Design Thinking Approach in Inculcation of Creative Thinking in Science Classroom

Ms. Jenis Swati Topno[1], Prof Elizabeth Gangmei[2]

[1]JRF, RIE, Bhubaneswar, India
[2]Professor in Education, RIE Ajmer, India

Abstract

Design thinking is traced from the field of architecture and designers of all stripes. Later on, it became popular among researchers and paved the way to used it in different field of education. Recently, the contribution of design thinking can be seen in education for molding the student's mindset and instilling capabilities. It is a framework of creative and systematic approach to teach problem-solving. Through it the individual learner progress through the stages of discovery, ideation, experimentation and evolution in pursuit of solutions to vexing problems. Design thinking not only inculcate 21st century skills but teaches to ask the right questions, make correct decision, learn from failure, test and generate ideas etc. This paper aims to assess the creative thinking of the students by introducing d.school design thinking model in science classroom. Content analysis was adopted to analyze the tasks of participants. The findings demonstrated the potential of design thinking framework in effective learning of science and contribution in creative thinking ability of the learner as it enables in understanding and reflection on content. Furthermore, it aids in construction of knowledge through activities and tasks related to problem solving. This not only enhances knowledge but an insight to apply the knowledge in real life situation. It inculcates the convergent and divergent thinking skills, develop problem-solving ability, teamwork, communication skills and empathy in the learner.

Keywords: Design thinking, Creative thinking, Testing, Ideation, Prototype and Empathy.

INTRODUCTION

Design Thinking is an innovative, creative and human-centered process and mindset that employs collaborative multidisciplinary approach to come out with products for the need of people, services or experiences. It comprises a variety of creative strategies for handling projects with multiple stakeholders or fostering organizational innovation. It has a wide, unbound problem space and complexity, are open for interpretation, surrounded by competing or conflicting opinions for solutions, and unlikely to ever be completely solved (Hawryszkiewycz, Pradhan & Agarwal, 2015). Design thinking is a process where the mindset of an individual is molded as a problem solver, as a creative person, as a critical thinker, as an innovative person and as a good decision maker.

More recently, design thinking has been utilized in education due to its ability of advancing creativity and innovation by applying an empathetic, flexible and iterative approach. With more emphasis on a teaching strategy for 21st century skills in the contemporary time, there has been, keen and wide interest towards design thinking as applied in education. Design thinking foresees steps that allow participants to analyze, synthesize, diverge and generate insights from different domains through drawing, prototyping and storytelling (Brown, 2009). During the design thinking process, the facilitator encourages learners to see constraints as inspiration (Brown & Wyatt, 2010). It does not direct toward a technological 'quick fix' but to a new integrations of signs, things, actions, and environments (Buchanan, 1992). The essence of design thinking is to put participants into contexts that make them reflect and work like an expert designer, and thereby foster civic literacy, empathy, cultural awareness and risk taking (Sharples et al., 2016).

While design thinking has caught the attention of practitioners and educators of numerous fields, this widespread interest has been repeatedly characterized as problematic in the scholarly discourse. The lack of conceptual clarity does not slow down the adoption of design thinking in education. For example, Dunne and Martin (2006) states, design thinking as an intriguing idea and gaining currency in the area but it does require further consideration, exploration and explanation. This framework supports Vygotsky's social constructivism theory socio cultural and relational theories

of learning, reflective (Schon 1983), experiential (Kolb, 1984), and authentic learning (Herrington, 2011). Callahan (2019) observed that design thinking is being used in K-16+ curricula to foster the development of 21st-century skills, championed by the company IDEO and Hasso Plattner Institute of Design. This has augmented the idea of using design thinking to nurture the contemporary skills and competencies of learners with an understanding of its appropriateness and context.

NEED OF THE STUDY

Researchers of other disciplines affirmed that design thinking is a unique and effective approach in the field of education. This method not only builds the capacity but it also inculcates curiosity among learner, it culminates the ability to raise the precise questions, to work in a team and to be an effective communicator. Although research is scarce in the academic field related to design thinking nevertheless it has paved the way for further use in the educational field. Design thinking review study conducted by Lor (2017) stated that, it has a wide scope in the field of education; mainly-k-12, higher education and teacher education which shows the light to researcher to explore in this area. It is more so relevant due to the focus on flexibility and adaptive in nature and not content- oriented which prepare the students for undisclosed future (Renard, 2014). This idea has paved a way to incorporate design thinking as an innovative method to adapt the needs of new generation of learners. There is a huge opportunity of design thinking in the present education system. The NEP 2020 has recommended concerted curricular and pedagogical initiatives for which design thinking is one of them as a new pedagogical enterprise for building capacities in learner. This accentuated the understanding that there is a huge scope in choosing and exploring the design thinking framework in relation to creative thinking in science classroom for current study.

RESEARCH QUESTIONS

The main concern of the present study is to explore the contribution of five-stage design thinking of d.school in the science classroom in creative thinking and to find it out following question is considered:

1.   Does five-stage design thinking framework contribute in creative thinking in science classroom?

METHODOLOGY

In this research, case study was adopted in a single state board school in Jharkhand. The innovative tools of design research namely participant observation, collective construction of knowledge and content map and tasks were employed for data collection. The researcher selected the theme 'Global Warming' to test the potential of design thinking (specific stages- empathy, define, ideate, prototype and test) for inculcating creative thinking in a science classroom.

INTRODUCING DESIGN THINKING APPROACH IN THE SCIENCE CLASSROOM

To bring research-based design thinking framework alive in science classroom and to go beyond typical daily lessons and to absorb students in thought-provoking real world-context the design thinking framework developed by institute of design at Stanford (2005) was used.

a. Exploring Design Thinking

Students were engaged actively in science classroom at the following stages of d.school design framework- empathy, define, and ideate, prototype and test. In empathy stage- students' curiosity was developed and they were encouraged to work towards fulfilling self-curiosity.

✓   In the define stage- they develop the capacity to raise the appropriate and thought provoking question.

✓   The ideate stage- students' while attempting to apply skills were reflecting, recalling the knowledge and making connection between the information and making it practical in the real context.

✓   The prototype stage- as per their knowledge they developed a prototype in the form of drawing and writing a short note as directed towards solution of particular problem raised during the define stage.

✓   The test stage- In this stage the application of the prototype was checked. The solution they came was cross-checked on whether their thoughts are really applicable in the real world context. These stages are iterative hence, they learn from the failure.

b. Affective and Social Skills in Design Thinking

The empathy, define and test stage denotes the affective domain. In the empathy stage, learners understood the severity of global warming and its harmful effects to humankind and nature. Thus, in define stage, they constructed the problem in the form of task and in test stage, they effectively communicate and justify their thoughts as a verbal presentation.

Figure 1. A student presentation in the classroom.

Figure 2. Students sharing Ideas in the school

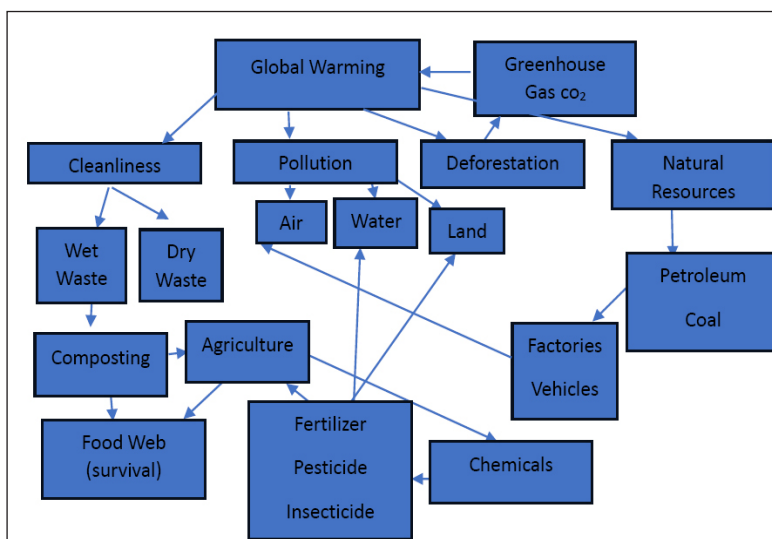**c. Knowledge of the Content**

Figure 3. Visual map of global warming developed by the students.

Visual map in figure-3 delineate that students have understood the concept and are able to connect with sub-topics and the realm of other disciplines. The content knowledge correlated with idea or issues in hand and is depicted in the drawings. The effective communication and expression of understanding of the issue shows the depth of knowledge.

THE PARTICIPANTS

The selected participants were all male students of class 10 (section A) wherein their age ranges between 15-17 years. Maximum students were from middle class background and mostly from first- and second-generation learners in their family.

TOOLS

The data was collected during the science learning-teaching session. Every design process begins with a specific and intentional problem to address; that is called a design challenge. In this study, the task namely, Situation task- 'what measures will you take to reduce global warming' was put before 4 groups of students which consists of 12 students in each team.

ANALYSIS

Qualitative content analysis was carried out and relevant code was developed after reflecting on the data and then broadened to specific themes to connect it with the creative thinking

Objective 1: To explore the potential of design thinking framework in inculcating creative thinking in the science classroom.

Creative thinking of the learners was examined by prototype they developed. Facilitated by researcher they reflected on the topic and emerged with the question and then brain stormed to find solution and developed drawings and short note which demonstrate their perception on how global warming can be reduce at personal level and how awareness can be created at school level.

Figure 4. 'Means to reduce global warming' diagram by a student

Group A:

To reduce the global warming, we will plant more trees and avoid deforestation. Utilize resources intelligently, and make the surrounding clean to reduce pollution by disposing the wastes in garbage and not in the land or any water bodies. Instead of using petroleum we will choose CNG gas or battery-aid vehicle and bicycle. We will reduce the consumption of electricity because electricity generation coals are used which is again the main cause of CO_2 production'

As seen in the group (A) idea expressed, there is a concern for global warming and it was contextualized to take care of this global warming concern.

Figure 5. 'Global warming awareness' diagram by a student

> *Group B:*
>
> *'We are using everything more than needed; ultimately it is causing us harm. Hence, we should limit the usage of resources. We will use car-pooling and choose to sit on vehicle which is running on CNG gas to promote the go green campaign. There is a need to reduce population because it leads to more consumption of resources, more pollution and more need of food which is somehow related to the industry and hence increase in the level of greenhouse gases. Development is necessary but we should always keep in mind the environment and healthy living should be our priority'.*

As seen in the drawing and idea shared, Group (B) perspective conveys how pollution is aiding in global warming and for healthy living the environment should be clean and green as seen in the design drawn visually meaningful, showing creative ways of handling global warming.

Figure 6. 'Causes of Global warming' diagram drawing by a student

> *Group C:*
>
> *'To reduce the global warming, we will support afforestation and avoid the unlimited use of resources. We know how industries are polluting our environment but we are dependent on it so we will request the authority to find a way to reduce the industrialization and find alternative way to produce organic things. We will not use chemical fertilizers and instead use biofertilizers in our field. Stop using plastics and use cloth bags. We should learn to recycle the material to create less pollution and effective use of the resources.*

Students of Group (C) thoughts converged on how industrialization is causing harm. The picture relates to the source of pollution which ultimately cause change in climate as main cause of global warming. They came up with ideas like using bio-fertilizers and cloth bags to reduce, reuse and recycle the plastics as well as to reduce the usage of refrigerator and Air Conditioner (AC) to reduce the Chlorofluorocarbons (CFCs) in the atmosphere.
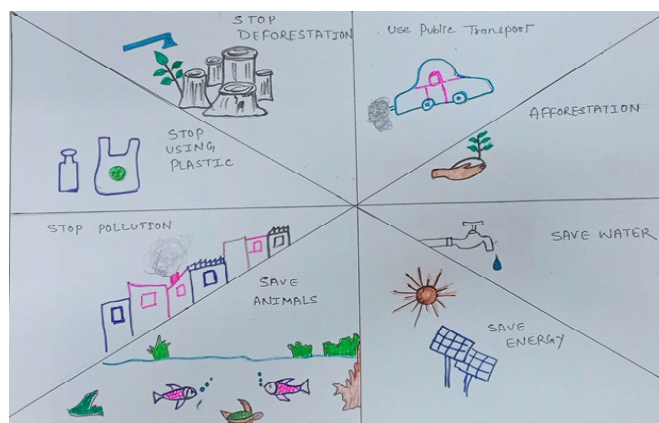

Figure 7. 'Ways to reduce global warming' a diagram drawing by a student

> *Group D:*
>
> *'We will plant more trees and make our environment clean and green. We can see that our country is growing in technology and many things are produced like nuclear bomb which is used in war and it is causing enormous pollution, the chemical fertilizers, the increased population, the contaminated river and oceans everything is harmful for us. We should talk to higher authority to stop forest rebellion and come up with the ways to conserve our nature'.*

Group (D) ventilated story in their visual and verbal expressions the drawing emphasizing on planting more trees, saving water, animals, energy and restricting deforestation which will save the earth. The diagram also depicted the excessive uses of petroleum vehicle leading to pollution. The clean and green nature can be achieved by reducing deforestation, supporting afforestation, and adopting public transport to limit the usage of energies.

FINDINGS AND DISCUSSION

The study finding shows how effective the design thinking framework contributed in the creative thinking of the learner. As reported by Bush et. al, 2018 the ideate, prototype, and test help prepare students which is limited in a traditional lesson. To be successful in these stages, students must work collaboratively, persevere and consistently work, and think critically as they brainstorm, build, and test to over to arrive at relevant solution. Similarly, in the present study d.school framework enhance the cognitive, affective and social domain of the students. Analysis was done under three themes - a) Learning through Design thinking (DT) b) Design Thinking and affective domain c) the experimentation during the science lesson.

THEMES	ACTIVITY	FINDINGS
Learning through DT	Through design thinking approach students discussed among themselves and with researcher and developed visual map.	Design thinking help students to process the concept and create a visual map (shows the correlation with different topics) as seen in the explanation and creating a visual image in the form of picture.
DT and affective Domain	Design thinking help students to empathize the situation and listening, valuing each other opinion. They also start responding, reacting and expressing their thoughts.	Design thinking elevated the affective domain of students by engaging them in thinking, collaborating, respecting and valuing the thoughts of others and putting themselves in the situation to find the best possible solution (drawing and short note)
Experimentation during the science lesson	Design thinking leads to various experimentation a) Discussion b) Writing short note c) Group assignment d) Presentation of the drawings	a) Discussion The students discussed the topic with the researcher and asked questions related to the content and tried to connect it with the real-life situations. They also discussed and shared the present situation in their area with its harmful consequences. b) Writing Short Notes Students expressed their ideas through written form. They contextualized by relating it with their daily life as- reducing usage of non-renewable resource, using cloth bags, turning off the engine when traffic light is red etc. c) Group Assignment Students after contemplation and articulation developed a drawing which is the result of active-creative thinking. Drawings portrayed the story of what they conceived and processed concept of global warming. d) Presenting the Drawing Design thinking helped in communication skills. Students presented and explained the drawing and ventilated their ideas effectively through verbal expressions before the students.

In the present study, the students reflected, conceptualized and experimented. In addition, they developed affective domain skills through the process of analyzing, mediation, empathy etc. The study found that, students creatively reflect upon the problem and continuously undergoes divergent thinking to generate the new ideas and thus they choose the appropriate and perfect solution to overcome the challenge given to them. However, as stated by Jamal et al (2021), the result showed a great deal of affect and affective empathy towards family and friends but little evidence was seen of students acting upon any affective desire outside of their everyday lives and social relationships. The study conducted by Bush et.al (2018); Jamal et.al (2021); Ching (2015) supports the results of the study.

CONCLUSION

Design thinking framework is an innovative tool or method for solving the every-day problem as well as inculcating the 21st century skills. Design thinking allowed the students to process the concept and mold the abstract concept to concrete form leading to portray ideas and imagination in written and visual form. The generated ideas delineate the active engagement, empathy towards the situation and the best possible solution of the problem. Although, it does not give quick-fix solution of the problem but it molds the mindset of an individual which in turns inculcate the creative thinking in students.

EDUCATIONAL IMPLICATIONS

In regard to design thinking framework as studied has the following educational implications:

- Learner can enhance the knowledge regarding the content.

- Learner applies the gained knowledge in real life situation.

- Inculcate the convergent and divergent thinking skills.

- Develop the problem-solving ability in the learner.

- Develop the culture of working in team, empathy in the learner, which ultimately helps in building social relationship.

- Students will be able to make the better decision and effective communication skills.

REFERENCES

1. Brown, T. (2009). Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation. New York: HarperCollins Publishers.

2. Brown, T., & Wyatt, J. (2010). Design thinking for social innovation. Development Outreach, 12(1), 29–43.

3. Buchanan, R. (1992). Wicked problems in design thinking. Design Issues, 8(2), 5–21.

4. Bush, S. B., Karp, K. S., Cox, R., Cook, K. L., Albanese, J., & Karp, M. (2018). Design thinking Framework: Shaping powerful mathematics. Mathematics teaching in the middle school, (23)4, e1-e5 https://www.jstor.or/stable/10.5951/mathteacmiddscho.23.4.00e1

5. Callahan, K. C. (2019). Design Thinking in Curricula. In The International Encyclopedia of Art and Design Education (pp. 1–6). American Cancer Society.

6. Ching, H. Y. (2015). Design thinking in classroom: an experience with undergrad students of a Business course. Business and management research, (3)2, 110-119. http://dx.doi.org/10.5430/bmr.v3n2p110

7. Dunne, D., & Martin, R. (2006). Design thinking and how it will change management education: an interview and discussion. Academy of management learning & education, 5(4), 412-523 http://dx.doi.org/10.1002/j.2168-9830.2005.tb00832.x

8. Hawryszkiewycz, I., Pradhan, S., & Agarwal, R. (2015). Design thinking as a framework for fostering creativity in management and information systems teaching programs. In Pacific Asia Conference on Information Systems. AISEL.

9. Jamal, T., Kircher, J., & Donaldson, J. P. (2021). Re-visiting design thinking for Learning and Practice: Critical peda-

gogy, conative empathy. Sustainability, 13, 1-25https://doi.org/10.3390/su13020964

10. Lor, R. (2017). Design Thinking in Education: A Critical Review of Literature. In International academic conference on social sciences and management / Asian conference on education and psychology. conference proceedings (pp. 37–68). Bangkok, Thailand.

11. Ministry of Human Resource Development Government of India. (2020). National Education Policy, NCERT https://www.education.gov.in/sites/upload_files/mhrd/files/NEP_Final_English_0.pdf

12. Renard, H. (2014). Cultivating design thinking in students through material inquiry. International Journal of Teaching and learning in higher education, 26(3), 414-429 http://www.isetl.org/ijtlhe/

13. Sharples, M., de Roock, R., Ferguson, R., Gaved, M., Herodotou, C., Koh, E., ... Wong, L. H. (2016). Innovating Pedagogy 2016: Open University Innovation Report 5. Milton Keynes: The Open University.