

## Abstracts

In this section we present the abstracts for each research article published in this issue of the journal. The abstracts are arranged in the same order as the full articles. We hope this is a useful addition to the journal and welcome feedback on the approach.

### The way Technology Teachers Think: The Role of Metaphor and Reflection for Technology Education practice

**Andreas Larsson, Linköping University, Sweden**

#### **Abstract**

This study investigates how technology teachers reflect on their practice by examining the metaphorical structures that underpin their reasoning. Drawing on Conceptual Metaphor Theory and supported by an AI-assisted Metaphor Identification Procedure (MIP), the analysis focuses on recurring metaphorical themes that shape how teachers make sense of challenges, plan instruction, and imagine future classroom scenarios. The results reveal a set of interrelated themes—such as time as a resource, learning as motion, teaching as burden, and structure as cohesion—that reflect and reinforce a view of teaching as a managed and goal-oriented activity. These metaphors are not merely descriptive devices; they function as cognitive tools that organise experience and support pedagogical decision-making. By framing teaching through metaphors of motion, containment, construction, and effort, teachers can navigate complex classroom dynamics and articulate a coherent sense of professional agency. The findings suggest that metaphor plays a dual role in reflection: both representing experience and guiding prospective reasoning. In this sense, metaphors support what is often described as reflection-for-action, where familiar conceptual frames are used to simulate possible futures. By surfacing these metaphorical patterns, the study contributes to a deeper understanding of how teachers conceptualise their work and offers a foundation for professional dialogue and development in technology education.

### Generative AI – Creative Pedagogy Versus Creative Application

**Dale Addy, Watkins College of Art, Belmont University, USA**

#### **Abstract**

Generative Artificial Intelligence (GenAI) is rapidly changing and influencing the advertising and graphic design industries. GenAI is reimagining workflows and modifying the skills required for new graduates to secure their first jobs. Agencies are investing in AI technologies, and creative

departments are leveraging GenAI for client engagement and conceptual development. However, design educators have been slow to adapt to this change. This lag risks leaving graduates unprepared for a creative industry in the midst of a technological transition. This qualitative study investigates how GenAI is being utilized in creative departments and how design educators are responding. Based on in-depth interviews with agency leaders and design faculty across the United States, a learning gap was made apparent. Agency leaders see GenAI as an essential creative tool for accelerating ideation and concept visualization, while educators remain cautious and prioritize foundational design training. Early pedagogical adopters understand the benefits of integration, but most curricula incorporate GenAI inconsistently, often relying on individual faculty initiative. The findings reveal the need for design educators to help students embrace GenAI as a tool that expands creative exploration and conceptual thinking. In an effort to remain relevant, graphic design educators must train students in both design and GenAI fundamentals. The ability for graduates to create authentic, human-centered design work will be the definition of success in an AI-driven creative industry.

## Assessing Students' Computer Programming Skills: How Technology Teachers in Sweden Evaluate Learning in Grades 4–6

**Eva-Lena Bjursten, Mälardalen University, Sweden**

**Lena Gumaelius, KTH Royal Institute of Technology, Sweden**

**Eva Hartell, KTH Royal Institute of Technology, Sweden**

### Abstract

This study aims to deepen the understanding of how computer programming is taught and assessed in Swedish schools by focusing on teachers' perspectives. It explores how technology teachers (teaching years 4–6, students aged 10–12) perceive their roles and responsibilities in teaching computer programming, primarily within the technology subject, and examines what computer programming content is taught and assessed. The research is based on a survey and interviews with seven experienced teachers who taught computer programming before it became mandatory. The findings reveal similar views among the teachers but also significant variation in assessment practices, categorized into four distinct personas, ranging from a strong disciplinary content and product focus to a weaker disciplinary content and process orientation. The discussion reflects upon how these variations may be influenced by teachers' backgrounds, computer programming knowledge, and unclear policy documents. The conclusions suggest that, due to this variety, Swedish students may not be equally equipped with the digital skills needed for participating in a digitalized society. To enhance equity, we argue that teachers need better preparation to effectively integrate computer programming skills across subjects. Additionally, we recommend clearer national guidelines on how to teach computer programming and how to assess this subject content in compulsory education.

## Designing for Entrepreneurship: STEM-Based Approaches in Primary Education

**Cemre Saraçlar, Independent Researcher, Türkiye**

**Ahmet Oğuz Akçay, Eskisehir Osmangazi University, Türkiye**

**Engin Karahan, Middle East Technical University, Türkiye**

### **Abstract**

This study aims to enhance primary school students' entrepreneurial skills by integrating STEM education. Employing a qualitative action research design, the study involved 19 fourth-grade students (aged 9–10) selected via convenience sampling. Over a six-week period totaling 18 instructional hours, researchers implemented two STEM-based activities aligned with the study's objectives. Data were gathered from multiple sources, including video recordings, e-portfolios, student journals, researcher journals, and student-generated artifacts. The research was guided by a framework encompassing 22 entrepreneurial skills, categorized into three domains: knowledge, skills, and attitudes. Findings indicate that while students did not demonstrate complete competence in all areas, particularly within the entrepreneurial aptitude domain, they showed notable development in their understanding, practical skills, and attitudes related to entrepreneurship.

## A repurposed geometric reasoning model for Engineering Graphics and Design: a conceptual paper

**Vernon Candiotes, University of Pretoria, South Africa**

**Willem Rauscher, University of Pretoria, South Africa**

**Sonja van Putten, University of Pretoria, South Africa**

### **Abstract**

Engineering Graphics and Design is a South African school subject which is foundational to fields such as mechanical, electrical, and civil engineering. However, persistent shortcomings in this subject's instruction have been documented in the South African National Senior Certificate examiners' reports over the past decade. These issues stem primarily from ineffective instructional strategies and a lack of structured reasoning development. These methodological deficiencies may influence the development of learners' visuospatial reasoning skills and conceptual understanding. The situation is exacerbated by the fact that no model for developing such conceptual understanding and reasoning currently exists in the Engineering Graphics and Design field. The need for such a model prompted our search for a suitable model for the structured development of visuospatial reasoning skills, culminating in this conceptual paper. We address the gap by demonstrating how the van Hiele model of geometric reasoning can be particularised to suit the needs for the development of visuospatial reasoning skills in this subject. Our methodology involved the extraction of nine cognitive descriptors from the

relevant literature dealing with the van Hiele model. We explain how these descriptors align with Engineering Graphics and Design reasoning requirements. The proposed model offers both diagnostic capabilities for assessing student reasoning levels and instructional guidance for systematic skill development. It is recommended that empirical studies be conducted to test the usability of this repurposed model both in teaching and in the evaluation of the levels of reasoning in assessments.

## The invisible remains invisible: a study of systems thinking in compulsory school students' descriptions of a wastewater system

**Nina Emami, KTH Royal Institute of Technology, Sweden**

**Susanne Engström, KTH Royal Institute of Technology, Sweden**

**Claes Klasander, Linköping University, Sweden**

### **Abstract**

This study investigates how ninth-grade students in Swedish compulsory school describe and explain a technological system: the wastewater system. The analysis focuses on students' verbal explanations while illustrating their self-drawn models of the system. Eleven students (aged 15–16) participated through semi-structured individual interviews. Transcripts and models were analysed using Hallström et al.'s (2022) classification model for system understanding and thematic analysis. The results indicate that most students were able to identify the system's purpose, namely, the collection and treatment of domestic wastewater, and describe components such as household outlets, sewer pipes, and treatment plants. However, their descriptions were largely linear and focused on visible components, such as inlets and manholes. Few references were made to energy flows, information control, system boundary, or interdependencies with other systems. Most students' reasoning remained at the Multistructural level; only two demonstrated relational understanding, and none reached an extended abstract level. The thematic analysis revealed that students faced difficulties in understanding temporal processes, feedback mechanisms, and the consequences of system failures, highlighting difficulties in grasping system complexity. The study calls for instruction that explicitly makes hidden structures, interconnections, and sustainability aspects visible in technological systems. It proposes combining student-generated drawings with visualizations, simulations, and structured reflection to promote deeper and more transferable systems thinking in technology education. Although grounded in a Swedish context, the findings and suggested teaching strategies may inform broader educational settings and contribute to strengthening systems thinking as a core competence in technology education globally.

# A Serious Game Proposal for Raising Awareness on Sustainable Development in the Built Environment

**Burcu Olgen, Concordia University, Canada**

**Negarsadat Rahimi, Concordia University, Canada**

**Carmela Cucuzzella, Université de Montréal, Canada**

## Abstract

Interactive serious games enhance science-based communication and promote deeper learning about sustainable development. It is yet undiscovered that how can AI-augmented interactive experiences enhance the engagement and spread awareness. This study proposes an AI-augmented digital serious game in public installation format. First, the study introduces a serious board game centered on Sustainable Development Goal (SDG) 11 to test the learning aspects and the engagement of the game. The study hypothesizes that a serious game with a clear message, engaging mechanics, and appealing design can significantly enhance understanding of sustainability's relevance to everyday life. Using a Research through Design (RtD) approach, the study incorporated iterative feedback from pilot tests. These tests highlighted the effectiveness of problem-solving and group discussions in fostering engagement. The insights directly informed the design of the digital version, which emphasizes streamlined and accessible gameplay.

# Design Thinking in educational publications: A document analysis of books issued by Turkish Public Institutions and implications for the Technology and Design course \*

**Ahsen Öztürk, Kütahya Dumlupınar University, Türkiye**

## Abstract

This research aims to investigate how the design thinking (DT) approach in education is defined and implemented in related books published by public institutions in Türkiye. The document analysis method, a qualitative research method, was used for data collection and analysis. Seven books published by the Republic of Türkiye Ministry of National Education (MONE) and the Scientific and Technological Research Council of Türkiye (TÜBİTAK) were selected as the data. Findings indicate that DT is perceived as a human-centered and interdisciplinary problem-

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\* This article was produced from the study titled "What Does Design Thinking Mean in Turkey? Analysis of DT-related Books Published by Public Institutions", which was presented as an extended abstract at EDUCONGRESS 2022 (International Education Congress) on 18.11.2022.

solving process that requires a set of skills and mindsets and incorporates some values associated with 21st-century skills. In the books, the matter of how to develop a designer's mindset and skills in non-designers – teachers and students – is generally overlooked or under-emphasized. Therefore, the DT approach in education is not comprehended and practiced as a holistic approach that requires the interaction between relevant processes, mindsets, and tools. Considering the findings, incorporating the human-centered, experimental, and collaborative characteristics of the DT approach into the educational culture or teaching method can help teachers and students to adopt DT as a holistic approach rather than just a problem-solving process. The DT approach can also be employed as a tool to establish a context for technology teaching or integration. In line with this, some strategies are proposed to strengthen the integration of the DT approach within *Technology and Design* education. This research is considered significant in terms of providing teachers with a perspective on the DT approach and how it is integrated into *Technology and Design* education.

## Recurriculation of Engineering, Technology, and Technical Education Programmes for the adoption of Industry 5.0

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### **Abstract**

Industry 5.0 is a new emergent industrial revolution that admits and promotes mutual and coordinated interaction of industrial workers' brains and creative skills, and artificial intelligence machines' qualities to maximize production in industries. Thus, the advent of Industry 5.0 demands new skills, knowledge, attitude and responsibilities/roles from workers to enable them to fit the positions. Consequently, Industry 5.0 has significant implications for engineering, technology and technical education programs. These programs need to be reshaped for the purpose of producing worthwhile graduates that can easily be absorbed into Industry 5.0. However, this article focuses on the 'recurriculation' of engineering, technology and technical education programs for adopting Industry 5.0. The article is anchored on a literature review. Specifically, the article dwells briefly on the pre-industrial revolution, Industry 1.0, Industry 2.0 and Industry 3.0. The article explicates on Industry 4.0 and Industry 5.0. Similarly, the article identifies problems that emanated during the Industry 4.0 era. It explains the importance of human beings in industries. Also, this article explains the needs for improving the knowledge, skills and attitude of industrial workers during Industry 5.0. Being a program where knowledge, skills and attitude needed in industry 5.0 can be acquired, the article briefly conceptualizes engineering, technology and technical education. Furthermore, the article explains the concept of recurriculation of engineering, technology and technical education programs. Finally, the chapter explains the phases for the recurriculation of engineering, technology and technical education programs.