovations, we focused on the additional data provided regarding each innovation; such as, gender of innovator, place of origin of the innovators, the name given to the innovation and the description of the innovation. We also decided to code these innovations on the basis of the category of problem areas they addressed. The method of qualitative data analysis that we undertook will be detailed in the next section. Table 3 depicts the information of one innovation as an example, but we have used letters instead of the names of the innovators.

Table 3: Specimen of data collected from National Innovation Foundation (NIF) website

Year	Innovator	Place	Innovation	Description	Category/Code
2015	SG (f) and NG (m)	Midnapur, West Bengal	Herbal medicine for respiratory distress in poultry	Innovation to cure respiratory problem in birds	Medicine

Method

The innovations presented on NIF website have been analysed for various innovators seeking external government support for enterprise building, by Abrol and Gupta (2015). They grouped the innovations under a few categories to characterize the fields of knowledge and domains of application that these innovations addressed such as mechanical engineering, masonry etc. As we scrutinized the data of innovations, we found that innovations could be grouped together into different categories based on a criteria of 'problem area identified' instead of 'field of knowledge'. According to us, 'field of knowledge' is different from 'problem area identified' because a person can use mechanical engineering knowledge, which is a field of knowledge in varied problem situations, say, in construction, in designing machines for farming, in designing a vehicle etc. The innovators in this study also had less experiences in 'fields of knowledge', but nevertheless they had identified some problems to work on and it is these identified problems that we are interested in.

Additionally, the research literature citing the parameter of flexibility in various tests for divergent thinking refers to the variety of categories or domains the problem solutions are related to (Dippo 2013). For example, solutions could be linked to many different kinds of categories – such as metals, nature, fabric, health, transport etc. The parameter of flexibility and other aspects of divergent thinking such as fluency (thinking of as many uses of an object as possible), originality (how uncommon are the uses given) and elaboration (how detailed are the uses described) are usually applied to evaluate responses of individuals to problems. But in this paper, we attempt to apply the criteria of flexibility to the total list of innovations produced by two groups of innovators; adults and student.

Our attempt at coding the innovations and arriving at categories of problems in a systematic way involved “many iterations of re-coding and re-categorizing” (Saldana, 2014). The method of coding we used was attribute coding and the primary attribute we used for categorizing was “the context of use” of the given innovation. Each innovation addresses some context of use, for example, a medicine that heals a human or animal patient (medicine), or a vessel used for cooking (kitchen). We thus tried to have a single code for the problem domain that each innovation addressed. The process of coding was manual and the problem domains of the innovations for years 2015, 2013 and 2012 are presented in Table 4.

Table 4: Total Number of Categories (problem domains or contexts of use)

Category: Description (innovation in a particular context)	
1. Agriculture (*gardening)*	12. Windmill
2. Health	13. Tree climbing
3. Construction	14. Drilling machine
4. Kitchen (*cooking)*	15. Pest control
5. High Yielding Variety crops/*seeds*	16. Vehicle
6. Tool/instrument *design*	17. Signalling
7. Electronics	18. Quality control
8. Disability	19. Cleanliness
9. Safety/protection	20. Prohibiter
10. Textiles	21. Electrical
11. Water heating/cooling	22. Miscellaneous

Thus, a total of 21 categories or problem domains were identified. The innovations that could not be categorised or which belonged to a fuzzy category were put in a category termed miscellaneous. Three coders (S, R and A) independently sorted the innovation into these categories. For each year and each group, if all three sorters found even one innovation to place in a category then and only then it was counted as a category for that group and year. For example, if rater 1 identified 4 innovations under category of 'Quality control', rater 2 identified 3 innovations under this category and rater 3 identified only 1 innovation in this category, then it was concluded that 'quality control' is a category that innovators in the group have worked on. However, if the 3rd rater did not rate even a single innovation under category of 'quality control', then this category was not counted for that group in a particular year. We found that even though the raters worked independently, there was consensus about categorising innovations in the categories in a majority of the cases. The number of categories of adult and student group innovations were analysed for comparing the 'diversity in problem areas' identified by both groups. No qualitative judgments were made on a single innovation of an individual.

Results

In Table 5 we present the total number of categories for the 3 years. When doing this only non-repeating categories were added. The total number of innovations in each category as rated by the raters S, R and A for the 3 years are given in Table 6.

Table 5: Total number of categories in adult and student group for year 2015, 2013 and 2012.

	Adult 2015	**Std 2015**	**Adult 2013**	**Std 2013**	**Adult 2012**	**Std 2012**	**Total Adult categories over the 3 years**	**Total Student categories over the 3 years**
Categories	10	9	12	8	13	7	**16**	**13**

The results from Table 4 indicate that adult innovations spanned more problem categories (16) than categories that were identified by student innovations (13) for the three years 2105, 2013 and 2012 combined. For every year too, adult innovations were in more categories. For 2015, adult innovations were in 10 categories while student innovations were in 9 categories. Similarly, the 2013 innovations by adults could be placed in 12 categories and those by students in 8 categories. And in the year 2012, adult innovations were found in 13 categories and student innovations only in 7 categories. We also see that as we progress from 2012 to 2015, the gap between adult and student innovations is gradually decreasing. But we are not sure whether this reduction in gap is a general trend or just a coincidence.

Table 6: Number of innovations in each category for adult and student groups of 2015, 2013 and 2012 (by raters S, R and A)

Category	Adult 2015			Std 2015			Adult 2013			Std 2013			Adult 2012			Std 2012		
	S	R	A	S	R	A	S	R	A	S	R	A	S	R	A	S	R	A
1. Agriculture	6	7	5	6	6	7	9	11	9	*	*	*	6	5	6	*	*	*
2. Health	10	10	10	3	2	4	5	5	5	*	*	*	4	4	4	*	*	*
3. Construction	3	2	3	*	*	1	1	1		*	*	*	*	*	*	*	*	*
4. Kitchen/Cooking related	4	4	4		1	1	4	4	4	1	1	1	6	6	6	1	1	1
5. High Yielding Variety	7	7	7	*	*	*	3	3	3	*	*	*	5	5	5	*	*	*
6. Tool/instrument	2	1	1	3	1	1	2	1	3	1	3	2	3	3	4	*	*	*
7. Electronics	1	1	1	*	*	1	2	2	2	5	3	7	1	1	*	3	4	3
8. Disability	2	2	2	3	5	3	1	1	1	2	2	2	*	*	*	1	1	1
9. Safety/protection	*	*	*	3	3	3	*	*	*	2	3	*	1	1	1	2	1	2
10. Textile	1	1	1	*	*	*	1	1	1	*	*	*	1	1	1	*	*	*
11.Water heating/cooling	*	*	*	*	*	*	2	2	2	*	*	*	*	*	*	*	*	*
12. Windmill	*	*	*	*	*	*	2	2	2	*	*	*	1	1	1	*	*	*
13. Tree climbing	*	*	*	*	*	*	1	1	1	*	*	*	1	1	1	*	*	*
14. Drilling machine	*	*	*	*	*	*	*	*	*	*	*	*	2	2	2	*	*	*
15. Pest control	*	*	*	*	*	*	2	2	2	*	*	*	3	3	3	*	*	*
16. Vehicle	1	1	1	1	2	2	*	*	*	5	3	6	1	1	1	2	2	2
17. Signalling	*	*	*	1	2	1	*	*	*	1	1	1	*	*	*	1	1	1
18. Quality control	*	*	*	5	1	1	*	*	*	*	*	*	*	*	*	*	*	*
19. Cleanliness	*	*	*	2	2	2	*	*	*	*	*	*	*	*	*	*	*	*
20. Prohibitor	*	*	*	1	1	*	*	*	*	3	4	4	*	*	*	8	8	8
21. Electrical	*	*	*	*	*	*	*	*	*	3	3	3	1	1	1	*	*	*
22. Miscellaneous	2	3	3	1	3	3	*	*	*	1	1		1	2	1	3	6	3

Reliability

The reliability of our categorisation was tested by a quantitative method of correlating the number of agreements between the 3 raters (S, R and A) divided by the total number of categories. The percentage Inter Rater Reliability (IRR) method was used for calculating the agreement among 3 raters. The final scores were the mean of the 3-different set of comparisons between the raters i.e. S-R, R-A and S-A.

Table 7: Percentage reliability score for 2015, 2013 and 2012 categories.

	2015	2013	2012
IRR score	.84	.84	.92

The percentage of agreement among the raters for the categorization of the data of 2015, 2013 and 2012 is high; more than 80% (Table 7). A limitation of percentage IRR is that in some cases, it ignores the agreement that could have happened purely because of chance and not due to agreement on the categories between raters. But such cases are more likely when number of categories are less. With 22 categories, the possibility of agreement by chance in many cases reduces and may be less significant.

Interpretation of results

The immediate inference drawn from the available data is that there were a greater number of problem categories (Table 4) in adults' innovation (16) than in school students' innovations (13). The differences in the adult and student group regarding the categories they worked on can be seen in Table 8.

Table 8: Comparison of differences in problem categories of innovations by adults and students for the 3 years combined

Innovation Category	**Innovations by adults**	**Innovations by students**
Agriculture	**20**	**7**
Health	**19**	**5**
Construction	3	0
Kitchen/Cooking related	**14**	**2**
High Yielding Variety	**15**	**0**
Tool/instrument	9	7
Electronics	**4**	**6**
Disability	3	6
Textile	2	0
Vehicle	**2**	**4**
Water heating/cooling	2	0
Windmill	3	0
Tree climbing	2	0
Pest control	6	0
Safety/protection	**1**	**4**
Drilling	2	0
Signalling	***0***	***7***
Quality Control	***0***	***5***
Cleanliness	*0*	*3*
Prohibitor	***0***	***14***
Electrical	1	3
Miscellaneous	3	6

A marked difference between the two groups was that some categories reported by a group were totally absent or limited in the other group. For example, the most common areas of innovation by students were related to 'prohibition' of an undesirable action, also other categories found in the student group, such as, 'quality control' (indicating quality of fruits), 'signalling' (signal to tell if car keys are left in the car) and 'cleanliness' (overturning seat for dirty benches in park. (http://nif.org.in/innovation/reversible-benches-at-public-places/863) were not found in adult innovations. Some examples of the 'prohibition' category innovations were; retractable spikes before zebra crossing that emerge when the traffic signal turns red to prevent vehicles from signal jumping, a chair with sensors at appropriate places which alerts the user if he/she sits in a bad posture and permits one to sit only in a correct posture; a device fitted in cars that prevents people from driving without a license. These examples all relate to some aspect of human behaviour and students have attempted a technological fix to correct the same. This is a very interesting category of problems identified by students which was totally absent in adults. Perhaps, the experience of the adults prevented them from crossing the boundary of technology related problems, while children had no such limits.

Some categories of problems found in adult innovations that were totally absent in the student group were, 'construction', 'textiles' and 'high yielding variety seeds', 'tree climbing', 'water heating/cooling', 'windmill' and 'pest control'. The possible reasons for these differences in student and adults categories of innovations are discussed in detail in the next section.

Discussion

There are studies on differences in creativity among children and adults which suggest that children are more creative than adults. There is also a perception among lay people that creativity is higher in children. Studies on creativity of students have reported a drop in creativity with age and schooling. Blake and Giannangelo (2012) found a reduction in divergent thinking from 98% to 32%, as age progressed from 3 years to 8 years, and from 10% to 2% from ages 13 to ages 25. The criteria for judgment of creativity in these tests is often divergent thinking, which involves tasks that require thinking of alternate uses of an object (Guilford, 1971). If children as a group are more creative, then more 'variation' in categories from a dataset of children's innovation should emerge. However, the dataset that we have collected from the NIF website, shows more variation in the innovation categories in adults as compared to the student. We also saw qualitative difference in the categories of problems identified by adults as against those identified by school students. The support for our findings comes from the contrast of the experiences of adults and children as explicated by Vygotsky:

> “We know that a child’s experience is vastly poorer than an adult’s. We further know that children’s interests are simpler, more elementary, and thus also poorer; finally, their relationship to the environment does not have the complexity, subtlety, and diversity that characterizes the behaviour of adults, and these are the most important factors that determine the workings of the imagination. (Vygotsky, 2004, p. 26)”

A study by Wu, Cheng, Ip and McBride-Chang (2005) looked at age difference in creativity and related these to task structure and knowledge base. They suggest that when tasks are knowledge-rich, experience would play an important role in creativity but not if the task does not require much knowledge. Other existing research shows that creative thinking is a universal ability that can help adults manage satisfying lives and that is increasingly in demand in the workplace (Kerka, 1999; Hickson & Housley, 1997; Flood & Phillips, 2007). Hence it cannot be presumed that creativity is only a domain for children. Adults may also have equal if not more access to developing this skill provided it is not thwarted by social environmental factors (Amabile, 1998).

Differences in problems identified by adults and children

In terms of kinds of problems identified in both adult and student groups, we see that adult innovations contained most categories related to 'Agriculture', 'Health' and 'Cooking'. This could be a reflection of their predominant experiences of farming in a rural context. For example, “RV” is the son of a farmer and is skilled in repairing farm implements and equipment. He had to dropout from college, to join his father on their farm and thereby gained experience in various aspects of farming and produced simple innovations regularly. The innovation that got him noticed by NIF was 'sugarcane bud planter machine' which automates the process of planting sugarcane buds (http://nif.org.in/innovation/sugarcane-bud-planting-machine/796). Figure 1.

Figure1(from NIF)

Figure 2 (from NIF)

Since many people in rural contexts also have experiences of growing/using herbal medicinal plants, there were a large number of innovations related to health in the adult group. For example, “BB”, who helps her husband in agricultural activities innovated a herbal medicine for treating diabetes (http://nif.org.in/innovation/herbal-medication-for-diabetes/800). Similarly, 'cooking' related innovations were also prominent in the adult groups, such as, the 'community rice cooker' innovated by PL (http://nif.org.in/innovation/community-rice-cooker-/770). Figure 2.

The predominance of 'prohibition' related innovations from students could be attributed to the restrictions that students experience in schools or at home. One example of such an innovation was a 'device for preventing people from driving without a license'. The innovator had suggested incorporating a slot near the vehicle’s ignition to insert the driving license. The system would stop anyone from driving (Figure 3) if the license is not present, is invalid or has expired (http://nif.org.in/innovation/preventing-people-from-driving-without-a-license/562).

Figure 3 (from NIF)

Figure 4 (from NIF)

Another category common among students but not found in adults was the category of 'signalling'. This was similar to prohibition, but the difference was that the signal would allow a person the chance to decide the future course of action after an undesirable action has taken place and to prevent further undesirable events from happening. For example, a signalling system that reminds the owner with a phone call if he/she has left the car keys in the car, developed by CK (Figure 4),(http://nif.org.in/innovation/reminding-the-owner-if-keys-are-forgotten-in-the-vehicle/633) aims to prevent the owner from leaving the car keys in the car, though the signal takes place only after the action has occurred. These problems identified by the students could be related to previous experiences of students, who in Indian context are prevented by parents from making mistakes or doing 'wrong' actions. The student may not have had the exact experience of driving without a license, but they are simply selecting all the possible 'wrong' things that they see people being punished for and they want to create an innovation to prevent some wrong thing from happening. Thus, students' innovations can also be aligned with Vygotsky's explanation that imagination also takes its clues from experience.

We can clearly see that the problems identified by students in the category of prohibition, signalling and cleanliness are aimed towards correcting a presumably undesirable human behaviour (undesirable according to the perception of the innovator). Some of these unwanted behaviours or rather habits include; not concentrating in classroom, forgetting car keys inside the car, not sitting properly on chair etc. If we look carefully, these are problems or rather not problems but actions conducted by humans by their choice or according to their personal life conditions. They have a psycho-social dimension to it. But the novice innovators are attempting to solve these ‘problems of bad behaviour’ by proposing some technological gadget. This shows the underlying belief of the novice innovator that people have bad habits and behaviours and these can be ‘corrected’ by inventing some device or gadget. This issue does not exist with expert innovators because their focus is on improving some existing technological artefact and not human conduct. From this we understand that novice innovators are not able to distinguish human behaviour related issues and problems in a technological artefact.

There are many contradicting studies about whether technology can change human behaviour or not. These studies focus on showing the effect of technology on humans (Safwat, Adel, George & Sobhy, 2012). But whether the research is in favour or opposed to technology’s potential for changing human life, these studies do not claim that the aim of technology is to correct wrong human behaviour even though behaviour may change as a side effect of technology and that can go in any direction, desirable or undesirable. But for most novice innovators, changing human behaviour for the better (according to the perception of innovator), seems to be the primary goal and power of technology.

Conclusion

Problem identification is an important aspect of problem solving and innovations. A diverse range of problems can be identified when individuals have the freedom to work on the problem of their choosing. Our study indicates that adults may be able to identify a range of problems greater than students, however, some categories in the students' group were unique. For example, a student had an innovation related to a 'mechanism for relocating clouds in rain deprived areas'. There was no other innovation addressing this issue; that is, water shortage which is a perennial problem in India. Further research needs to be carried on to understand the process of problem identification and how freedom in problem identification can affect creative solutions to a problem. The data about student female innovators being more than double the number of adult female innovators also is an indicator of societal conditions that may be more restrictive for females than males.

The study supports the idea that diversity of experience leads to diversity of problems identified. If teachers are to lead students toward exploring their creative potential, then teachers may need to have experience of diverse problem areas even within a single domain of expertise. Students also need to be exposed to a variety of experiences, from as many diverse areas as possible as their imagination and creativity may be limited by the kinds of experiences they have.

We have seen from the predominant category of problems identified by novices, that they conflate problem with an artefact or situation with problem with a human being. ‘A child not concentrating in class’ is identified as a problem by a novice innovator that can be solved by some gadget. While such problems are actually dealt with by psychologists and social scientists in real world, such examples show that novice innovators who work on self-defined problems, may not be in a position to distinguish a human related problem with a technological problem and may attempt to solve all problems with technology only.

Students of design and technology need to be sensitized about, not just what technology can achieve, but also about the limits of technology and the category of problems that technology can address and those that technology cannot address and that there are certain category of problems, that exist outside the purview of providing a technological solution. The question that emerges is how can D&T students be sensitized to these psycho-social or socio-technological problems. This category of problems can constitute a different level of challenge for design and technology educators and students. This may have scope for opening up creative innovations that address psycho-social and socio-technological issues that do not have a conventional technological solution in the form of some device or gadget.

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