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# Design Thinking as a Pedagogical Approach in Educational Settings: A Systematic Review

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**Abstract**
Design thinking (DT) is a creative, innovative and human-centred mindset and process which employs multi-disciplinary collaborative teams to yield user-focused experiences or services and products. DT stands as a promising teaching approach in education since it is constructed on the notion that student learns through dealing with wicked issues. Such an approach to implement in a school setting is not straightforward. Through systematic literature review, the study enumerates reports, reviews, different scholarly works and theoretical reflections to enhance the understanding of DT context, benefits, affordances, effects, limitations, outcomes and purpose of DT in the education sector. The article explicated the systematic article selection about characteristics of DT, to make it fruitful in education, its approach, how it is innovatively utilised to develop pedagogy in K-12 schools, lessons learnt in its application, techniques and tools applied in DT. The existing literature was reviewed, and studies were synthesised to bring out a preliminary analysis of the researchers on DT to be used as a pedagogical approach in K-12 schools. However, the paper seeks to enunciate how this design education offers a sound-based foundation not alone towards traditional academic education or professionals indulged in knowledge or design-based industries, but significantly it imparts problem-skills like curiosity, innovation, communication, citizenship, empathy, social skills, facilitation, critical ideas thinking and creativity by this DT approach on school students. Since these skills traverse beyond peculiar knowledge-focussed fields and lie sound-based for a person's career, hence this DT-based education is recommended to be utilised as a paradigm to get adopted in school.

**Keywords:** Design thinking, Innovation, K-12 Schools, Pedagogy, Learning & Teaching Strategy

## Introduction

Design Thinking (DT) is a flexible approach that helps integrate opposing ideas or themes, identify shared goals and individual requirements, effectively utilize various backgrounds, promote empathy, and establish a common objective (Rusmann&Ejsing-Duun, 2021). Although DT practices vary, the defining features of DT that explain why it may be considered a problem-solving method in education as a pedagogical tool have been demonstrated through the proposed model in this systematic literature review (SLR). In the realm of K-12 education, Diefenthaler advocated for the adoption of DT, which involves cultivating a creative mindset and employing a systematic approach to address problems and identify possibilities. This approach emphasizes the need to understand human beings and design unique solutions to meet their needs (Diefenthaler et al., 2017). To deal with the constantly evolving and diverse demands of the 21st century, learners require competencies in critical thinking, problem-solving, creativity, and collaboration. The emphasis on competencies has been growing in higher education settings and K-12 institutions. There is a scarcity of studies or evaluations on DT in educational settings, particularly in K-12 schools. Additionally, there is a lack of emphasis on recognizing the importance of thinking as a crucial aspect of educators' professional toolkits (Parker et al., 2021). Therefore, the study focuses on the systematic literature that examines the use of DT in instructional practices in K-12 Schools. This method can be applied in education in several ways, specifically in four key areas: curricula design, pedagogical approaches, processes, spaces, and instruments of DT (Chin et al., 2019). The objective of the systematic literature review (SLR) is to provide a comprehensive overview of the current knowledge base about the use of DT in education as a pedagogical tool. The aim is to enhance our understanding of how DT might improve team collaboration, critical thinking, creative thinking, and communication skills among K-12 education schools. The study focuses on deliberating the most effective techniques for suggestive practice and highlighting the opportunities for practice and research.

Schools have the potential to cultivate proficient collaborators, innovative individuals, effective communicators, and analytical thinkers who possess a natural curiosity and a strong commitment to society. The paper consolidates the process of selecting articles and scholarly discoveries from the literature on DT in the K-12 educational environment. The study investigates the skills that students utilize and the teaching methods that teachers use in the DT approach.

## The evolving discipline of design thinking in K-12 schools

DT is utilised widely in different entrepreneurial-minded organisations, for instance, Google, Apple, Nike, etc. (Panke, 2019). DT has been integrated into cutting-edge

teaching methods and design strategies. Ultimately, the effective design can be investigated through sophisticated approaches across every domain (Arshi& Burns, 2019). The DT technique is being used in the business environment, various colleges, and educational institutions to stay current by promoting the use of interdisciplinary approaches to address instructional challenges. The initial institutions that implemented DT are d.School at Stanford University in California and Hasso-Plattner Institute in Potsdam, Germany. These institutions began implementing DT in 2005.

These methods are specifically designed to stimulate collaborative effort and innovation. Students in schools receive instruction in a range of subjects, such as business, medicine, education, humanities, and engineering. They collaborate to address problems with a focus on human needs and perspectives. With the emergence of DT in the business world, schools are making efforts to adapt their teaching techniques to stay current. The courses feature collaborative cross-disciplinary project work, with programmes co-taught by many institutions.

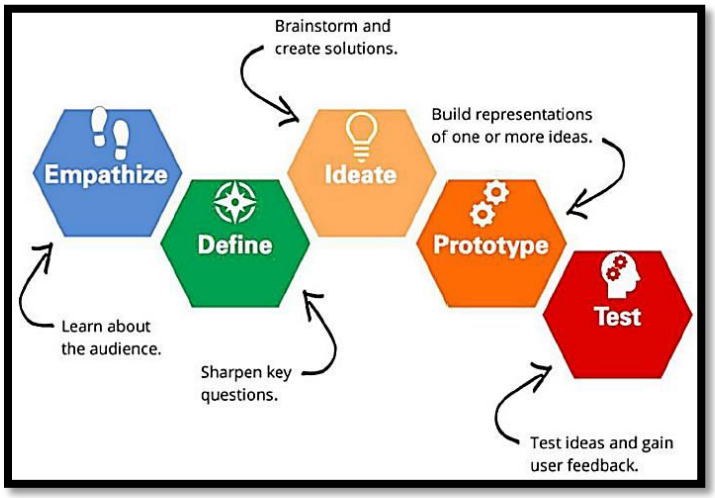


**Figure 1. Stanford Design Thinking Model** (Hoover, 2018)

There consists of various practical variants like how the multistage model could be combined with course activities, but the approach broadly falls into four categories:

Discovery - Empathy, Research and Problem definition
Ideation – Interpretation, Creation, and to make
Experimentation – Prototype, Test and evaluation
Deployment – To Socialize, Pilot and integrate

There are accounts of various model that falls under the DT umbrella. The five modes of DT are illustrated below

**Empathize:** During this stage, the learner carefully observes, actively interacts, intently watches, and attentively listens to the problem. The objective of this phase is to comprehend individuals within the framework of the design challenge. This includes understanding the target audience and the specific problem that has to be resolved (Midler et al., 2016).

**Define:** During this stage, the student clearly articulates the challenge based on their updated comprehension and the problem at hand. The learner formulates coherent problem statements to direct their activity.

**Ideate:** During this stage, the learners are going to create ideas. All ideas will be valued. The suspension of the judgment allows the team to go beyond conventional solutions and provide unique ideas for exploration (Brenner et al., 2016).

**Prototype:** The learners actively participated in the design thinking process to create solutions for the end-users. This process is a repetitive stage that allows for the occurrence of failures. The prototypes necessitate neither a significant time commitment nor any resources.

**Test:** The learners actively seek feedback on the prototypes from the end users. The test provides an additional chance to develop empathy and understanding towards the end users for whom the learners were building prototypes and solutions.

**Iteration is key:** The five modes mentioned above are not always in a specific sequence. They can occur in parallel and be repeated iteratively. DT learners go through this process repeatedly to achieve practical solutions. DT is an approach used to find solutions for challenging problems in a human-centred manner. It involves collaborative and interdisciplinary processes in organizations. When teaching DT to learners, it is important to develop a strong foundation that includes their values, attitudes, abilities, and potential, such as creative habits and a supportive environment. Innovation educators and managers should consider these essential qualities of design and innovation when empowering individuals to create tangible solutions for complex and open problems (Aflatoony et al., 2018).

Regarding educational methods, DT can be applied to K-12 education to enhance creative and collaborative problem-solving abilities in students, particularly in STEM subjects - Science, Technology, Engineering, and Mathematics (Menggo et al., 2019). This approach is consistent with interpersonal, socio-cultural, and social constructivist learning theories, as well as experimental, genuine learning, and reflective theories. DT learning prioritizes pedagogical practices that involve learners in active learning, such as problem-based learning, inquiry-based learning, and project-based learning. DT was also integrated into

the school curriculum by introducing "maker spaces" or genius hours, where learners were given specific time to explore their creative abilities and interests (Juliani, 2014; Parker et al., 2021).

## Method

This present section describes the sequential process adopted for determining the relevant or appropriate papers which ought to be reviewed in this SLR. The common four sequential steps of this selection of relevant papers are enumerated below:

**Searching literature:** The step indulges in defining the search terms, determining data sources and identifying the data collection process.

**Inclusion Criteria and Exclusion Criteria:** In this step of SLR, specific criteria were defined for guiding the extraction process of the most appropriate relevant research or studies.

**Quality Evaluation:** In this phase, every article or the extracted journal papers were reviewed based on three criteria categories in quality evaluations. The section was elaborated in upcoming following section.

**Data Analysis:** Once the selected researchers were reviewed, the appropriate data were extracted and then recorded in the study.

**Step 1:Criteria for searching the literature:** To search out well-defined peer-reviewed databases, through inputting related keywords.
The phase indulges to decide the following:

**Databases utilised:** the data sources and electronic scientific articles chosen in sourcing papers for SLR were Google Scholar (www.scholar.google.com.au), Research Gate Portal(www.researchgate.net), Elsevier Publisher (www.elsevier.com), SAGE Publications, Frontiers (www.frontiersin.org), Springer Publications (www.springer.com), Taylor & Francis. The publisher databases mentioned were chosen primarily since the journals provide proficient coverage of literature that seems relevant to this SLR.

**Search Terms used:**To create the records to build out a literature database, search terms are specifically given to scholars. The search terms “Design thinking approach”, “Design thinking in education”, “Design thinking method in K-12 schools”, and “Design thinking as a signature pedagogy” were entered into the publication databases. The search key

terms yielded the results by retrieving nearly 328 papers from nearly 10 or more publications. The sources chosen included the literature surveys, research papers or empirical studies.

**Required information from chosen papers:**The essential information, that is required for every paper or record is the full-text document or the precise abstract.

**Publication period of records:**For any paper, that is considered for analysis of SLR, it just needed to get published after the year 2015. This seems logical since there is low consideration of non-fungible tokens, evolvement and usage before this period. The table below lists the selected journals category in which the articles are taken.

**Journals:** American Journal of Art and Design, Asia Pacific Journal of Educational, Canadian Journal of Education, Computers & Education, Design Thinking for innovation, Education Sciences, European Journal of Education, International Journal of Art & Design Education, International Journal of Instruction, International Journal of Technology and Design Education, Journal of Hospitality, Leisure, Sport & Tourism Education, Journal of the Learning Sciences, Open Education Studies, Organizations and Markets in Emerging Economies, Research and Practice, SN Business & Economics, Sustainability, System, Teaching Education, Teaching in Higher Education, Technological Forecasting and Social Change, Thinking Skills and Creativity, Wise &Ideo retrieved in as mentioned in Table 1. Identification of ArticlesandStep 2: Inclusion and Exclusion Criteria.

It is not the entire records or papers determined in the steps that have been considered for SLR presentation. Those papers were shortlisted further to the below inclusion criteria and exclusion criteria.

**Inclusion criteria:**It should consist of meta-analyses. The papers must present research papers, a literature review and a review paper with a defined search process, data extraction and research question. Regardless of whether the review or paper was the part of main component or any articles, the papers were included. The entire research work must be associated with the study area.

**Exclusion criteria:** The papers were excluded if the articles, papers or reviews of the records follow the below conditions:
If the articles or papers were duplicate reports or papers of similar research studies. The informal literature reviews which have no defined research question, no defined search

process and no nil-defined data extraction phase were excluded. If the articles or papers are not written in the English language were excluded.

The below Table 1 enumerates the stages involved in evaluating and choosing the relevant papers, articles or reviews for SLR.

| Filtration Stage | Method | Assessment Criteria |
|---|---|---|
| Identification of relevant researches | Determine all the related researches from database. | Search terms are included |
| Identification of relevant researches in stipulated time period | The elimination of studies performed based on publication date. | Exclude the studies that are published before 2015. |
| Applying 1st filtration | Selecting only related research titles to the keywords | If the title of the research includes the inputted keywords, like "Design thinking approach", "Design thinking in education", "Design thinking method in K-12 schools" and "Design thinking as a signature pedagogy" |
| Applying 2nd filtration | Deleting repeated or duplicated results | If two papers or more than that resembles the single paper, then the duplicated publications or papers were neglected. |
| Applying 3rd filtration | Selecting only related results based on the abstract | If the abstract of the study seems relevant to present research, it is included otherwise excluded. |

**Table 1. Summary of stages of evaluating and selecting relevant papers for SLR**

As depicted in Figures 2 and 3, the number of papers was 323 after searching out the publication venues. Among those research papers, few papers were neglected or excluded based on publication data, and around 150 research papers were considered. The studies were further eliminated based on appropriate keywords and titles and the resultant papers were 78. Further applying the fourth filtration stage, on reading out the abstracts,

the studies were refined to 52 papers as the finalised ones. In this stage, the abstracts of research are read and then assessed to neglect irrelevant research papers. Upon this evaluation, the count of research papers was minimized to 30.

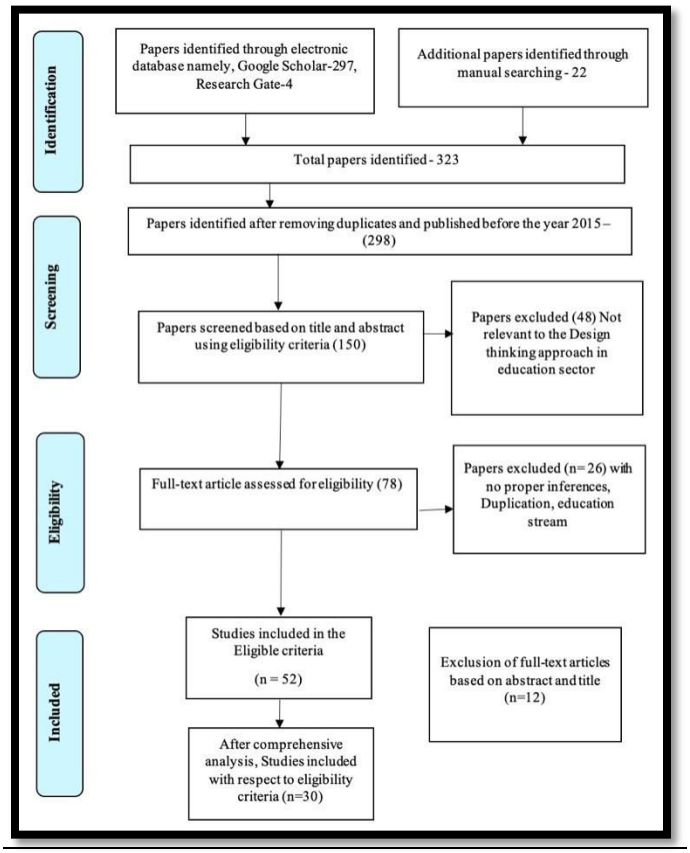


**Figure 2. Article Selection - PRISMA guidelines**

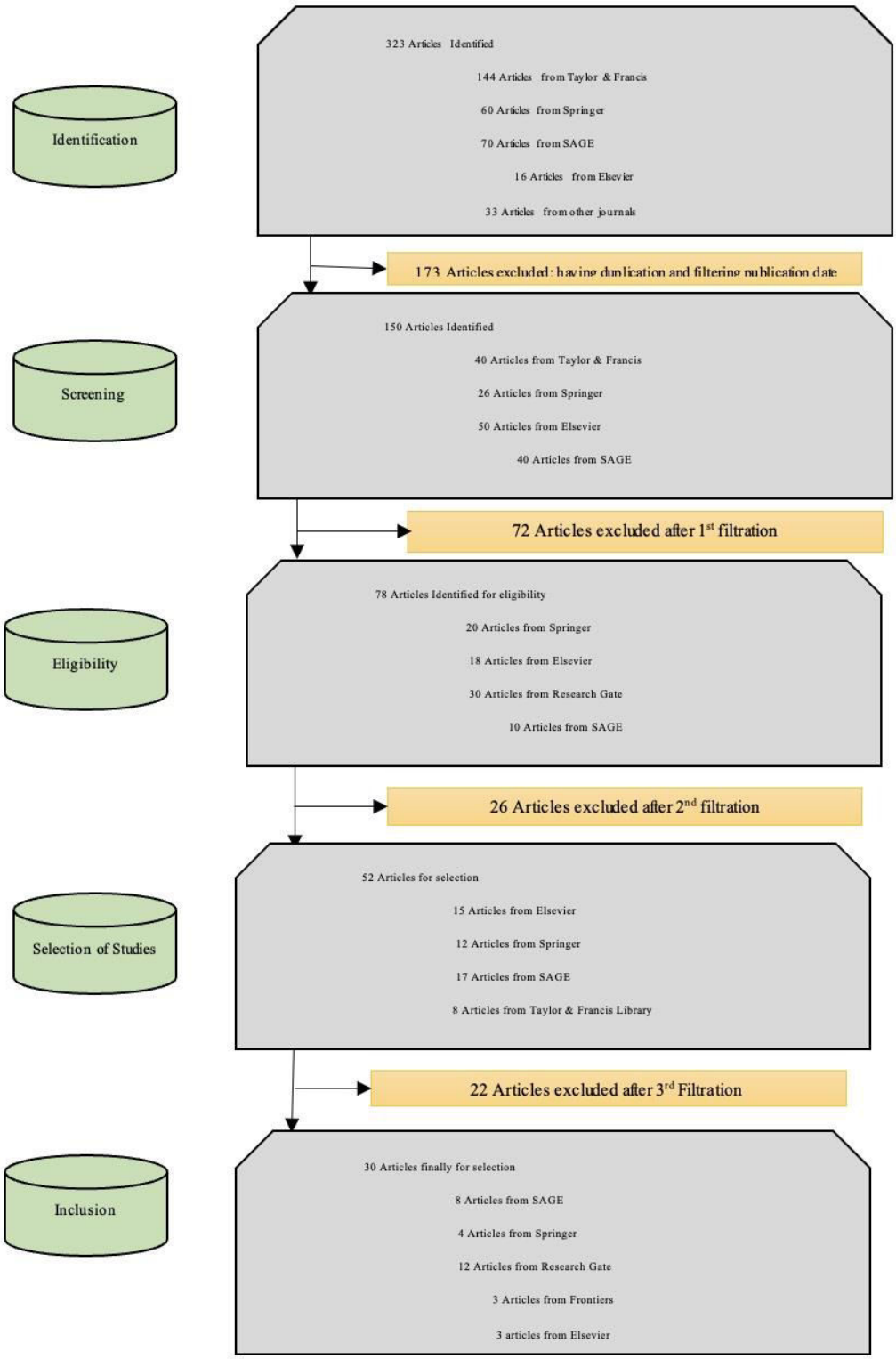


**Figure 3. Journal-wise Article selection**

**Step 3: Quality Evaluation:** The 52 papers from the selection knowledge are retrieved and evaluated critically based on three kinds of quality evaluation parameters stated below:
The paper should cover relevant research work and should explore research topics comprehensively.
The papers should offer clear implications with justifiable outcomes and their conclusions. The articles, papers or reviews should provide future directions. Any selected paper from among those 52 papers that had 'yes answers to three of these evaluation criteria was included in SLR. Out of the 52 papers, 30 papers satisfied this criterion.

**Step 4:** Shortlisted refined papers for this SLR and categorised them into broad areas. Every shortlisted paper was analysed as per scope, area of the topic, a summary of the research question and research answers, and information on the author and country. Based on this analysis, the chosen papers are classified into various broad areas such as how the innovative approaches to DT as a pedagogical method and the lessons acquired from applying DT to teaching strategy in K12-schools.

**Innovative approaches to the Design Thinking approach as a pedagogy**
Gruber et al. stated that the focus on the working methods and cognitive processes of designers has gradually shifted from the domain of industrial design to the wider realm of management in the context of education and training (Gruber et al., 2015) and inculcated in the research of Magistretti and Ardito (Magistretti et al., 2021). The utilization of designerly tools and designerly thinking, such as prototyping, human-centeredness, engagement among learners, map-building, and storytelling, can assist non-designers (such as policymakers and school managers) in effectively tackling complex and poorly defined challenges that extend beyond traditional design learning challenges.

The growing interest among researchers and businesses is becoming evident. Kurtmollaiev et al. conducted a study to investigate the relationship between innovation and the utilization of DT methodologies, tools, and complete DT approaches in their projects (Kurtmollaiev et al., 2018; Wylant, 2008). This innovative methodology produces a balanced state of harmony between the use and exploration of novel prospects, as well as the development and adaptation of the learning process. Liedtka et al. study report supports Norman and Verganti's claim that the first phase of DT is an inquiry process. This involves gathering data to reveal the fundamental needs of users, setting design standards, and redefining or reimagining problem definitions (Liedtka et al., 2020; Norman &Verganti, 2014). In the second phase, the practitioners apply design learning to create an innovative portfolio that includes alternatives that are possible. A prototype is

developed and potential solutions are assessed. Liedtka, et.al.suggested that DT seeks to challenge conventional understandings of barriers to learning and their proposed solutions. It then encourages learners or consumers to actively engage in every step of the process, especially generating ideas and carrying out real-world experiments (Liedtka et al., 2020).

S Bourgeois-Bougrine et al. emphasized that creativity is a crucial element of disruptive innovation, resulting in the creation of new and revolutionary concepts. Their research aimed to develop a highly effective system for enhancing DT in schools, with a specific focus on educational settings, to promote empathy and build a creative mindset among students. The instructors, practitioners, and management were progressively using the DT methodology to foster creative thinking and innovation in the students (Bourgeois-Bougrine et al., 2018). According to Lynch et al., learners need to acquire the necessary abilities to create an entrepreneurial, innovative, and creative learning environment in the corporate setting. Lynch, et.al. stated that the DT approach and its understanding may be utilized in a particular educational setting to generate creative solutions. The implications offered novel insights into the thoughts and experiences of students during and after their participation in the course. This would cultivate a mindset focused on entrepreneurship and improve comprehension of the process of commercializing technologies through the DT approach. The study's findings suggested that DT pedagogy could effectively engage science, business, and engineering students during their learning. The research examined the understanding of alternatives, such as human-centred design. The DT approach focuses on the learning process that starts with the research phase of creativity, followed by the construction of mock-ups and the presentation of early prototypes. It also involves enhancing design ideas, reflecting on the learning outcomes, and considering the social effects of the ideas(Lynch et al., 2021)

On a similar note to the research mentioned above, Yrjönsuuri et al. conducted a study to evaluate and highlight the specific benefits of material prototyping in the collaborative design process used in elementary schools. The research findings revealed that students in school utilized prototypes as a means to facilitate collaboration and enhance creativity. The artefacts played a crucial role in the investigation, as they were used to translate abstract ideas into tangible representations such as prototypes. These objects represent the process of thinking and play a crucial role in facilitating the formation of understanding through social interactions. The research also mentioned that the DT process in the learning environment is influenced by learners' understanding levels and skills, as well as the qualities of the artefact materials (Yrjönsuuri et al., 2019). McLaughlin and Lodge's study aimed to explore how studio learning in schools may be applied to

different disciplines, while also addressing the challenges faced by educators. The article focuses on the necessity for ongoing DT exercises by learners as well as educators to meet the knowledge-contextual requirements. The study reveals that the design approach is comprised of six primary stages, each of which is accompanied by secondary activities (McLaughlan& Lodge, 2019).

Padagas explained that the DT strategy aims to combine diverse fields of specialization and leverage distinct concepts. It utilizes tools from many domains to develop, synthesize, and analyse novel concepts and insights among K-12 learners through innovation. Padagas argued in the study that creative thinking promotes innovation, which is seen as crucial in improving decision-making processes. Hence, the acquisition of creative thinking is a crucial talent that students should develop through formal schooling. The key point raised in the paper's premise is that the teacher-centred model lacks innovative thinking and creativity for both learners and teachers. The issue could alternatively be resolved using DT. The statement stated that autonomy in learning may be enhanced through the implementation of innovative teaching methodologies such as DT (Padagas, 2021). Micheli et al. suggest the key to innovative learning design is the process of transitioning from abstract thinking to visualizing ideas, and then further developing thoughts beyond the visualization stage (Micheli et al., 2019).

Micheli et al. conducted a thorough literature review that adds to the knowledge of DT and innovation management techniques and theories. They argued that functional design teams were crucial for the successful implementation of DT and emphasized that DT approaches should prioritize the maintenance of emotion and communication among the team members (Micheli et al., 2019). According to a study conducted by Francis et al., professionals working in various STEM fields observed that learners who engaged in the investigation were utilizing design processes, problem-solving skills, collaboration, coding, and communication. The individuals described their experiences as including solving problems, trial and error, and experimentation. The study is aimed to enhance educators' comprehension of spatial reasoning and promote the integration of spatial reasoning in primary education (Francis et al., 2017).

Brenner et al. define DT as a process, tool, and mindset for learners, as stated in their research. The DT approach was marked by several important ideas, including the incorporation of both convergent and divergent thinking, prototyping, and a heightened focus on uncovering the hidden needs of learners (Brenner et al., 2016). The learners' projects typically required the use of technology together with simple tools. The learners in school follow a DT process that allows them to unleash their creativity while also

ensuring a more organized approach to project accountability. In this particular situation, an integrated curriculum proves to be more effective on this platform. Meinel et al. conducted a research study where they analysed data from fifty-three teams and compared the performance of a team using DT with a control group. The study found that the DT team outperformed the control group in terms of the specificity, relevance, and feasibility of the concept. However, there was no significant difference in terms of uniqueness. The learner, with their unique ideas, has the potential to foster team collaboration in the information-sharing process and stimulate creativity in generating ideas. Additionally, they possess exceptional communication skills across all project phases (Meinel et al., 2020).

Learning about global citizenship, character growth through collaboration among teammates, creative thinking, communication, and critical thinking goes beyond the boundaries of their respective subjects. Therefore, incorporating a DT curriculum is an effective method for teaching the competencies necessary for the 21st century and enhancing academic performance. Drake and Reid stated that pupils can distinguish between credible and relevant data and deliberately fabricated alternative facts. A creative thinker who can generate ideas is needed to gain unhindered access to information. The competencies required are being cognizant of effectively manoeuvring through a constantly evolving and dynamic environment (Drake & Reid, 2018). The key skills being instilled through innovative DT solutions are critical thinking, creative thinking, and high-order thinking, as they serve as key advantages of interdisciplinary activities. Referencing Meyer and Norman, the integrated curriculum should offer an adaptable, realistic recommendation, offering flexibility and guidance, that permits curricular design, and innovation and tracks recent development in the field. Fusion is probably the approach that has begun in integrating the learning curriculum(Meyer & Norman, 2020). The general approach focussed on empowering the students to have better user communication with empathy to recognize the real-world problem constraints, possibly restructuring it, co-designing the project objectives, and co-creating the user's solution to the problem.

Anagün's research revealed that the results of the DT approach demonstrated a favourable correlation between 21st-century competencies and teachers' perceptions of the constructivist learning environment in schools. The simplified meaning is that when teachers develop a greater understanding, aligned with critical thinking, problem-solving abilities, creativity, communication, and collaboration among students, it leads to improved learning and teaching outcomes. Engaging in this technique can enhance

students' comfort in the learning environment and promote their willingness to explore and inquire, ultimately fostering a positive mindset among students (Anagün, 2018).

According to Balakrishnan, the effects of the DT tool enhance the growth of innovative abilities and drive among design graduates. During DT, the exercises have a positive effect on raising the learner's awareness and enhancing their ability to think critically. The development of critical thinking abilities in learners will enhance their ability to communicate effectively orally (Balakrishnan, 2022). Ponce argued that the collaborative nature of DT could be applied to any educational program to help students develop a cognitive structure that prioritizes collaboration, inclusivity, and equity. Ponce discovers the traditional types of specialized knowledge and explains how this isolation was not enough to produce the best results (Ponce, 2021).

In the review, Robinson et al. asserts that the adoption of DT as a learning approach promotes a change in focus from instructor to student-centred learning (Robinson et al., 2016). Gemmill expressed his perspective on the necessity of educating pupils about ambiguity instead of simply giving them issues to solve (Gemmill, 2011). Rowland stated that the component of the design process instructs learners on the skills of empathy towards their peers in schools, embracing uncertainty, and taking accountability for their actions (Rowland, 2004).

**Lessons from applying DT as a pedagogical strategy**

Secondary education learners need a greater level of proficiency and creative abilities that are inadequately provided by the existing educational framework. Educators are requesting robust pedagogical support to enhance their teaching skills, with a particular focus on meeting the demands of the 21st century. To achieve the objectives, it is necessary to implement a distinct culture of experiential learning in school practices for each project. One particular research project was the introduction and implementation of a pilot study aimed at teaching co-creation, collaboration, and innovation in secondary education. The proposed pedagogy technique utilized a design approach that incorporated critical thinking, an entrepreneurial mindset, and digital skills. It also emphasized experimental cooperation, fostering a culture of making and creating. The goal was to strengthen students' abilities to collaborate, co-create, and engage in inventive project-making and thinking. The primary consequence is that this type of suggested teaching method improves the students' abilities (Androutsos&Brinia, 2019).

Managing and maintaining the progress and learning status of DT might be somewhat challenging. If the teachers lacked sufficient training or did not receive adequate support

regarding DT, it could provide barriers to implementing DT in the classroom, particularly with young learners. Teachers who were enthusiastic about exploring DT may encounter pushback from school management due to the perception that DT is unconventional. This might hinder educators with a lack of flexibility or access to resources (Henriksen et al., 2018).

People need to have the ability to resolve real-world problems through the use of technological tools, hence stimulating learners' motivation to learn. The learners participating in this study on DT claimed that DT encouraged learning processes by facilitating the development of innovative solutions through data visualization. Furthermore, scaffolding strategies and instruments should be specifically crafted to facilitate the process of DT. For instance, learners could employ the tools to disseminate digital works and concepts. By implementing this concept, students would have the opportunity to engage in a collective DT process and connect their theoretical knowledge from the textbook with practical, real-world experience through their projects. The DT mindsets have assimilated more effective ideas in a more accessible manner, hence indirectly fostering the acquisition of subject matter knowledge. Consequently, the teacher's role shifted from teaching to developing the project and providing support during its implementation. The educators should revamp the activities in the project to actively involve the learners in the execution phase and then instruct them on the methods for gaining knowledge instead of passively teaching them (Lin et al., 2020).

In another investigation, a group of educators worked together to actively promote students' flexible utilization of time and physical environment. The inference provides new and unique perspectives on the reflections and experiences of students who are involved in a course that combines entrepreneurship and technology through the use of DT. This course challenges students to recognize and capitalize on commercial and technological possibilities. Hence, students understand that starting a new project requires not only teamwork and critical thinking but also the organization and inventiveness of the activities involved as part of the school curriculum. The DT approach provides a fresh opportunity for learning that focuses on the practical use of technology rather than solely relying on theoretical concepts. School educators must consider the subtle distinctions when designing educational programs for novice learners, school experts, and influential policymakers. These collectives foster the cultivation of transferable talents and entrepreneurial mindsets among students. (Lynch et al., 2021).

**Design Thinking Framework**

DT in education was conceptualized as design-based learning. This learning was believed to improve resilience, originality, involvement, inventiveness, and critical thinking abilities. The benefit of incorporating DT in pedagogy is in its ability to cultivate the qualities necessary for students to collaborate in multidisciplinary groups and implement design-driven, constructive transformations in society.

The institutions might initiate the process by formulating project definitions and establishing performance requirements for fundamental competencies. The performance criteria might function as an evaluation rubric. An example of a rubric for assessing creative and critical thinking would include many categories based on the definitions provided.

Inquiry - To ascertain, investigate, and synthesize information.
Idea Generation - Generating actions and possibilities.
Analysing - Assessing and combining the methods and rationale.
Contemplating the methodology and approaches of thinking.

The curriculum planners can begin by adopting a unifying model that provides an overarching framework and serves as a foundation for unit plans or courses. The procedure acknowledges the knowledge-driven approach and prioritizes the competencies of learners.

Next, the educators should be encouraged to adopt an integrated design solution approach to the curriculum at the correct stage. The team focusing on pertinent and dynamic interdisciplinary topics is crucial, and it should strengthen the notion that teaching that combines skills with an integrated curriculum would be an effective teaching method.

Ultimately, teacher training and innovation programs should incorporate direct teaching approaches that align with students' competencies. Additionally, educators should get continual professional development that effectively enhances their teaching practices.

Betty Ray recommended working in collaborations or small groups, proceeding with six DT steps: opportunity identification, design, prototype, getting feedback, scale-out, and present (Ray, 2012). One of the overarching principles pertains to how inquiries are posed and opinions are conveyed. The students were instructed to respond affirmatively by saying "yes" when they concur with the concepts put forth by others, and to express

disagreement by using the phrase "yes...but". The purpose of this activity is not to dissuade students from communicating their viewpoints, but rather to engage in the exploration of additional perspectives that are necessary for constructing project prototypes. The concept said that even a minor deviation could have a significant impact on the outcomes (Razali et al., 2022). The activity commenced with a problem provided to be solved by students. Such activity consists of six phases.

**Phase 1: Identifying possibilities:** The step is carried out through active participation in group activities or class discussions. At this stage, students are required to ascertain the indispensability of the problem that needs to be resolved and identify the individuals who would gain from the solution. It is recommended to select an external person/s who has been personally affected by the topic and share their firsthand experiences. The learners must conduct interviews with those individuals. This can be accomplished by personal engagement in extracurricular activities or by inviting external individuals to participate in lessons, allowing learners to engage in questions or interviews.

**Phase 2:The designing and planning activity:** During this phase, learners should critically analyse the narratives they have encountered in the previous phase and engage in a collaborative process of generating innovative solutions. An effective method involves distributing pens and sticky notes to the learners, allowing them to engage in a brainstorming session to generate potential ideas. After the learners finish brainstorming, it is important to identify the main topics. Then, the learners should form smaller groups to conduct an inquiry into their initial ideas.

**Phase 3: Prototype:** It is crucial to evaluate the concepts initiated or developed and choose one particular prototype. The prototype ought to fix one aspect of the issue at hand. Currently, one solution is specifically aimed at addressing the identified problem component. Subsequently, the students select the subsequent difficulty component and adopt an analogous strategy. To gain a visual representation of the cognitive process, it is advisable to create a brainstorming map that accurately depicts the sequence of thoughts.

**Phase 4: Feedback and Review:** In this phase, the groups present their solution to outside experts to receive suggestions. It is recommended to have a minimum of two experts who come from different categories of stakeholders.

**Phase 5: Expand and Transmission:** During this part of the process, the learners engage in collaborative teamwork to identify the optimal solution to the challenge presented in the preceding phase. During the process, teachers can offer support by guiding

possibilities. If the teams received differing feedback from specialists, they may be divided into smaller teams, with each team focusing on a specific topic. Subsequently, the sub-teams can merge and reach a consensus on the overall structure, presentation, design and format.

**Phase 6: Share:** The problem-solutions are put forth by the teams. To enhance the significance of the process for learners, individuals who have been interviewed by students in the initial stage may be extended an invitation to participate.

The primary benefit of this activity is that it gives learners the possibility to address real-life issues and offer solutions to those in need. The learners thoroughly examine all potential alternatives, including even the most subtle distinctions, and ultimately reach an outcome. The DT approach proposes that each problem can be addressed through multiple iterations. The obstacle faced by the practitioner or educator may be dependent upon the fact that the task cannot be completed during a single lecture or class, and thus requires a significant amount of time. To facilitate the DT approach for the project-based activity, the educator might provide clear and specific timelines for each task.

**Discussions**

DT offers school-based activities that promote both teamwork and individual work. These activities aim to prepare students for future tasks and enhance their understanding of DT pedagogy. The learners are actively engaged in the process of preparing interviews, focusing on the questions of "What? How? and Why?" This allows for collaborative sharing and capturing of ideas within teams, as well as independent work. An empathy map generated will facilitate group collaboration. The DT framework provides a methodology guide for utilizing numerous activities. For example, the "Why How laddering" journey map outlines multiple brainstorming techniques that can be utilized in effective manners (Luka, 2019). The researcher proposes the incorporation of DT fundamentals in the educational setting to achieve favourable outcomes. This includes involving various stakeholders, broadening the scope of the classroom, expanding opportunities for learning, promoting student diversity, and facilitating knowledge sharing beyond physical boundaries. The DT approach offers a variety of materials, methodological tools, and practical guidelines that are used to develop abilities in DT, such as creativity, team collaboration, critical thinking, and innovation. These skills are applied both in self-directed learning and in the classroom to varying learning methodologies. The educators might potentially embrace this pedagogical DT approach and modify traditional resources to suit specific target groups and pedagogical needs

while incorporating the DT concept to create their own learning and teaching aids and to motivate and enhance the learning experience of students.

## Conclusion

Innovation can be strengthened by either making gradual improvements to existing systems or by introducing completely new approaches or methods. In the context of demographic variation and global competition, the importance of innovation becomes more significant as people age and the need to retain resilience in a nation's economy increases. Education, too, should be revolutionized at all levels. This could be achieved through the use of the DT approach, which is applicable in pedagogy and can be implemented in schools to promote diversity in the learning and teaching process and foster motivation among learners. The current education paradigm is recognized to have several deficiencies in developing pedagogy and predictors for student achievement, such as the growth mindset. The articles provide a comprehensive overview of the use of DT in educational contexts by conducting a thorough literature study. DT pedagogy, through its teaching approaches, procedures, and techniques, presents a valuable chance to emphasize cognitive abilities and abductive thinking in learners. The importance of having empathy skills across various professional fields suggests that including DT pedagogy as an educational tool in K-12 schools will establish a strong basis, aiding all students in becoming innovative professionals and guiding them towards active participation in school and future success in their careers as professionals. The current examination of the literature on the DT approach to teaching in K-12 schools at the elementary and secondary levels establishes a strong basis for future experimentation.

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