A DESIGN-BASED INSTRUCTIONAL MODEL INTEGRATING DIGITAL STORYTELLING FOR CREATIVE THINKING SKILLS IN CHINESE HIGHER EDUCATION

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Abstrak

Penceritaan digital semakin mendapat perhatian dalam pendidikan tinggi, namun kebanyakan kajian masih menanganinya sebagai intervensi pedagogi berbanding amalan reka bentuk multimedia. Akibatnya, interaksi antara pembinaan naratif, pengorkestraan multimodal, dan penjujukan pengajaran dalam menyokong pemikiran kreatif kurang diberi perhatian, sekaligus mewujudkan kekurangan kerangka penyelidikan yang berorientasikan reka bentuk dan menjelaskan proses secara eksplisit. Kajian ini mencadangkan model Penceritaan Digital untuk Kemahiran Pemikiran Kreatif (DSCTS) yang mentakrif semula penceritaan digital sebagai sistem reka bentuk naratif multimodal yang berorientasikan proses. Model ini menjelaskan bagaimana pemikiran kreatif diintegrasi dalam aliran kerja penceritaan digital dengan menghubungkan penjanaan idea naratif, komposisi multimodal, dan penambahbaikan secara iteratif dengan dimensi pemikiran kreatif yang dimaklumkan oleh kerangka 3P. Berlandaskan prinsip pembelajaran konstruktivisme serta dioperasikan melalui model ADDIE dan pendekatan pembelajaran berasaskan projek, Dengan mengaplikasikan paradigma Penyelidikan Sains Reka Bentuk (DSR), kajian ini mengikuti proses pembangunan berperingkat yang merangkumi sorotan literatur komprehensif, kajian awal bersama pengajar, penilaian pakar, pemprototaipan dan penambahbaikan secara iteratif. Satu intervensi selama lapan minggu yang melibatkan 31 orang pelajar telah dijalankan bagi menilai keberkesanan model DSCTS. Hasil kuantitatif daripada Ujian Torrance bagi Pemikiran Kreatif (TTCT) menunjukkan peningkatan yang signifikan secara statistik dalam kemahiran pemikiran kreatif pelajar. Dapatan kualitatif turut menunjukkan bahawa model ini menyokong reka bentuk penceritaan multimedia yang lebih koheren serta meningkatkan penglibatan pelajar dalam pembangunan naratif dan proses kreatif secara iteratif. Walaupun terhad dari segi saiz sampel, skop disiplin, dan tempoh intervensi, kajian ini menyediakan asas penting untuk penyelidikan masa hadapan dalam memperhalusi dan mengembangkan kerangka penceritaan digital berorientasikan proses merentas pelbagai bentuk naratif dan konteks reka bentuk.

Kata kunci: Penceritaan digital (DS), Kemahiran pemikiran kreatif (CTS), Model reka bentuk konseptual, Penyelidikan Sains Reka Bentuk (DSR).

Abstract

Digital Storytelling has gained attention in higher education; however, most studies treat it primarily as a pedagogical intervention rather than a multimedia design practice. As a result, insufficient attention has been given to how narrative construction, multimodal orchestration, and instructional sequencing interact to support creative thinking, leading to a lack of process-explicit and design-oriented frameworks in digital storytelling research. This study proposes the Digital Storytelling for Creative Thinking Skills (DSCTS) model which reconceptualizes digital storytelling as a process-oriented multimodal narrative design system. The model explicates how creative thinking is embedded in digital storytelling workflows by linking narrative ideation, multimodal composition, and iterative refinement to creative thinking dimensions informed by the 3P framework. Grounded in constructivist learning principles and operationalized through the ADDIE model and project-based learning. Adopting a Design Science Research (DSR) paradigm, the study followed a multi-stage process that included a comprehensive literature review, a preliminary instructor study, expert evaluation, prototyping and iterative refinement. An eight-week intervention with 31 students was conducted to evaluate DSCTS model effectiveness. Quantitative TorranceTests of Creative Thinking (TTCT) results showed a statistically significant improvement in creative thinking skills. Qualitative feedback, also indicates that the model supported coherent multimedia storytelling design and enhanced students' engagement in narrative development and iterative creative processes. Despite limitations related to sample size, disciplinary scope, and intervention duration, this study provides a foundation for future research to refine and extend process-oriented digital storytelling frameworks across diverse narrative and design contexts.

Keywords: Digital storytelling (DS), Creative thinking skills (CTS), Conceptual design model, Design science research (DSR).

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List of Abbreviations

DS	Digital Storytelling
EDS	Educational Digital Storytelling
CTS	Creative Thinking Skills
DSCTS	Digital Storytelling for Creative Thinking Skills
DSR	Design Science Research
PBL	Project-based Learning
ADDIE	Analyze, Design, Develop, Implement, and Evaluate
CTML	Cognitive Theory of Multimedia Learning
SAMR	Substitution, Augmentation, Modification, and Redefinition
TPACK	Technological Pedagogical And Content Knowledge
3D	Three Dimensional
2D	Two Dimensionalq
RQ	Research Question
RO	Research Objective

List of Pubilications

1. **Tian, Y.,** & Suki, N. M. (2023). Evaluating Future Trends of Digital Storytelling in Higher Education: A Bibliometric Analysis. *International Journal of Interactive Mobile Technologies,* 17(17).

2. **Tian, Y.,** Suki, N. M., & Omar, A. C. (2021, November). Two Decades of Digital Storytelling: A Comprehensive Bibliometric Analysis. In *2021 IEEE 19th Student Conference on Research and Development (SCOReD)* (pp. 125-129). IEEE.

CHAPTER ONE

INTRODUCTION

1.1 Overview

This chapter provides a comprehensive background analysis of the study, emphasizing the role of digital technology in fostering students' creative thinking abilities within the Chinese educational context. It examines the current state of research on educational digital storytelling, highlighting its potential to enhance students' creative thinking skills. The chapter identifies a research gap in developing a conceptual model that leverages digital storytelling to improve students' creative thinking abilities. It outlines the study's objectives and contributions, defines key terms, and delineates the research scope and thesis structure.

1.2 Background of the Study

In the era of artificial intelligence (AI), creative thinking skills (CTS) have emerged as a decisive competency that extends beyond the accumulation of knowledge. Grybauskas et al. (2022) identify contemporary social development as shaped by three interconnected trends: informatization, digitisation, and intelligence. Within this context, talent is no longer evaluated by the sheer volume of knowledge retained, but by the capacity to apply knowledge innovatively, integrate information across modalities, and generate novel solutions (Li & Zhu, 2021). Consequently, traditional educational approaches centred on rote memorisation and passive knowledge transmission have become increasingly inadequate for addressing the demands of complex, technology-rich work environments. Employers now place greater emphasis on individuals’ creative thinking, problem-solving ability, and capacity to work with digital and multimedia information. As Nasifoglu Elidemir, Ozturen, and Bayighomog (2020) argue, competition for talent in the 21st century is fundamentally a competition for creativity.

A growing body of research has demonstrated that CTS, like other higher-order skills, can be systematically cultivated across different age groups and educational levels (Dou, Li, & Jia, 2021; Gube & Lajoie, 2020; Kim, 2017; Karaahmetoğlu & Korkmaz, 2019). This recognition has elevated creativity development to a central concern of contemporary educational research. In the digital age, attention has increasingly shifted from the mere presence of technology in classrooms to the pedagogical design of multimedia learning environments that actively engage learners in creative meaning-making. Multimedia design, understood as the intentional integration of text, images, audio, video, and interactivity, has been shown to support deeper cognitive processing and creative engagement when guided by sound instructional principles (Mayer, 2002, 2020).

University students, often described as "digital residents," are already deeply immersed in multimedia environments through smartphones, tablets, and digital platforms used for both learning and everyday communication (Gonzalez-Ramirez et al., 2021). Leveraging students' familiarity with multimodal media through well-designed multimedia learning tasks aligns with their existing learning behaviours and provides fertile ground for cultivating CTS. Empirical evidence suggests that active engagement with multimedia creation, rather than passive consumption, can deepen conceptual understanding while simultaneously stimulating divergent thinking, originality, and elaboration (Lynch et al., 2021; Bedir, 2019; Lu & Xue, 2017). From this perspective, multimedia design functions not merely as a technical skill, but as a cognitive and creative process through which learners externalise ideas, test alternatives, and refine meaning.

Within the broader framework of 21st-century skills (Rotherham & Willingham, 2010; Joynes, Rossignoli, & Amonoo-Kuofi, 2019; Khoiri et al., 2021), CTS occupy a central position alongside digital literacy and communication competence. These skills are increasingly interdependent, as creative expression in contemporary contexts is often mediated through digital and multimedia forms. Employers consequently prioritise graduates who can think creatively while effectively working with multimedia tools and digital content (Hassan et al., 2021; Steinerowska-Streb & Głód, 2020). Furthermore, recent disruptions in the global economic and employment landscape, particularly in the aftermath of the COVID-19 pandemic, have intensified the demand for graduates capable of navigating uncertainty, adapting creatively, and communicating ideas across digital platforms (Cech & Hiltner, 2022; Raifman, Bor, & Venkataramani, 2021). From both individual and societal perspectives, fostering CTS through digitally and multimedia-rich learning environments has therefore become an educational imperative.

In sum, the AI era has foregrounded CTS as a core competency essential for success in both academic and professional domains. Addressing this challenge requires educators not only to adopt digital technologies, but to design structured, theory-informed multimedia learning experiences that actively support creative thinking development. Embedding multimedia design into higher education pedagogy offers a powerful pathway for advancing CTS, achieving deeper learning outcomes, and preparing graduates to thrive in an innovation-driven world. Within this global context, the *China Education Modernisation 2035* blueprint explicitly prioritises creativity, innovation, and digital transformation, providing a strong policy foundation that underscores the urgency and relevance of cultivating CTS through multimedia-enhanced pedagogical models in Chinese higher education.

Building on this background, the present study conceptualises multimedia design not merely as a technical skill or digital toolset, but as a structured cognitive and creative process through which learners externalise, reorganise, and refine ideas. Consistent with multimedia learning theory (Mayer, 2002, 2020), effective multimedia design requires learners to make intentional decisions about modality selection, narrative sequencing, visual–verbal integration, and audience interpretation, processes that closely correspond to core dimensions of creative thinking such as fluency, originality, and elaboration.

1.3 Rsearch Motivation

The motivation for this study arises from two interconnected dimensions: the pedagogical promise of Digital Storytelling (DS) in fostering Creative Thinking Skills (CTS), and the distinctive educational and policy context of contemporary China, where innovation and creativity are prioritised as strategic imperatives in higher education.

1.3.1 Digital Storytelling's Potential for Creative Thinking

The integration of digital technologies has reshaped traditional narrative practices by combining multimodal resources, such as images, video, music, and audio,into coherent story artefacts (Miller, 2019; Rosli & Kamaruddin, 2020; Vashney, 2022). Digital Storytelling (DS), as a transformative technologically mediated narrative form, merges intentional narrative construction with digital media tools, empowering learners to develop and share engaging multimodal stories,typically 3 to 5 minutes in length and often infused with personal perspectives,across educational, professional, and public contexts (Lambert, 2010; Lambert & Hessler, 2018; Robin, 2008). Its application across diverse domains, including healthcare, education, and marketing, illustrates its potential to enrich learning by coupling creative and technological affordances.

Within education, DS has been widely recognised for enhancing student engagement, motivation, and academic achievement (Hava, 2021; Rahiem, 2021; Ivala et al., 2014). It provides a powerful platform for innovative pedagogy that supports the development of 21st-century competencies (Robin, 2008; Gürsoy, 2021). Particularly significant is its contribution to higher-order thinking,analysis, synthesis, and evaluative judgement (Yuksel, Robin, & McNeil, 2011; Anderson, Chung, & Macleroy, 2018). Unlike passive learning approaches, DS requires students' active participation in selecting, structuring, and presenting information, thereby stimulating cognitive engagement and creative problem-solving (Saritepeci, 2021; Rodríguez et al., 2021). Through these processes, learners cultivate divergent thinking, decision-making, and original expression across media (Monika & Martin, 2022; Di Blas, 2022). Moreover, DS strengthens communication and presentation competencies, which are essential for academic and professional success (Nair & Yunus, 2021).

Given these established affordances, this research seeks to investigate how DS can be systematically leveraged as a pedagogical model for fostering CTS in higher education.

1.3.2 Policy Imperatives for Innovation in Chinese Higher Education

As a major developing nation, China has undergone rapid industrial transformation and is now advancing towards an innovation-driven economy (Literature Research Office of the CPC Central Committee, 2016). In this context, the cultivation of creative and critical thinking has become a national educational priority (Lee & Yuan, 2018). The *China Education Modernisation 2035 plan* provides a comprehensive roadmap for building a modern, high-quality education system with a strong emphasis on innovative talent development and the integration of technology in teaching and learning.

Universities are thus positioned as key agents in nurturing students' innovative capacities. DS aligns closely with these policy objectives, as it represents a participatory, technology-enhanced pedagogy that fosters knowledge acquisition, skill development, and creativity (Tao, 2022). International and Chinese research has already demonstrated the efficacy of DS in higher education (McLellan, 2007; Jamissen et al., 2017; Austen, 2021), particularly in cultivating competencies linked to global citizenship and creative expression. Accordingly, China's educational landscape offers a conducive and timely context for exploring DS as a structured vehicle for creativity cultivation, supported by robust governmental backing for pedagogical innovation.

1.3.3 Summary of Research Motivations

In summary, this study is motivated by the convergence of two key factors: the established pedagogical value of DS in fostering CTS, and China's strategic emphasis on educational innovation and talent cultivation. Against this backdrop, this study positions DS as a design-mediated learning process, in which multimedia artefacts function as vehicles for creative thinking development rather than as isolated products for aesthetic evaluation. This perspective directly informs the development of the DS for CTS model, which systematically embeds creative thinking components into each phase of the DS workflow, guided by instructional design principles. In doing so, the model operationalises the theoretical link between multimedia design activities and creative thinking development, addressing a key gap identified in prior research.

1.4 Problem Statement

DS has emerged as a prominent learner-centred pedagogy in higher education, widely recognised for enhancing student engagement, digital literacy, and collaborative learning (Robin, 2016; Rodríguez et al., 2021). Its contribution to knowledge construction and narrative competence is well established, particularly in project-based and cross-disciplinary learning environments (Nishioka, 2016; Bai et al., 2025). More recently, scholars have argued that DS also holds substantial potential for fostering creative thinking skills (CTS), competencies increasingly prioritised in international educational frameworks and innovation policies (OECD, 2018; Nasir,Halim, & Arsad, 2024).

Despite this recognised potential, substantive conceptual and operational gaps persist between DS practice and creativity development. Empirical studies frequently associate DS with enhanced idea generation and learner creativity (Tisoglu et al., 2022), yet they rarely articulate how specific phases of the DS process, such as storyboarding, multimodal composition, and peer critique, systematically correspond to established dimensions of creative thinking (Treffinger, Schoonover, & Selby, 2021). In the absence of such mechanism-level specification, practitioners lack structured strategies to scaffold, implement, and assess creativity, leading to inconsistent pedagogical outcomes and diminishing institutional confidence in DS as a reliable instructional approach (Di Blas, 2022).

A critical, and largely under-addressed, source of this inconsistency lies in the incomplete integration of instructional design (ID) frameworks with CTS development within DS practice. While ID models such as ADDIE provide systematic processes for curriculum and activity design, they rarely embed explicit mechanisms for cultivating creativity. Conversely, creativity research foregrounds divergent thinking, curiosity, and problem-solving dispositions, yet without structured instructional scaffolds these capacities are unevenly enacted in formal educational settings. Bridging ID and CTS is therefore essential to combine structured learning processes with the deliberate nurturing of creativity. Prior research demonstrates that ID approaches aligned with creativity-oriented pedagogies can balance domain knowledge acquisition and creative exploration (Mishra & Koehler, 2006; Henriksen, Mishra, & Fisser, 2016), and that supportive environments, learner autonomy, and collaboration are central to creativity development in classrooms (Beghetto & Kaufman, 2014; Cropley, 2015). Foundational creativity theories further emphasise that creativity is shaped by personal traits, task structures, environmental conditions, and assessment practices (Guilford, 1967; Torrance, 1988; Sternberg, 2003; Sawyer & Henriksen, 2024), and should be evaluated through multidimensional, process-and-product-aligned lenses (Plucker & Makel, 2010; Craft, 2005). However, these insights have not been coherently operationalised within DS-based instruction.

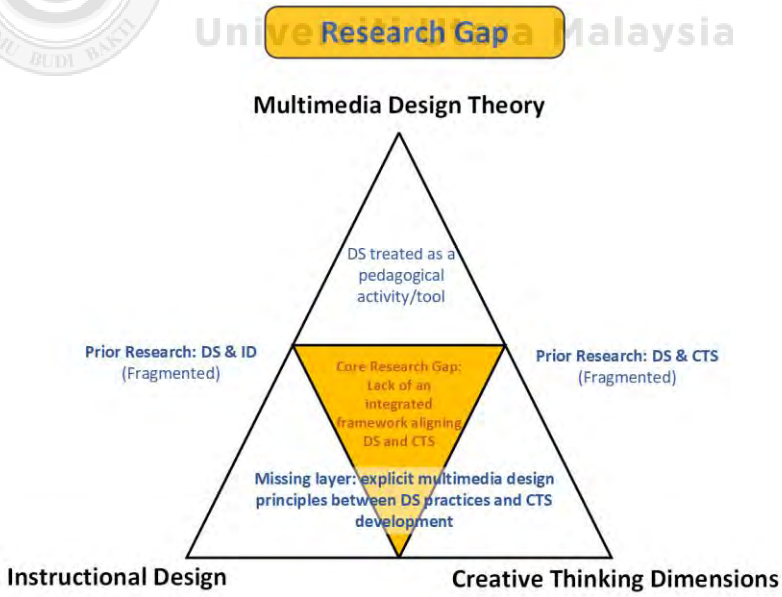
In addition to this pedagogical gap, the present study identifies a second, closely related gap within multimedia and multimodal design theory. DS is inherently a multimedia practice, involving the orchestration of visual, auditory, textual, and interactive elements across time. Nevertheless, existing DS research seldom draws explicitly on established multimedia learning principles, multimodal design frameworks, or human–computer interaction (HCI) heuristics to explain how specific design decisions during DS production shape cognitive processing and creative outcomes. For instance, principles from multimedia learning theory, such as coherence, modality, signalling, and generative processing, have been shown to influence learners' cognitive load, meaning-making, and knowledge construction (Johnson & Mayer, 2009; Mayer, 2020), yet these principles are rarely mapped onto DS production stages. Similarly, multimodal discourse and design research emphasises that meaning and creativity emerge from the intentional orchestration of modes rather than their mere combination (Kress, 2009; Jewitt, 2009). From an interaction-design perspective, narrative interaction and participatory feedback are recognised as critical for reflection, sense-making, and creative refinement (Spierling, 2015; Murray, 2017), but such insights remain largely absent from DS-based creativity models.

As a result, DS practice occupies an ambiguous position at the intersection of pedagogy and multimedia design: it is frequently treated as a technical or expressive activity, rather than as a theoretically grounded multimodal learning system. The absence of multimedia design principles that explicitly map DS production phases onto measurable CTS outcomes constitutes a significant theoretical omission, limiting DS's contribution to multimedia studies as well as to creativity-focused pedagogy.

These limitations are particularly consequential in Chinese higher education, where pedagogical innovation is expected to align with national innovation strategies and deliver measurable, standards-driven learning outcomes (Ministry of Education of the People's Republic of China, 2018). In the absence of an integrated framework that unites instructional design, creativity theory, and multimedia design principles, DS adoption remains fragmented and its educational value is reduced to loosely defined "creative" activities rather than a systematic, outcomes-oriented pedagogy.

Accordingly, this study addresses three interrelated research gaps (see Figure 1.1):

i. **Multimedia-theoretical gap**: the absence of explicit multimedia design principles and interaction heuristics that map DS production and interaction processes onto CTS development.
ii. **Creativity-operational gap**: the lack of process-oriented mechanisms that link DS activities to measurable creative thinking outcomes beyond end-product evaluation.
iii. **Pedagogical gap**: the absence of a theoretically integrated instructional design framework that systematically aligns DS phases with specific CTS constructs.



Note. DS = Digital Storytelling ID = instructional design

CTS = Creative Thinking Skills

Figure 1.1. Research Gap

Therefore, the central problem addressed in this study is the lack of a theoretically integrated and procedurally operational instructional design model that explicitly links the pedagogical, creative, and multimedia dimensions of digital storytelling to specific creative thinking outcomes.

To address this problem, the study proposes a dual reconceptualisation of DS. The first strand involves theoretical integration, synthesising educational theory, creativity research, and multimedia learning principles to establish DS as a cognitively and creatively grounded pedagogical system. The second strand focuses on procedural operationalisation, translating this integrated foundation into a structured, replicable instructional design model that aligns DS activities with design principles and assessable CTS outcomes.

Central to the proposed DSCTS model are hypothesised directional linkages between discrete DS phases and targeted CTS constructs. Specifically, the model posits that: storyboarding (Pre-production) supports CTS fluency and flexibility through visualisation and ideation; multimedia production (Production) promotes originality through multimodal synthesis and design decision-making; and peer critique and iterative revision (Post-production and Distribution) enhance elaboration and evaluative judgement, with critique also reinforcing originality. These phase-to-construct relationships form the testable core of the study, are visually articulated in Chapter 4, and are empirically examined through correlational analyses in the Results chapter.

1.5 Preliminary Study

A preliminary study was conducted to refine the research focus and validate the core research problem. Informed by Adams (2015), who affirms that semi-structured interviews are effective for gathering rich information and insights, this exploratory phase aimed to investigate Chinese university instructors' perceptions of educational DS. Specifically, the study sought to assess their awareness of DS, explore their views on its potential as an engaging pedagogy for promoting CTS among students, and identify perceived challenges in integrating DS into the curriculum.

i. Method

The preliminary study employed a qualitative approach using semi-structured interviews with five university instructors from China. The development of the interview protocol followed a rigorous three-stage process (see Figure 1.2). An initial set of questions was drafted based on a comprehensive review of relevant literature and practical teaching contexts. This draft was subsequently refined through consultations with educational practitioners. Finally, the questions were further revised and finalized based on feedback from pilot respondents, ensuring scientific validity, contextual relevance, and clarity.

The finalized interview questions, listed in Table 1.1, were designed to elicit qualitative data regarding instructors' awareness, perceptions, and experiences related to DS and CTS.

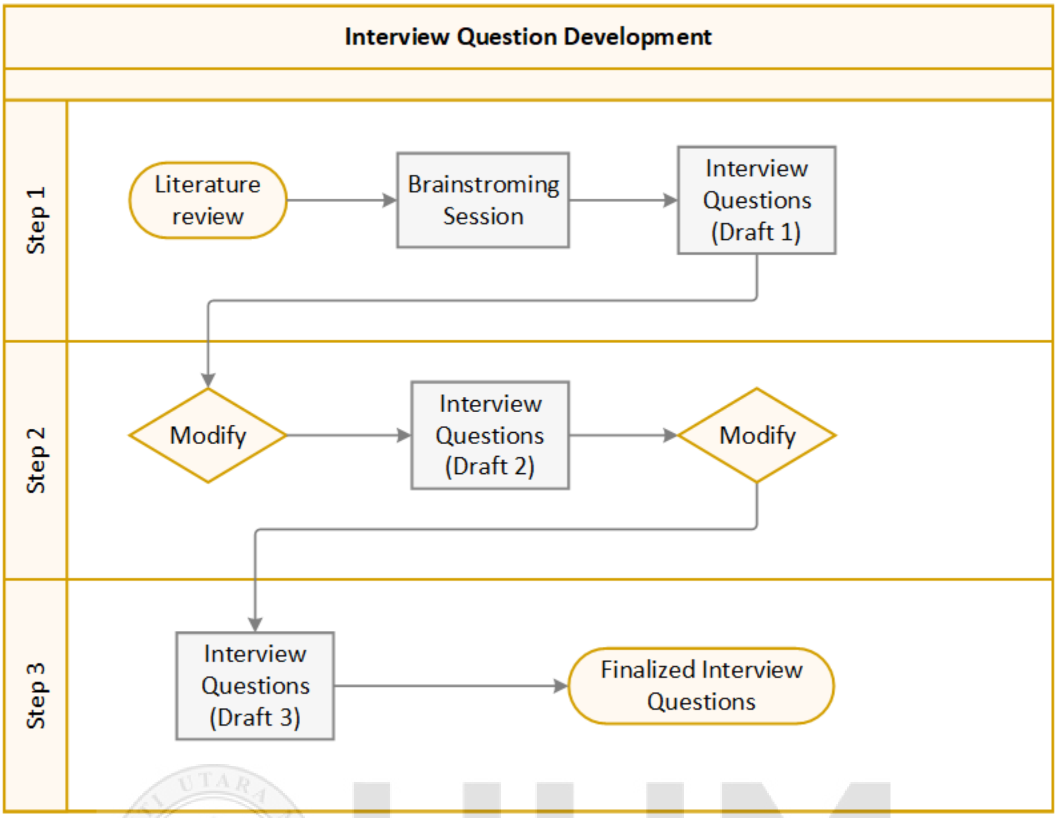


Figure 1.2. Design of The Preliminary Interview Questions

Table 1.1

List of Interview Questions

No.	Items
Q1	How do you understand Digital Storytelling as an educational approach?
Q2	In your opinion, what are the potential benefits of using Digital Storytelling to foster students' creative thinking skills?
Q3	Have you ever integrated Digital Storytelling into your teaching practice? If so, how? If not, what are the main barriers preventing its adoption?
Q4	What challenges do you face when incorporating Digital Storytelling into your curriculum, particularly in terms of fostering students' creative thinking skills?
Q5	How do you balance the demands of completing curriculum requirements with integrating Digital Storytelling into your lessons?

The participant selection strategy aimed to capture a diverse range of perspectives across different regions and disciplines. Potential respondents were identified via the China Knowledge Network (CNKI) platform, targeting university lecturers who had previously published scholarly articles. Invitations were extended to 12 instructors, of whom five agreed to participate. The final sample represented a variety of geographic and economic contexts, as well as multiple academic disciplines, enhancing the representativeness of the findings. The regions and disciplines of the five respondents are summarized in Table 1.2.

Table 1.2

Region and Discipline of the Respondents

No.	**Region**	**Discipline**
1	Shenzhen	E-commerce
2	Hangzhou	English education
3	Zhengzhou	Art Design
4	Guizhou	Marketing
5	Yinchuan	Applied Mathematics

To ensure conceptual consistency across responses, an explicit operational definition of educational digital storytelling, emphasizing narrative-driven, pedagogically focused multimedia production rather than general digital content,was provided at the beginning of each interview. Pre-screening questions and concrete examples (e.g., educational narratives created with Scratch) were used to calibrate understanding, and real-time clarifications were offered during interviews to align participants' interpretations with the study's framework. These measures are documented in the methodology to establish validity and consistency in respondent comprehension.

ii. Findings and Implications

This section draws on responses from five university instructors across diverse regions and disciplines in China, including Shenzhen (e-commerce), Hangzhou (English education), Zhengzhou (art design), Guizhou (marketing), and Yinchuan (applied mathematics), to distill two core insights: all respondents uniformly recognized the educational value of DS as a pedagogical approach, yet its integration into formal curricula remains stagnant due to a consistent, unresolved barrier.

Across fields, respondents highlighted DS's dual strengths: boosting student learning engagement and enhancing CTS, with observations tailored to their disciplinary contexts. For instance, Respondent 1 (e-commerce, Shenzhen) noted that DS transformed passive case-study analysis into active creation, prompting students to proactively research brand stories and build digital narratives, a stark shift from the low participation seen in traditional lecture-based teaching. This focus on engagement extended to technical disciplines: Respondent 5 (applied mathematics, Yinchuan) shared that DS made abstract equations "relatable," as students grew more willing to explore math concepts when tasked with explaining them through short digital stories, rather than relying on rote problem-solving. Equally notable was DS's impact on CTS: Respondent 2 (English education, Hangzhou) explained that adapting classic texts into DS projects pushed students to "reimagine plotlines and add original character motivations," a level of creative expression rarely observed in traditional essay assignments. Respondent 3 (art design, Zhengzhou) similarly emphasized DS's role in fostering experimental thinking, as students tested multiple visual styles from animation to interactive infographics to convey stories, moving beyond the single-format constraints of conventional design tasks. For applied fields like marketing, Respondent 4 (Guizhou) added that DS helped students “craft creative audience-centric narratives,” a critical CTS for the industry that went beyond memorizing theoretical frameworks.

Despite this clear recognition of DS’s benefits, no respondent had fully integrated DS into their formal curricula, and all pinpointed the absence of a practical, discipline-adaptable conceptual design model as the root cause. For those who attempted limited DS implementation, such as Respondent 1 (e-commerce) and Respondent 3 (art design), the lack of a model led to misalignment with course goals: Respondent 1 noted that while DS projects were well-received, “without a framework to link them to ‘brand strategy’ learning objectives, they felt like extra activities, not core to the syllabus,” while Respondent 3 struggled to assess if student work actually built the “creative storytelling competency” required by their course, as “no model meant no clear evaluation guide.” For respondents who had not tried DS at all, including Respondent 2 (English education), Respondent 4 (marketing), and Respondent 5 (applied mathematics), the missing model created paralyzing uncertainty: Respondent 2 explained, “I want to use DS to boost creativity, but I need a model that shows how it connects to exam-related skills like critical analysis. Without that, I can’t justify taking time from required content,” while Respondent 4 echoed that generic DS guides only covered technical tools and failed to “tie stories to marketing principles like consumer psychology,” a gap a tailored model could address.

These insights collectively confirm that DS is a valuable pedagogical tool, capable of driving student engagement and strengthening CTS across diverse disciplines. Yet its translation from “recognized value” to “consistent classroom practice” is stalled by the lack of a structured, discipline-aligned conceptual design model. This gap directly reinforces the necessity of the present research: developing the DSCTS framework, a practical tool that will enable educators to integrate DS into curricula in ways that align with disciplinary goals, while fully harnessing its potential to boost student engagement and creative thinking.

1.6 Research Questions

Building on the problem statement and preliminary investigations, three specific research gaps are identified:

First, there is a lack of conceptual models that systematically integrate Digital Storytelling (DS) into higher education for the cultivation of Creative Thinking Skills (CTS). Although DS has demonstrated potential in enhancing autonomy, higher-order thinking, and multimodal learning (e.g., Robin, 2008; Rodríguez et al., 2021), existing studies have not translated these benefits into robust and theoretically grounded models tailored to fostering CTS.

Second, current research has predominantly employed traditional methodologies, focusing on theoretical exploration and hypothesis testing. These approaches often neglect the practical implementation of DS in authentic educational contexts. A design-oriented methodology such as Design Science Research (DSR) offers a more effective pathway by emphasising the development, testing, and refinement of practical pedagogical models that directly address instructional needs.

Third, there is a notable geographical gap in the literature concerning DS and CTS within Chinese higher education. While DS has been examined internationally, research situated in China remains limited, despite the strong policy emphasis on creativity and innovation as national educational priorities.

Taken together, these gaps underscore the need for a structured, contextually relevant model that operationalises DS as a pedagogical framework for CTS cultivation in Chinese higher education. To address this, the present study proposes developing the Digital Storytelling for Creative Thinking Skills (DSCTS) model, guided by Design Science Research (DSR; Hevner & Chatterjee, 2010). Reframing DS as a strategic pedagogical framework (not merely a digital tool), the DSCTS model seeks to bridge the identified gap by offering a pedagogically grounded, process-driven blueprint,enabling consistent, measurable CTS cultivation and supporting the broader goal of preparing innovation-ready graduates.

Accordingly, the study is driven by the following research questions:

a) What design components and pedagogical elements constitute the proposed DSCTS model for fostering creative thinking skills in tertiary education?
b) How can a DSCTS conceptual model be systematically designed and refined, by integrating instructional design principles, creativity theories, and digital storytelling workflows?
c) How can the proposed DSCTS model be validated through expert review and model–prototype alignment analysis in terms of feasibility, coherence, and design consistency?
d) Does the intervention of the DSCTS model improve students' creative thinking skills as as measured by the TTCT (Torrance Tests of Creative Thinking) in a Chinese higher education context?

1.7 Research Objectives

This study aims to propose a design conceptual model based on educational DS project for cultivating students' CTS in the context of China. Through DSR perspective, the production process of this model is standardized, observable, repeatable, and ve rifiable. Specifically, the subdivided objectives of the study are as follows:

a) To identify and analyse the core components and design elements of the DSCTS model that are theoretically associated with creative thinking development.
b) To design and develop a DSCTS conceptual model by integrating instructional design frameworks, creative thinking theories, and digital storytelling processes for application in tertiary education.
c) To validate the DSCTS model through expert review, including assessments of content validity, reliability, and model–prototype consistency.
d) To evaluate the initial effectiveness of the DSCTS model in enhancing students' creative thinking skills, as measured by TTCT pre- and post-tests and supported by teacher interviews in a classroom implementation.

1.8 Scope of the Study

This aim of this study is to construct a conceptual design model of DSCTS at tertiary level. The research scopes are as following:

i. Due to the convenience and exploratory nature of the study, the scope of this study was limited to the higher education level.

ii. This conceptual model integrates course knowledge and is facilitated by the instructor, with active participation from both the teacher and students throughout the process.

iii. The context of the research is in China, including the practitioners, respondents, except the international experts.

iv. This study focuses on enhancing students' CTS based on the design of DS model design and does not include the enhancement or testing of other skills.

1.9 Significiance of the Study

China’s rapid socio-economic transformation has created an urgent demand for highly innovative talent capable of addressing complex and unpredictable challenges. Traditional exam-oriented education, while effective in knowledge transmission, has proven insufficient in cultivating creative thinking skills (CTS), which are critical for sustaining innovation and national competitiveness. This study responds to this pressing need by constructing the Digital Storytelling on Creative Thinking Skills (DSCTS) conceptual model through Design Science Research (DSR), systematically integrating learning theories, creativity frameworks, and digital storytelling pedagogy. The significance of this study is reflected across practical, theoretical, and policy dimensions.

- **Practical Implications:** Innovating Talent Cultivation in Higher Education. The study offers a tangible framework for universities to embed digital storytelling (DS) into teaching and learning practices. By structuring project-based and multimodal learning experiences, the DSCTS model enables students to connect disciplinary knowledge with creative problem-solving. This directly supports national priorities articulated in China’s Education

Modernization 2035, which emphasises innovation-driven education. For instance, its pilot application in Introduction to Folk Art demonstrates how the model bridges theory and practice, fostering students' adaptability, collaboration, and creativity. By doing so, it prepares graduates to meet societal and industry demands for versatile innovators.

- **Theoretical Advancement in DS Pedagogy**. From an academic standpoint, this research addresses a major gap: the lack of integrative frameworks that link DS phases with learning and creativity theories. The DSCTS model synthesises educational psychology (constructivism), creativity studies (Rhodes' 4P framework), and multimedia design principles into a coherent, evidence-based structure. Validated through expert evaluation and prototype testing, the model demonstrates that DS can serve not only as a storytelling medium but as a catalyst for cognitive growth and creative performance. This extends theoretical discourse in creativity research while repositioning DS as a cross-disciplinary pedagogy capable of advancing higher-order thinking skills.
- **Policy-Relevant Insights for Educational Reform.** At the policy level, the study aligns with China's shift from knowledge-oriented to quality-oriented education. The DSCTS model provides policymakers with replicable processes, such as its four-phase development cycle, which standardises innovative teaching practices across disciplines. By empirically demonstrating how DS fosters both academic achievement and creativity, this research supports the development of curricula, assessment reforms, and teacher training that value creativity alongside knowledge acquisition. Its policy relevance lies in offering a culturally contextualised pathway for integrating technology-enhanced pedagogies into national educational strategies.

In conclusion, this study contributes significantly to bridging China's innovation talent gap by offering a theoretically grounded, empirically validated, and practically applicable model. It enriches academic scholarship on DS and creativity, informs higher education practice, and provides evidence-based insights for policy reform. Positioned at the intersection of pedagogy, theory, and policy, the DSCTS model serves as a scalable framework for cultivating the next generation of problem solvers and innovators, both within China and in comparable educational contexts worldwide.

1.10 Research and Theoretical Framework

This study adopts DSR as the methodology. DSR aims to improve existing artifacts or design new artifacts for solving real-world problems (vom Brocke, Hevner, & Maedche, 2020). The form of the created artifacts can be entities, methods, models, concepts, etc. As mentioned above, few studies have explored the conceptual design model of the DSCTS through the DSR approach. According to Vaishnavi and Kuechler (2015), the DSR research circle includes five steps: awareness of the problem, suggestion, development, evaluation, and conclusion. Compared to other research frameworks, such as Vom Brocke, et al. (2020), Hevner & Chatterjee (2010), and Peffers, et al. (2007), this research framework is more concise and straightforward. Therefore, this study used this research framework as a guide to conduct the study.

The research process involves several steps. Firstly, it is crucial to identify the research problems and determine the scope by conducting a literature review, analysing the reality context, and conducting preliminary investigations. In order to gain a comprehensive understanding of the research status, the researcher analysed the research status of DS, CTS, and learning theories. Additionally, a comparative study was conducted to examine different models of DS and strategies to enhance students' CTS.

Once the first step is completed, the next phase involves determining the components of the proposed model based on the findings obtained in the previous step. Subsequently, all the identified components are integrated in the suggestion phase to construct the conceptual design model of DTCTS. To ensure the validity and refinement of the conceptual design model, it is then evaluated and validated by experts through their valuable advice.

Moving forward, the subsequent step is to build a prototype of the conceptual model and test its effectiveness in practical scenarios. By implementing the prototype, the researcher aims to gather empirical evidence and assess the impact of the model.

Finally, based on the results obtained and the subsequent discussions, the researcher draws conclusions and prepares a comprehensive report summarizing the entire research process and its outcomes.

This structured approach ensures that the research process follows a logical progression, from problem identification and literature review to model construction, prototype development, and conclusive reporting of findings. Figure 1.3 shows the theoretical framework and research flowchart.

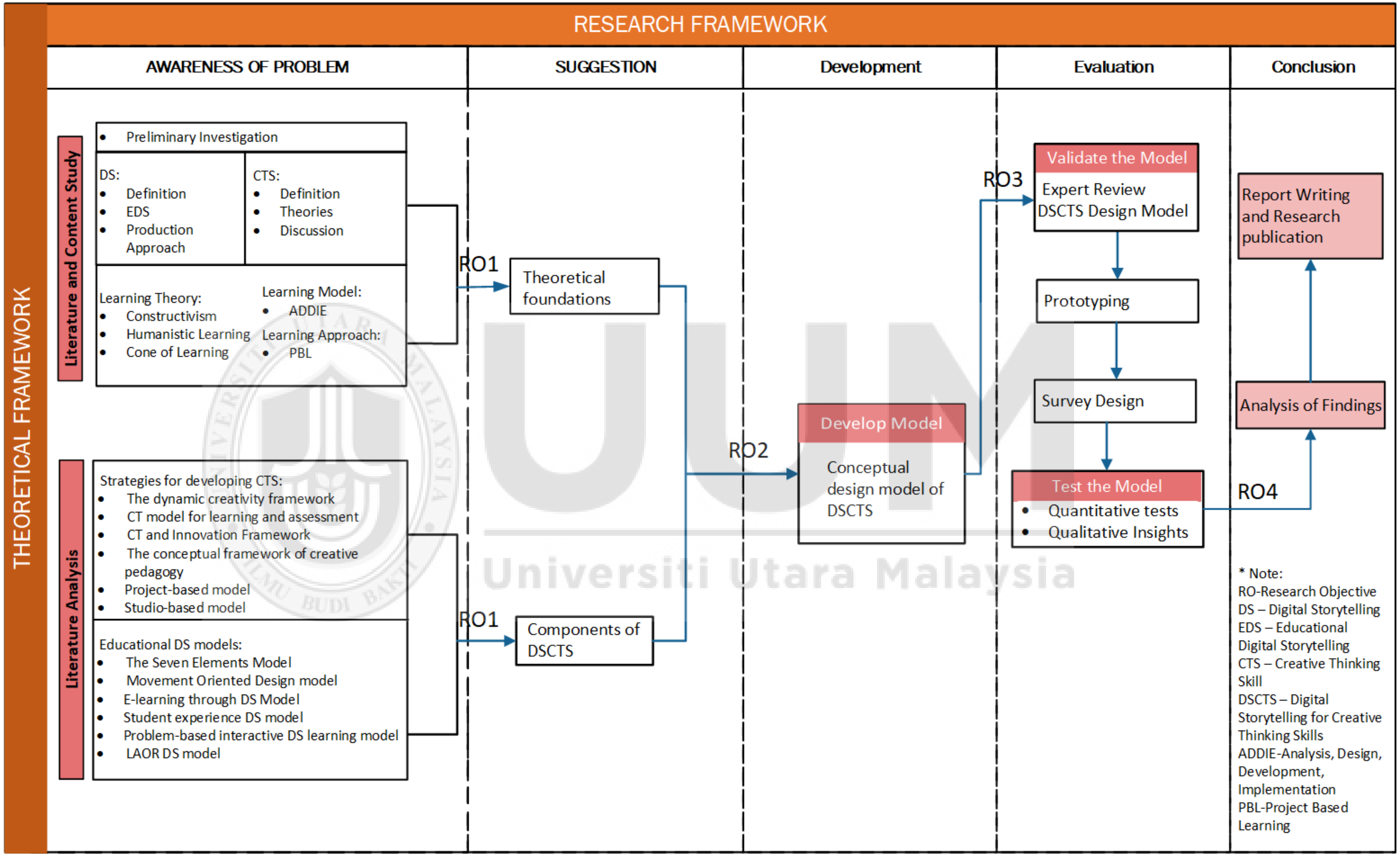


Figure 1.3. Research Framework

1.11 Definition of Key Terms

This section explains the terms relevant to this study, establishing the operational definitions frequently applied throughout the thesis.

- **Digital Storytelling (DS)**

The narrator tells a story with a personal perspective through multimedia elements, such as voice-over, picture, music, video, etc. It is usually 3 to 5 minutes long (Robin, 2008).

- **Creative Thinking Skills (CTS)**

Combining the definitions of creative thinking by authorities such as Wallas (1926), Gilford (1950), and Terence (1966), in this study, CTS refer to the thought process of finding new and optimal solutions to problems from different perspectives, and the thought process can be cultivated by training.

- **Digital Storytelling for Creative Thinking Skills (DSCTS)**

In this study, DSCTS (an acronym for Digital Storytelling for Creative Thinking Skills) based on project-based learning serves as the core focus for constructing a conceptual design model. The formulation and exploration of all research questions are closely aligned with the creation and practical application of this model.

- **Research Design Science (DSR)**

According to vom Brocke et al. (2020), DSR is a research paradigm that focuses on finding a solution to a real-world problem and improving the relevant context by creating a creative artifact. The artifact can be models, instruments, theories, instantiations, etc., which can enhance the human knowledge of the researched domain (Hevner et al., 2010; vom Brocke, et al., 2020). DSR is an iterative cycle of progressive improvement through user feedback. In this study, the artifact is an instructional model for practitioners at tertiary level.

- **Practitioners**

In this study, practitioners are instructors, teaching assistants, professors and associate professors of higher education standard, external tutors, etc., anyone who can guide students in their learning.

- **Conceptual Design Model**

Conceptual model refers to a systematic framework or approach used to guide the development of instructional materials and learning experiences in this study. It provides a structured process for designing and delivering effective instruction that based on DS projects to promote students' CTS and learning outcomes.

- **Literature Analysis**

The research incorporates a comprehensive Literature Analysis that systematically examines and contrasts different models of DS, learning theories, and strategies for cultivating students' CTS. The primary aim is to obtain valuable insights, derive meaningful conclusions, and make a significant contribution to the knowledge within a specific field or discipline.

1.12 Organization of the Study

This thesis consists of six chapters in total. The contents of each chapter are outlined as follows:

Chapter 1: Introduction

This chapter highlights the critical need for innovative talent in China at its current stage of development. By reviewing preliminary literature, this study identifies a gap in the existing studies: the lack of conceptual design model that focuses on fostering CTS among college students through DS. And few studies have been conducted in China. Employing DSR as its framework, the study develops a model aimed at enhancing CTS at tertiary level through DS projects. The chapter outlines the research objectives and questions, defines the scope of the study, and details the significance, content, and structure of key terminologies and subsequent chapters.

Chapter 2: Literature Review

This chapter reviews literature on Digital Storytelling (DS), Creative Thinking Skills (CTS), and relevant learning theories, identifying several salient limitations in current scholarship. Existing studies lack specificity in delineating how distinct phases of DS (e.g., storyboarding) facilitate particular dimensions of CTS, which are often subsumed under broader constructs such as 21st-century skills. Methodologically, many studies rely on correlational designs or oversimplified metrics, with limited integration of pedagogical frameworks such as ADDIE, resulting in tool-oriented implementations rather than theory-grounded instruction. Furthermore, contextual gaps remain concerning the application of DS in discipline-specific settings.

In response to these gaps,particularly the underexplored causal mechanisms between DS and CTS, and the scarcity of scalable, theory-informed models,this study proposes a DSCTS framework integrating the ADDIE instructional model and Rhodes' 3P (Person, Process, Product) creativity model. This framework aims to systematically align DS processes with CTS development, offering a structured pedagogical pathway for fostering creative thinking in higher education..

Chapter 3: Methodology

Based on the Design Science Research process, this chapter explains the framework of the methodology adopted in the context of the study, which consists of five stages: awareness of the problem, suggestion, development, evaluation, and conclusion. In this study, each stage of the DSR methodology was meticulously designed in alignment with the research objectives to facilitate their achievement. Especially, the evaluation phsae, the chapter provides a comprehensive outline of the survey design, the employed scales, the demographics of the participants, and the systematic process of data collection and analysis.

Chapter 4: Model Development, Prototyping, and Effectiveness Testing

This chapter focuses on the systematic development of a conceptual model for DSCTS, building on the foundation established in Chapter 2. This chapter addresses the key research questions concerning the components, development, validation the proposed DSCTS model, and further prototyping and testing the application of the DSCTS model in reality. It is divided into four parts: first, the extraction of elements for the model through comparative analysis; second, the construction of the proposed conceptual model; third, the validation criteria; and fourth, the prototyping based on the proposed conceptual model and the testing the effectiveness. Expert feedback plays a critical role in refining the proposed conceptual model, ensuring both its theoretical soundness and practical application. Additionally, this chapter details the process of constructing a prototype and the testing procedure, which further confirms the usefulness of the conceptual model.

Chapter 5: Disscussion and Conclusion

This chapter is the concluding section, wherein it is discussed whether the research questions posed in Chapter 1 have been addressed and whether the research objectives have been achieved. Additionally, the limitations of the study are outlined, alongside recommendations for future research. This chapter Furthermore, it engages in a thorough analysis and discussion of the experimental results, with the aim of addressing the final research question posed in this study.

CHAPTER TWO

LITERATURE REVIEW

2.1 Overview

This chapter critically reviews and synthesises literature relevant to digital storytelling (DS), creative thinking skills (CTS), and learning theories in undergraduate education. Rather than providing a descriptive catalogue of theories and models, the review adopts an integrative analytical lens to examine how DS has been conceptualised, operationalised, and empirically linked to the development of CTS in educational contexts.

The chapter pursues three interrelated objectives. First, it clarifies conceptual distinctions between DS as a multimodal design practice, educational digital storytelling (EDS) as a pedagogical approach, and DS production models as procedural frameworks. Second, it critically examines dominant theories of creative thinking and evaluates their applicability to undergraduate learning environments, particularly within multimedia disciplines. Third, it synthesises learning theories and empirical findings to identify unresolved issues in existing research, thereby establishing a clear theoretical rationale for the subsequent model development.

2.2 Digital Storytelling as a Multimodal Design Practice

2.2.1 Conceptualising Digital Storytelling

DS is commonly defined as a technology-mediated narrative practice that integrates oral storytelling traditions with multimedia elements such as images, audio, video, and text to produce concise, emotionally engaging narratives (Robin, 2016). While this definition captures the formal characteristics of DS, it remains insufficient for analytical purposes in educational research unless its conceptual boundaries and functional mechanisms are clarified.

Historically, storytelling has functioned as a fundamental mode of cultural transmission and meaning-making. The emergence of DS in the late 1980s and early 1990s marked a significant transformation of this practice, driven by developments in digital media technologies and participatory culture (McLellan, 2007). The institutionalisation of DS through initiatives such as the Center for Digital Storytelling (CDS) formalised a practice that emphasised short, personal narratives, typically 3–5 minutes in length, constructed through a combination of first-person voice, visual imagery, and sound (Hull & Katz, 2006; Lambert & Hessler, 2018).

However, positioning DS merely as a digital extension of traditional storytelling risks reducing it to a descriptive label rather than a theoretically meaningful construct. From an educational and multimedia studies perspective, DS should be understood as a multimodal design practice, where meaning emerges through the orchestration of narrative structure, media elements, and audience engagement rather than from narrative content alone (Robin, 2016; Çetin, 2021). This distinction is critical, as it shifts the analytical focus from what stories are told to how meaning is designed and communicated through multimodal affordances.

2.2.2 Digital Storytelling as Multimodal Meaning-Making

Synthesising prior scholarship, DS can be analytically distinguished from traditional oral or written storytelling through three interrelated characteristics.

First, technological mediation fundamentally reshapes narrative production and dissemination. Digital platforms eliminate temporal and spatial constraints, enabling stories to be archived, shared, remixed, and recontextualised across diverse audiences (Weststrate, 2021). This persistence and scalability introduce new pedagogical possibilities but also demand intentional design decisions to manage cognitive load and narrative coherence.

Second, multimodal integration lies at the core of DS. Unlike linear text-based narratives, DS relies on the coordinated use of visual, auditory, and temporal elements to construct meaning (Çetin, 2021). Research in multimedia learning suggests that such integration can enhance comprehension and engagement when design principles are appropriately applied, but may also hinder learning if media elements are poorly aligned (Robin, 2016). Thus, DS should be treated not simply as "story + media," but as a design problem requiring deliberate orchestration of semiotic resources.

Third, participatory and collaborative engagement differentiates DS from conventional storytelling formats. Practices such as story circles, peer feedback, and collaborative production position DS as a socially situated activity that supports shared meaning-making and empathy development (Carvalho & Noronha, 2020; Nicoli et al., 2022). This participatory dimension aligns DS with constructivist and sociocultural learning theories, particularly in educational contexts where knowledge construction is mediated through interaction.

These three characteristics collectively indicate that DS functions simultaneously as a narrative form, a multimedia design process, and a social learning practice. Treating

DS as any one of these dimensions in isolation risks conceptual ambiguity, a limitation evident in portions of existing educational DS literature.

2.2.3 Functional Domains of Digital Storytelling: From General Use to Educational Application

DS has been applied across multiple domains, including healthcare communication, community engagement, and academic research. In healthcare settings, DS is employed to translate complex medical information into emotionally resonant narratives that foster empathy and patient understanding (Kim, Coenraad, & Park, 2021). In community and civic contexts, participatory DS initiatives have been shown to amplify marginalised voices and preserve cultural memory, positioning storytelling as a tool for social empowerment (Jamissen, Hardy, & Nordkvelle, 2017).

Within educational contexts, DS has been widely adopted as a pedagogical strategy to enhance learner engagement, multimodal literacy, and reflective learning (Gürsoy, 2021; Hava, 2021). Lambert (2006) reported that approximately 60% of DS initiatives are situated in educational environments, indicating its long-standing integration into teaching practice. However, the mere prevalence of DS in education does not, in itself, justify its pedagogical effectiveness. What remains under-theorised is how DS functions as a learning mechanism, and which aspects of the DS process contribute to specific learning outcomes, particularly creative thinking skills.

This distinction is essential. While DS is frequently credited with improving motivation and engagement, many studies conflate affective outcomes with cognitive development, offering limited explanation of the underlying processes through which DS supports higher-order thinking. Consequently, DS in education is often treated as a generic “innovative tool” rather than a structured pedagogical intervention grounded in learning theory and design principles.

2.2.4 Educational Digital Storytelling

Educational Digital Storytelling (EDS) can therefore be conceptualised as a contextualised application of DS that explicitly aligns narrative design, multimedia production, and learning objectives. Unlike general-purpose DS, EDS operates within institutional constraints such as curriculum standards, assessment requirements, and instructional timelines (Wu & Chen, 2020). This shift necessitates a clearer differentiation between DS as a creative practice and EDS as a pedagogical framework.

Importantly, EDS should not be viewed as a single instructional model but as an umbrella term encompassing diverse pedagogical configurations, ranging from teacher-designed instructional narratives to student-generated, project-based storytelling. The effectiveness of EDS depends not on the presence of digital stories per se, but on how storytelling processes are structured, scaffolded, and evaluated in relation to targeted learning outcomes.

Accordingly, the subsequent sections move beyond definitional description to examine how EDS has been classified, operationalised, and modelled in prior research. Particular attention is given to distinguishing process models, conceptual frameworks, and empirical relationships, thereby addressing conceptual ambiguities identified in existing literature and laying a rigorous foundation for the analysis of creative thinking development.

2.3 Educational Digital Storytelling: Typologies, Pedagogical Logics, and Conceptual Distinctions

2.3.1 The Classification of Educational Digital Storytelling

Educational Digital Storytelling (EDS) refers to the purposeful integration of digital storytelling practices into formal educational contexts to support learning objectives, cognitive development, and skill acquisition (Wu & Chen, 2020). Unlike general-purpose DS, which may prioritise self-expression or community engagement, EDS operates within institutionalised pedagogical structures, including curriculum design, assessment frameworks, and instructional timelines. Consequently, EDS must be examined not only as a creative activity but also as an instructional strategy shaped by educational intent.

A recurring limitation in the existing literature is the tendency to treat EDS as a homogeneous pedagogical intervention. In practice, however, EDS encompasses multiple instructional configurations that differ substantially in terms of learner agency, cognitive demand, and alignment with learning theory. Without clarifying these distinctions, empirical findings on EDS risk conceptual ambiguity and limited transferability across educational contexts.

2.3.2 Teacher-Created and Student-Created Digital Storytelling

Building on Robin's (2006) foundational classification, EDS is commonly divided into teacher-created digital storytelling and student-created digital storytelling. While this dichotomy is widely cited, its theoretical implications are often underexplored.

Teacher-created digital storytelling positions educators as primary narrative designers. In this configuration, instructors develop multimedia stories to introduce concepts, contextualise abstract content, or illustrate disciplinary perspectives (Hava, 2021). Pedagogically, this approach aligns with instructor-led models of teaching, where DS functions as an enhanced instructional resource rather than a learning process in itself. Empirical studies suggest that teacher-created DS can improve learner motivation, attention, and content comprehension, particularly when addressing complex or abstract subject matter (Gürsoy, 2021). However, its cognitive impact is largely receptive; students engage primarily as viewers rather than producers of meaning.

In contrast, student-created digital storytelling repositions learners as active knowledge constructors. Students assume responsibility for topic selection, narrative development, media integration, and presentation, typically under teacher facilitation (Smeda, Dakich, & Sharda, 2014; McGovern, Burt, & Schwittek, 2021). This approach reflects constructivist and experiential learning principles, whereby knowledge is generated through active inquiry, reflection, and social interaction. Research consistently indicates that student-generated DS supports higher-order cognitive processes, including analysis, synthesis, and creative expression (Budiman, Samani, & Setyawan, 2021; Pande & Bharathi, 2020).

Critically, the distinction between these two forms is not merely operational but epistemological. Teacher-created DS primarily supports knowledge transmission, whereas student-created DS foregrounds knowledge construction. This difference has direct implications for the cultivation of creative thinking skills, which depend on learners' opportunities to engage in divergent thinking, problem framing, and iterative refinement.

2.3.3 Pedagogical Implications of Student-Created Digital Storytelling

The growing emphasis on student-created DS reflects broader shifts in higher education toward learner-centred and inquiry-based pedagogies. Within this approach, DS functions not only as a final product but as a process-oriented learning activity, encompassing ideation, design, production, reflection, and revision.

From a cognitive perspective, student-created DS requires learners to integrate prior knowledge with new information, translate abstract ideas into narrative form, and coordinate multiple semiotic resources. These processes align with established models of creative cognition, particularly those emphasising fluency, flexibility, and originality (Torrance, 1966; Runco & Kim, 2020). Empirical evidence suggests that such engagement reduces performance anxiety associated with traditional assessments while increasing emotional investment and intrinsic motivation (Lazareva & Cruz-Martínez, 2021).

Nevertheless, the literature also reveals limitations. Many studies adopt student-created DS without articulating how storytelling processes are scaffolded or how creative outcomes are evaluated. As a result, improvements in creativity are often inferred rather than systematically measured. This lack of theoretical and methodological clarity weakens causal claims regarding the effectiveness of EDS for creative thinking development.

2.3.4 Beyond Dichotomy: Process Models, Frameworks, and Empirical Applications

While the teacher–student dichotomy provides a useful starting point, it does not sufficiently capture the complexity of EDS practices. Existing studies frequently conflate three analytically distinct levels:

i. Process models, which describe stages of DS production (e.g., planning, production, sharing);
ii. Conceptual frameworks, which articulate theoretical rationales linking DS to learning mechanisms;
iii. Empirical applications, which report observed outcomes of DS interventions.

Failure to distinguish among these levels has led to conceptual overlap and inconsistent terminology across the literature. For example, student-created DS is sometimes described simultaneously as a pedagogical model, a learning strategy, and an assessment method, without clarifying its theoretical positioning. This conflation complicates comparative analysis and obscures the specific contributions of DS to creative thinking development.

To address this issue, this study treats student-created EDS as a process-oriented pedagogical approach rather than a standalone instructional model. The analytical focus therefore shifts from categorising EDS by authorship alone to examining how storytelling processes are structured, supported, and aligned with learning theories.

2.3.5 Rationale for Focusing on Student-Created EDS in Higher Education

Given the objectives of this research, to examine and enhance creative thinking skills within higher education, student-created EDS offers greater theoretical and empirical relevance than teacher-created approaches. Its emphasis on learner agency, multimodal design, and reflective practice aligns with constructivist learning theory and contemporary creativity frameworks.

However, the literature also indicates a lack of integrated, theory-driven models that systematically connect DS processes with creative thinking development. Many implementations rely on ad hoc instructional decisions or tool-driven practices, limiting their pedagogical coherence and replicability. This gap underscores the need for a structured framework that clarifies the role of storytelling processes, instructional design, and creative cognition within EDS.

Accordingly, the subsequent sections move beyond typological classification to examine the production processes, instructional models, and theoretical foundations underpinning educational digital storytelling, thereby establishing a critical basis for later model analysis and synthesis.

2.4 Digital Storytelling as a Process-Oriented Pedagogical Practice

2.4.1 From Product-Oriented Views to Process-Oriented Understanding

Although EDS has been widely adopted across disciplines, early studies frequently conceptualised DS as a product, a completed digital artefact used for presentation or assessment, rather than as a learning process (Robin, 2008). Such product-oriented perspectives tend to emphasise technical proficiency and narrative polish while under-theorising the cognitive, creative, and instructional processes that lead to story construction.

Recent scholarship increasingly recognises that the pedagogical value of DS lies not primarily in the final story, but in the iterative process of ideation, design, production, reflection, and revision that learners engage in (Smeda, 2014; Wu & Chen, 2020). This shift mirrors broader movements in educational research that privilege learning processes over outputs, particularly in studies of creativity and higher-order thinking.

Consequently, analysing DS through a process-oriented lens is essential for understanding how storytelling activities support creative thinking development. Process models of DS provide a structured means of examining when, how, and through which mechanisms learners engage cognitively and creatively during storytelling tasks. Within this context, several DS process models have been proposed, among which Lambert's framework occupies a foundational position.

2.4.2 Lambert's Digital Storytelling Model as a Foundational Framework

Lambert's digital storytelling model, developed through the work of the Center for Digital Storytelling (CDS), is widely regarded as the earliest and most influential articulation of DS as a structured creative process (Lambert, 2006; Lambert & Hessler, 2018). Rather than presenting DS as a linear technical workflow, Lambert conceptualises storytelling as a human-centred narrative process, grounded in reflection, personal meaning-making, and emotional resonance.

The model is commonly articulated through the Seven Elements of Digital Storytelling: point of view, dramatic question, emotional content, voice, soundtrack, economy, and pacing (shown in Figure 2.1). While these elements are sometimes criticised for appearing prescriptive, their pedagogical significance lies in how they foreground narrative intentionality and reflective authorship, rather than technical sophistication alone.

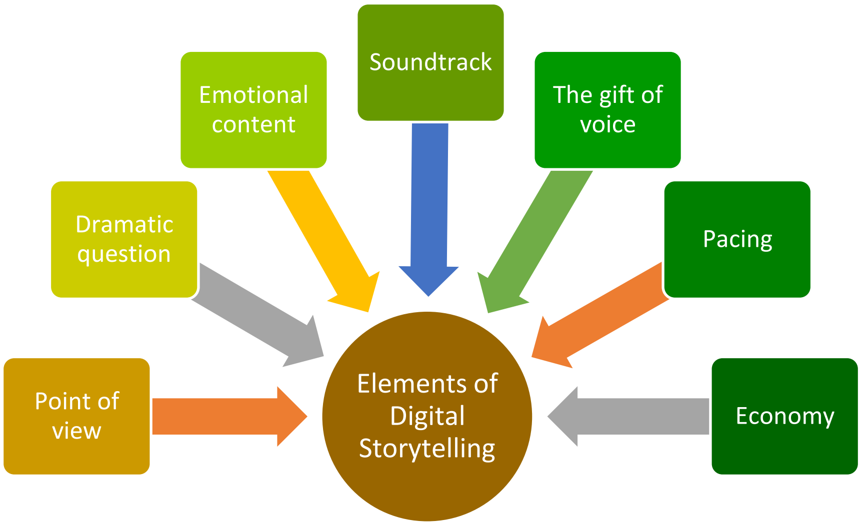


Figure 2.1. The Seven Elements of Digital Storytelling

From an educational perspective, Lambert's model is particularly valuable for three reasons.

First, it explicitly positions storytelling as a meaning-making process rather than a media production task. By prioritising point of view and emotional content, the model encourages learners to engage in self-reflection, perspective-taking, and interpretive decision-making, processes that are closely aligned with creative cognition and divergent thinking.

Second, Lambert's framework is inherently process-oriented. Although not always presented as discrete stages, the CDS methodology emphasises story circles, scripting, peer feedback, and iterative refinement. These practices situate DS within a social and reflective learning environment, consistent with constructivist and sociocultural learning theories (Hull & Katz, 2006).

Third, Lambert's model has served as the conceptual origin for many subsequent DS frameworks. Later models often adapt, extend, or operationalise Lambert's principles within specific educational or technological contexts. As such, Lambert's framework functions as a theoretical baseline against which later developments can be meaningfully compared.

2.4.3 Limitations of Lambert's Model in Formal Educational Contexts

Despite its foundational status, Lambert's model also exhibits limitations when applied to formal educational settings, particularly in higher education.

One key limitation is its implicit instructional structure. While Lambert emphasises reflection and storytelling ethics, the model offers limited guidance on how DS processes should be scaffolded within curriculum constraints, assessed systematically, or aligned with explicit learning outcomes. As a result, educational implementations based solely on Lambert's framework often rely heavily on instructor intuition rather than theoretically grounded instructional design.

A second limitation concerns cognitive specificity. Although Lambert's elements implicitly support creative engagement, they do not explicitly articulate how storytelling activities map onto distinct dimensions of creative thinking, such as fluency, flexibility, originality, or elaboration (Torrance, 1966; Runco & Kim, 2020). This lack of alignment makes it difficult to establish clear empirical links between DS processes and measurable creative thinking outcomes.

Finally, Lambert's model emerged primarily from community-based and informal learning contexts. Its transfer to higher education—particularly in art, design, and multimedia disciplines, requires additional consideration of disciplinary knowledge, technological complexity, and instructional sequencing.

These limitations do not diminish Lambert's significance; rather, they underscore the need to situate his model within a broader comparative landscape of DS process frameworks.

2.4.4 Rationale for Selecting and Comparing Subsequent DS Process Models

In response to the limitations of Lambert's framework, several scholars have proposed alternative or extended DS process models that place greater emphasis on instructional structure, cognitive processes, or technological integration. Among these, models proposed by Ohler (2013) and Chung (2021) are particularly relevant to educational research.

Ohler's digital storytelling model reframes DS as a media literacy and narrative planning process, introducing clearer phases such as story mapping, scripting, media selection, and production. This approach responds directly to instructional needs by offering educators a more explicit pedagogical sequence. However, Ohler's model tends to foreground narrative coherence and media logic, sometimes at the expense of deeper reflective or affective dimensions emphasised by Lambert.

Chung's framework, by contrast, situates DS within design-based and project-based learning paradigms, emphasising learner autonomy, iterative design, and collaborative problem-solving. This orientation aligns well with higher education contexts and contemporary creativity research. Yet, Chung's model presupposes a level of learner readiness and institutional support that may not be universally available, limiting its generalisability.

The selection of these models for comparative analysis is therefore not arbitrary. Together, Lambert, Ohler, and Chung represent three complementary perspectives on DS as a learning process:

i. Lambert foregrounds narrative meaning and reflection;
ii. Ohler emphasises instructional structure and media planning;
iii. Chung highlights design thinking and learner agency.

Comparing these models allows for a systematic examination of how different process emphases shape the educational affordances of DS, particularly in relation to creative thinking development.

2.4.5 Process Models and Conceptual Frameworks: An Analytical Distinction

It is important to distinguish DS process models from broader conceptual frameworks. Process models describe how storytelling unfolds over time, whereas conceptual frameworks explain why DS supports learning by linking processes to theoretical constructs. Many studies conflate these two levels, attributing learning outcomes to DS without specifying whether effects arise from narrative reflection, multimodal design, collaboration, or instructional scaffolding.

By foregrounding process models in this section, the literature review establishes a clear analytical boundary. The focus here is not on validating specific learning outcomes, but on examining how DS activities are structured and what cognitive opportunities they afford. This distinction is critical for avoiding conceptual ambiguity and for enabling meaningful synthesis across studies.

2.4.6 Critical Synthesis and Adaptation

To address the multimedia design theoretical deficiencies and pedagogical limitations of existing digital storytelling (DS) instructional models, this study triangulates the narrative-focused framework of Lambert (2017), disciplinary goal-oriented model of Chung (2016), and technically procedural workflow of Ohler (2008) via complementary integration, with the core tenets of multimedia design theory (Mayer, 2009; Mishra & Koehler, 2006) as the unifying anchor. A critical limitation of the three precursor models is their fragmented treatment of multimedia design: Lambert's (2018) "Seven Elements" prioritizes narrative aesthetics but neglects evidence-based multimedia cognitive design principles; Chung's (2016) framework centers on disciplinary learning alignment yet overlooks the synergy between multimodal composition and knowledge construction; Ohler's (2008) production stages provide technical guidance but lack systematic multimedia design scaffolding for educational contexts. This integration addresses these gaps by embedding multimedia design principles (e.g., dual coding, spatial contiguity, modality) into every phase of DS creation, ensuring that narrative expression, disciplinary learning, and multimodal design are mutually reinforcing.

Lambert's (2017) narrative-focused "Seven Elements" (e.g., point of view, dramatic question) offsets Chung's (2016) overemphasis on disciplinary goals (and consequent lack of narrative structure), with multimedia design theory guiding the alignment of narrative elements with multimodal expression, for example, history students use Lambert's "point of view" to analyze historical biases, and translate this perspective into a multimodal narrative (e.g., visual juxtaposition of primary source imagery and voiceover) that adheres to Mayer's (2009) modality principle, aligning with both Chung's disciplinary critical thinking goals and evidence-based multimedia design.

Ohler's (2008) technically rigorous production stages (pre-production to post-production) merge with Chung's (2016) evaluative criteria (learning objective alignment) to form a multimedia design quality loop: mid-production drafts are assessed not only for narrative coherence (Lambert) and educational validity (Chung) but also for adherence to core multimedia design principles (e.g., avoiding redundant visual/audio information, ensuring temporal contiguity between text and imagery), thus avoiding overreliance on either technical polish or disciplinary goals at the expense of effective multimodal communication.

To solve collaborative scalability challenges in group DS creation, Ohler's (2008) workflow is paired with role-based division of multimedia design tasks, aligning with Vygotsky's (1978) constructivist peer learning principles and the TPACK framework (Mishra & Koehler, 2006) that emphasizes technological pedagogical content knowledge integration. This ensures efficient group DS implementation while fostering students' specialized multimedia design competencies within a collaborative framework.

Table 2.1 synthesizes the three models into four overarching stages, pre-production, production, post-production, and distribution, each integrating core multimedia design considerations alongside elements from all three frameworks. For example, pre-production merges Lambert's narrative elements (e.g., defining "point of view") with Ohler's planning activities (e.g., storyboarding) and Chung's topic development (e.g., aligning themes with course syllabi), and adds explicit multimedia design planning (e.g., determining multimodal channels for content delivery). This integration ensures that DS creation is artistically intentional, pedagogically purposeful, and grounded in evidence-based multimedia design.

Table 2.1

Stages of Digital Story making and Related Elements

Stage	Related Elements/Processes
Pre - production	Related to Lambert's Seven Elements: Consider and determine the "Point of Related to Lambert's Seven Elements: Consider and determine the "Point of view", "Dramatic question", and "Emotional content" to clarify the core direction for subsequent production. Related to Ohler's Process: Story planning (brainstorming ideas, selecting a topic, outlining the story structure), and making necessary preparations such as gathering resources, scripting, and storyboarding. Related to Chung's Process: Topic development (choosing a topic or theme), script writing (developing a script), storyboard production (creating visual representations), and creation material preparation (gathering and organizing multimedia materials). **Multimedia Design Consideration: Define multimodal delivery channels;** align storyboard layout with Mayer’s (2009) spatial contiguity principle; categorize multimedia assets (visual/audio/text/animation) by disciplinary content relevance.
Production	Related to Lambert's Seven Elements: Determine the relevant content of "The gift of your voice" and "The power of the soundtrack", and construct the story while adhering to the principle of "Economy". Related to Ohler's Process: Creating and collecting multimedia elements (including visuals, audio, and video). Related to Chung's Process: Producing the digital story by recording voice-overs, capturing visuals, and combining them into a cohesive presentation. **Multimedia Design Consideration:** Apply dual coding principle (Paivio, 1986) for visual-audio synergy; avoid multimedia redundancy (Mayer, 2009); ensure technical consistency of multimedia assets (resolution, format, tone).
Post - production	Related to Lambert's Seven Elements: Check if the overall work complies with the principle of "Economy" and control the "Pacing" of the story. Related to Ohler's Process: Editing and refining the digital story to ensure a coherent narrative and the desired effect. Related to Chung's Process: Story evaluation (assessing the completed digital story for its effectiveness, coherence, and alignment with the intended goals). **Multimedia Design Consideration**: Refine multimodal temporal contiguity; eliminate extraneous multimedia information to reduce cognitive load (Sweller, 2010); validate multimedia accessibility (e.g., closed captioning for audio).
Distribution	Related to Lambert's Seven Elements: Present the work to the audience with an appropriate "Pacing", and convey the "Point of view", "Dramatic question", "Emotional content", etc. Related to Ohler's Process: Sharing the completed digital story with the audience through presentations, online platforms, or other means. Related to Chung's Process: Sharing the digital story with the target audience through presentations, online platforms, or other means.

Table 2.1 *continued*

	Multimedia Design Consideration: Adapt multimedia format for cross-platform compatibility; optimize multimedia assets for different viewing devices; align multimodal presentation with audience digital literacy levels.

2.4.7 Educational Digital Storytelling: A Process-Based Multimedia Design Analysis

Educational Digital Storytelling (EDS) has emerged as a powerful educational tool that synergises creativity, technology, and narrative, with multimedia design as its foundational technical and pedagogical core (Mayer, 2009; Mishra & Koehler, 2006). This section explores the benefits of EDS by analyzing its production process and elements (depicted in Table 2.2) through the lens of multimedia design theory, with the four-stage DS process (pre-production, production, post-production, distribution) serving as a scaffold for examining how multimodal composition fosters creative thinking, disciplinary learning, and digital literacy. Each stage's multimedia design practices are linked to empirical research, with a focus on how evidence-based multimodal design amplifies EDS's educational value for creative thinking development.

Table 2.2

Benefits of Digital Storytelling for Creative Thinking

Stage	Element	Corresponding Literature	Condensed Benefits
Pre-production			
	Theme Development	Moestrup&Vestergaard, 2023	Fosters critical thinking and reflection, enhancing idea articulation.
	Evaluation of Core Concepts	Rule's, 2017	Strengthens cognitive processes via information analysis for narrative coherence.

Table 2.2 *continued*

	Storyboard Creation	Foundation's, 2020.	Develops organizational skills and visual literacy for structured storytelling.
	Selection of Multimedia Assets	Supatmo & Ghufron, 2019	Fosters critical thinking and improves Academic performance.
Production			
Multimedia Creation & Collection	Text	Lambert, 2017	Enhances curiosity, conversations and creativity.
	Audio	Davis, 2023	Improves communication and collaboration through audio-based message delivery.
	Video	Wilson, 2014	Improves communication skill.
	Graphic	Spante, 2019	Enhances visual communication and design proficiency.
	Animation	Rebelo, 2022	Builds technical skills and creativity through animated storytelling.
Post-production			
	Editing Multimedia Elements	Cosme,2014	Promotes collaboration learning and reflection.
	Multi-dimensional Quality Review	Lee, 2000 Johnson, 1994	Promotes self-evaluation and emotional impact.
Distribution			
	Content Publication	Brilliantio, 2024	Provides a platform for work showcase and enhance active learning.
	Audience Engagement	Daniels & Venter, 2023	Enhances communication and cross-cultural empathy.
	Data-driven Iteration	Doe & Smith, 2023	Iterative process of feedback and reflection via Feedback and Reflection.

i. Pre-Production: Planning and Preparation

The pre-production stage is the foundation of EDS, focusing on story planning and resource preparation, and establishing the multimedia design blueprint that guides all subsequent creation. This stage includes setting up core conflicts, completing multimedia-integrated storyboards, and listing discipline-relevant multimedia assets, with all activities grounded in Mayer's (2009) spatial contiguity principle and the TPACK framework (Mishra & Koehler, 2006). Moestrup and Vestergaard (2023) propose a nine-step Digital Story Model that emphasizes critical thinking through theme selection and narrative angle refinement, with its storyboarding phase explicitly augmented by multimedia design planning to ensure that narrative choices are translated into effective multimodal expression. This aligns with Lambert's (2017) seven principles of digital storytelling, where "point of view" and "dramatic question" are not only narrative constructs but also multimedia design prompts (e.g., selecting a first-person visual perspective to frame a historical narrative). The IP Awareness Foundation's filmmaking guide further highlights that multimedia-integrated storyboarding enhances organizational and visual literacy skills by forcing students to visualize scene transitions, multimodal integration, and adherence to cognitive design principles, skills that are central to AI-era creative thinking (Runco & Kim, 2020). Supatmo & Ghufron (2019) further validate that intentional multimedia asset selection (based on disciplinary relevance) fosters critical thinking by requiring students to analyze which multimodal channels best convey complex concepts, directly improving academic performance and creative problem-solving.

ii. Production: Creation and Assembly (Multimedia Design Implementation)

The production stage involves multimedia creation and collection (text, audio, video, graphic, animation), the core phase of EDS where students apply evidence-based multimedia design principles to translate narrative and disciplinary content into multimodal expression. This phase fosters interdisciplinary integration by requiring students to combine knowledge from language arts, disciplinary content, and multimedia design theory, with each multimodal element serving a dual purpose: conveying narrative/emotional content and representing disciplinary knowledge. Davis (2023) highlights how digital multimedia production integrates visual design, programming, and collaborative workflows, with multimedia design principles guiding the synergy between these elements to directly enhance technical literacy and creative problem-solving. Wilson's (2014) audio production framework emphasizes auditory communication skills (e.g., using tone and pacing to convey emotion) and aligns with Mayer's (2009) modality principle, ensuring that audio elements complement (rather than duplicate) visual content to strengthen verbal and nonverbal expression. For graphic and animation creation, Spante (2019) demonstrates that stop-motion storytelling develops spatial reasoning and iterative design thinking—core multimedia design competencies, while AI-driven tools like HeyGen (Rebelo, 2022) enable students to experiment with dynamic visual effects while adhering to the principle of multimedia economy (Lambert, 2017; Mayer, 2009), balancing creative experimentation with evidence-based design. In all cases, production stage multimedia design is not a technical afterthought but a creative thinking practice, as students make intentional design choices to translate abstract ideas into concrete multimodal expression.

iii. Post-Production: Reflection and Refinement (Multimedia Design Optimization)

The post-production stage focuses on content optimization and evaluation—centered on multimedia design refinement to enhance EDS's narrative, pedagogical, and communicative efficacy. This stage involves editing multimedia elements and conducting a multi-dimensional quality review (narrative, pedagogy, multimedia design), and it encourages critical reflection and quality control by requiring students to evaluate their multimodal design choices against empirical principles and learning objectives. Johnson's (1994) collaborative learning model underscores the role of peer feedback in refining narratives, with peer review extended to multimedia design critique (e.g., identifying redundant visual/audio information, suggesting improvements to temporal contiguity) to foster a holistic approach to EDS refinement.

Lee’s (2000) improvisation assessment method, adapted for digital contexts, promotes self-evaluation through criteria that include both emotional resonance and multimedia design coherence, linking creative expression to evidence-based multimodal practice. Cosme’s (2014) analysis of pathos in digital media further validates how post-production multimedia editing choices (e.g., soundtrack timing, visual fade-ins/outs) amplify emotional impact—when guided by the modality and temporal contiguity principles (Mayer, 2009). Critically, post-production also addresses multimedia accessibility (e.g., adding closed captioning, optimizing visual contrast), a key component of inclusive multimedia design that extends EDS’s reach and fosters ethical creative thinking (Craft, 2005).

iv. Distribution: Sharing and Iteration (Multimedia Design Adaptation)

The distribution stage involves deployment and feedback loops—with cross-platform multimedia design adaptation as a core practice that extends EDS’s educational value beyond creation to audience engagement and iterative improvement. This stage includes cross-platform publishing, audience engagement, and data-driven iteration, and it enhances students' social, communication, and adaptive multimedia design skills as they learn to modify their multimodal narratives for different audiences, platforms, and devices. Brilliantio (2024) notes that social media integration transforms passive viewers into active participants through features like clickable narratives and user-generated content, with adaptive multimedia design (e.g., short-form video for TikTok, high-resolution infographics for LinkedIn) being essential for effective audience engagement. Daniels and Venter (2023) highlights immersive technologies (VR/AR) as tools for creating culturally adaptive stories, with multimedia design principles guiding the integration of immersive visual/audio elements to foster cross-cultural empathy, without overwhelming the audience with extraneous cognitive load (Sweller, 2010). Doe and Smith (2023) conceptualized artwork distribution as an iterative process characterized by cyclical phases of feedback integration and reflective analysis, with EDS distribution adding a multimedia design iteration layer: students use audience feedback to refine their multimodal design choices (e.g., simplifying visual elements for younger audiences, adding more detailed audio explanations for expert audiences), creating a cycle of creative thinking and evidence-based design that is central to lifelong learning (Beghetto & Kaufman, 2014).

Based on the analysis of the four stages (through a multimedia design lens), the benefits of EDS as an educational tool encompass multiple dimensions (shown in Table 2.2), with multimedia design competencies serving as a unifying thread that links all benefits to creative thinking development. From multimedia design planning in pre-production (stimulating critical thinking) to multimodal implementation in production (applying technical and creative skills), design optimization in post-production (fostering reflection), and adaptive design in distribution (enhancing communication and empathy), EDS is not merely a teaching tool but a comprehensive platform for enhancing students' creative thinking, disciplinary learning, and digital literacy with multimedia design as its core technical and creative foundation.

2.4.8 Implications for Creative Thinking in Higher Education

From the perspective of creative thinking research, process-oriented EDS models are particularly significant because creativity is widely understood as an iterative, context-sensitive process rather than a static trait (Runco & Jaeger, 2012). DS processes that involve idea generation, narrative experimentation, media selection, and revision provide fertile conditions for creative engagement, provided they are pedagogically scaffolded.

However, the literature reveals that no single DS process model sufficiently integrates narrative meaning-making, instructional structure, and creative cognition. Lambert's model provides a human-centred foundation, but lacks instructional specificity; later models address structural concerns, but often fragment the creative process.

This unresolved tension points to a conceptual gap in existing scholarship: the absence of an integrated, process-oriented framework that explicitly connects DS practices with creative thinking development in higher education contexts.

2.4.9 Section Summary

In summary, this section has examined digital storytelling as a process-oriented pedagogical practice, with particular emphasis on the role of Lambert's model as a foundational framework. While Lambert's approach remains central to understanding the narrative and reflective dimensions of DS, its limitations in formal educational contexts necessitate engagement with subsequent process models. Comparative analysis of these models highlights both shared principles and unresolved theoretical gaps, thereby setting the stage for deeper examination of instructional design, learning theory, and creative cognition in the sections that follow.

2.5 Instructional Design Supporting Educational Digital Storytelling

2.5.1 Clarifying Analytical Levels: Principles, Models, and Pedagogical Approaches

A persistent limitation in the DS literature lies in the conflation of learning principles, instructional models, and pedagogical approaches. Constructivism, ADDIE, and project-based learning are often cited interchangeably, despite addressing fundamentally different analytical levels. This conceptual ambiguity weakens theoretical coherence and complicates model comparison.

To address this issue, the present study distinguishes among three levels of analysis:

i. Learning principles, which explain how learning occurs at a cognitive and affective level;
ii. Learning and instructional models, which guide how learning experiences are systematically designed;
iii. Pedagogical approaches, which describe how teaching and learning are enacted in practice.

Within this structure, educational digital storytelling (EDS) is theorised as a pedagogical practice grounded in constructivist learning principles, operationalised through instructional design models, and enacted through project-based learning. This layered alignment allows DS to be examined as a coherent learning process rather than a collection of loosely associated theories..

2.5.2 Constructivist Learning as the Core Learning Principle

Constructivist learning theory posits that learners actively construct knowledge through engagement, interpretation, and integration of new information with prior experience (Piaget, 1972). In the context of EDS, storytelling functions as a meaning-making activity in which learners must select perspectives, organise ideas, and represent understanding through narrative and multimodal design.

Student-created digital storytelling exemplifies constructivist learning in several respects. Learners do not merely consume content; instead, they interpret subject matter, make representational decisions, and externalise understanding through creative artefacts. This process aligns with constructivist views of learning as active, contextualised, and learner-driven.

However, constructivism alone does not sufficiently explain why DS may support creative thinking. Active knowledge construction does not automatically entail originality or cognitive flexibility. For this reason, constructivism in this study is complemented by additional learning principles that address affective engagement and experiential depth.

2.5.3 Humanistic Learning: Meaning, Agency, and Emotional Engagement

Humanistic learning theory emphasises personal meaning, self-expression, and learner agency as central to educational experience (Rogers, 1969; Maslow, 1970). These principles are particularly relevant to DS, which frequently involves personal voice, narrative identity, and emotional resonance.

Lambert’s emphasis on point of view and emotional content reflects a humanistic orientation, positioning learners not only as knowledge constructors but as meaning-makers whose experiences and values shape learning outcomes (Lambert & Hessler, 2018). In educational settings, this humanistic dimension contributes to intrinsic motivation and sustained engagement—conditions that are widely recognised as supportive of creative expression.

Within this study, humanistic learning theory supplements constructivism by explaining why learners invest cognitively and emotionally in storytelling tasks, thereby creating conditions conducive to creative exploration.

2.5.4 Cone of Learning: Multisensory Experience and Learning Depth

Edgar Dale's Cone of Learning provides an experiential perspective on how different modes of engagement influence learning retention, suggesting that active, multisensory experiences foster deeper understanding than passive reception (Dale, 1969). Although the cone has been critiqued for oversimplification, it remains influential as a heuristic for emphasising experiential and participatory learning.

EDS aligns with the upper levels of the cone by engaging learners in creating, narrating, and presenting stories through multiple sensory channels. The integration of visual, auditory, and narrative elements supports experiential learning and complements constructivist and humanistic principles by embedding cognition within action and reflection.

In this study, the Cone of Learning is not treated as an empirical hierarchy but as a conceptual reinforcement of the value of active, multisensory engagement in DS-based learning activities.

2.5.5 ADDIE as the Core Instructional Design Model

While learning principles explain why DS supports learning, instructional design models explain how DS activities can be systematically structured. Among various models, ADDIE (Analysis, Design, Development, Implementation, Evaluation) serves as the core instructional framework in this study due to its clarity, flexibility, and widespread application in higher education (Branch, 2009).

ADDIE is particularly suited to EDS because it accommodates iterative design while maintaining instructional coherence. The analysis phase clarifies learning objectives and learner characteristics; the design and development phases support structured storytelling processes; implementation enables guided production; and evaluation provides mechanisms for reflection and feedback (Wahyudin et al., 2022).

Importantly, ADDIE functions in this study not as a rigid procedure but as a meta-structure that organises DS processes within pedagogical constraints.

2.5.6 SAMR and TPACK as Complementary Technology Integration Models

To address the role of technology in DS, ADDIE is complemented by SAMR and TPACK, which offer distinct but supportive perspectives on technology integration.

The SAMR model conceptualises technology use along a continuum from substitution to redefinition, encouraging educators to move beyond surface-level digital enhancement toward transformative learning experiences (Puentedura, 2014). In EDS, SAMR helps distinguish between merely digitising traditional storytelling and redesigning narrative tasks that would be impossible without digital tools.

TPACK, by contrast, emphasises the intersection of technological, pedagogical, and content knowledge (Mishra & Koehler, 2006). This framework is particularly relevant in DS contexts, where effective storytelling requires alignment among disciplinary content, narrative pedagogy, and media tools.

Together, SAMR and TPACK complement ADDIE by addressing qualitative and integrative aspects of technology use without functioning as standalone instructional models.

2.5.7 Project-Based Learning as the Pedagogical Approach

At the pedagogical level, EDS in this study is enacted through project-based learning (PBL). PBL is characterised by student-centred inquiry, extended tasks, collaboration, and interdisciplinary integration (Thomas, 2000; Bell, 2010; Silma et al., 2024).

DS aligns naturally with PBL characteristics. Story creation requires sustained inquiry, problem framing, collaboration, and iterative refinement. Moreover, DS projects often integrate multiple disciplines, including narrative writing, visual design, media production, and subject-specific knowledge.

Key features of PBL relevant to this study include:

i. **Student-centred learning**, which supports autonomy and creative agency;
ii. **Multisensory learning**, enabled through multimodal storytelling;
iii. **Collaborative learning**, facilitated through peer feedback and group production;
iv. **Interdisciplinary learning**, inherent in narrative and media design tasks.

Through PBL, DS becomes a structured learning experience rather than an isolated creative activity.

2.5.8 Integrated Theoretical Alignment and Implications

By integrating learning theoried, instructional design models, and project-based pedagogy, this study establishes a coherent theoretical foundation for educational digital storytelling. Each theoretical component addresses a distinct dimension of the learning process, while instructional design functions as the integrative mechanism that aligns theory with practice.

This integrated perspective responds directly to critiques in the literature that DS-based studies rely on theoretical aggregation rather than synthesis. Rather than treating learning theories as interchangeable justifications, the present framework clarifies their complementary roles in supporting creative thinking development through structured digital storytelling processes.

2.5.9 Section Summary

This section has refined the theoretical foundation of educational digital storytelling by distinguishing learning principles, instructional design models, and pedagogical approaches. Grounded in constructivism and supported by humanistic and experiential learning perspectives, EDS is operationalised through ADDIE and complemented by SAMR and TPACK within a project-based learning context. This layered theoretical alignment provides a rigorous basis for analysing DS as a creativity-oriented pedagogical practice in higher education.

2.6 Creative Thinking: Theoretical Foundations and Assessment Frameworks

2.6.1 Conceptualising Creativity and Creative Thinking

Creativity is a multifaceted construct that has been examined across psychology, education, and design studies. While creativity is often broadly defined as the ability to produce work that is both novel and appropriate (Runco & Jaeger, 2012), such a definition remains too abstract for educational intervention research unless operationalised at the level of cognitive processes.

In educational contexts, scholars increasingly differentiate creativity as a general human capacity from creative thinking as a set of observable and developable cognitive skills (Cropley, 2015). Creative thinking refers to learners' abilities to generate ideas, explore alternatives, restructure problems, and elaborate solutions within specific task constraints. This distinction is particularly important in higher education, where the goal is not to identify creative "geniuses" but to cultivate transferable thinking skills.

Accordingly, this study adopts creative thinking as its primary analytical construct, focusing on cognitive processes that can be intentionally supported through pedagogical design, including digital storytelling activities.

2.6.2 Early Cognitive Models of Creative Thinking

Foundational models of creative thinking emerged from cognitive psychology in the mid-twentieth century. Guilford's (1950, 1967) Structure of Intellect model introduced the concept of divergent thinking, proposing that creativity involves generating multiple, varied, and original responses to open-ended problems. Guilford identified fluency, flexibility, originality, and elaboration as core dimensions of divergent thinking, establishing a framework that continues to inform creativity research.

Building on Guilford's work, Torrance (1966, 1974) translated divergent thinking theory into educational practice through the development of the Torrance Tests of Creative Thinking (TTCT). Torrance conceptualised creative thinking as a process that could be nurtured through learning experiences and assessed through task-based performance rather than abstract aptitude measures.

These early models are particularly relevant to the present study because they conceptualise creative thinking as process-oriented, domain-flexible, and educationally malleable, characteristics that align closely with digital storytelling pedagogy.

2.6.3 The Definition of 4P Framework

The 4P model of creativity (Person, Process, Product, Press), first conceptualised by Rhodes (1961), provides a more comprehensive framework than preceding theories by synthesising multiple dimensions of creative phenomena.

i. Person: The Creative Individual

The *Person* dimension focuses on intrinsic attributes that drive creative potential. Rhodes emphasized traits such as intellectual curiosity, risk tolerance, and intrinsic motivation. These are further refined into:

- **Cognitive Abilities**: Divergent thinking, problem-solving fluency, and metaphorical reasoning.
- **Personality Traits**: Openness to experience, resilience, and tolerance for ambiguity.
- **Skill Sets**: Domain-specific expertise and interdisciplinary knowledge, enabling individuals to synthesize novel ideas.

In educational contexts, fostering the Person dimension involves cultivating metacognitive skills and growth mindsets, as seen in talent development programs targeting self-regulated learning.

ii. Process: The Creative Journey

The *Process* dimension examines the stages and interactions that lead to innovation. Synthesising Wallas' (1926) stages with Guilford's divergent thinking metrics, Rhodes conceptualized creativity as a dynamic sequence involving:

- **Preparation:** Gathering knowledge and defining problems.
- **Incubation:** Subconscious idea generation.
- **Illumination:** The "aha moment" of insight.
- **Verification:** Refining and testing ideas.

iii. Product: The Creative Outcome

The *Product* dimension evaluates the novelty, utility, and impact of creative outputs. Rhodes defined products as artifacts, theories, or services that address unmet needs . Key criteria include:

- **Originality:** Departure from existing paradigms.
- **Functionality:** Practical applicability and user-centric design.
- **Aesthetic Value:** Emotional resonance, particularly in experiential products like virtual reality interfaces.

Educational programs often assess creativity through project-based portfolios, where students demonstrate mastery of both technical and creative standards.

iv. Press: The Creative Environment

Press refers to external conditions that enable or inhibit creativity. Rhodes differentiated between psychological press and physical press. Research identifies nine environmental enablers: autonomy, challenge, diversity, trust, playfulness, debate, risk tolerance, recognition, and time flexibility.

2.6.4 Contemporary Perspectives on Creative Thinking

While Wallas' (1926) four-stage model narrowly focuses on cognitive phases of preparation, incubation, illumination, and verification, and Guilford's (1950) divergent–convergent dichotomy emphasises thinking styles, these early frameworks primarily conceptualise creativity as an internal cognitive activity. Although foundational, they provide limited consideration of contextual influences, personality dispositions, or evaluative dimensions of creative outcomes.

Similarly, Torrance's (1988) problem-solving model, which prioritises problem identification and solution communication, remains largely procedural. While valuable for operationalising divergent thinking in educational measurement, it does not explicitly address systemic influences such as cultural expectations, motivational dynamics, or environmental affordances.

In contrast, Rhodes' (1961) 4P model transcends reductionism by integrating four interrelated dimensions:

- **Person** – intrinsic motivators, personality traits, and cognitive dispositions
- **Process** – stage-based ideation and refinement mechanisms
- **Product** – novelty–utility criteria for evaluating outputs
- **Press** – environmental, social, and cultural influences

This integrative framework recognises creativity as the dynamic interplay between individual characteristics, creative workflows, evaluative standards, and contextual conditions. Rather than isolating cognition, Rhodes conceptualises creativity as an emergent property of multidimensional interactions. This systemic lens is particularly relevant for analysing real-world innovation ecosystems and educational environments (Zhou, 2024; Tian & Li, 2022).

Rhodes' 4P model endures as a foundational taxonomy due to its heuristic versatility and multidisciplinary applicability. By extending beyond the procedural narrowness of Wallas' stages and Guilford's cognitive reductionism, it offers a scaffold for designing future-oriented creativity curricula (Zhou, 2024).

Recent refinements by Runco and Kim (2020) introduce a hierarchical interpretation of the 4P framework. They categorise Person, Process, and Press as components of creative potential, while Product is conceptualised as an indicator of creative performance. Given that the present study aims to enhance creative thinking skills (CTS) within an educational intervention, the focus is placed on cultivating students' creative potential rather than exclusively evaluating end products. Accordingly, the identified elements are organised into Person, Process, and Press (3P).

Building on the extraction and categorisation of elements from related models in the previous section, conceptually analogous elements were amalgamated and reorganised under the 3P structure to avoid redundancy while preserving theoretical integrity.

Contemporary creativity research has moved beyond a sole emphasis on divergent thinking to incorporate developmental, contextual, and socio-cultural dimensions.

The Four-C model (Kaufman & Beghetto, 2009), for example, differentiates between mini-c (personal creativity), little-c (everyday creativity), Pro-C (professional-level creativity), and Big-C (eminent creativity). This framework is particularly relevant for higher education, where the cultivation of mini-c and little-c creativity forms the foundation for professional development.

Similarly, Amabile's (1996) componential model emphasises the interaction among:

- **Domain**-relevant skills
- **Creativity**-relevant processes
- **Intrinsic motivation**

These perspectives reinforce the view that creative thinking emerges from dynamic interactions between individuals, tasks, and environments rather than from isolated traits or purely cognitive operations.

However, despite their conceptual richness, many contemporary socio-cultural models lack clear operationalisation for empirical educational research. They describe enabling conditions for creativity but often do not specify measurable cognitive outcomes suitable for pre–post intervention studies. Consequently, divergent thinking–based frameworks remain central in research that requires observable and quantifiable indicators of creative thinking performance, particularly in higher education settings.

2.6.5 Creative Thinking in Higher Education Contexts

In higher education, creative thinking is increasingly recognised as a core graduate competency, particularly in disciplines related to art, design, and digital media (OECD, 2019). Universities are expected to cultivate students' abilities to address ill-defined problems, integrate knowledge across domains, and communicate ideas through diverse media forms.

Digital storytelling aligns naturally with these expectations. The storytelling process requires idea generation, perspective shifting, narrative structuring, and iterative refinement, all of which map onto established dimensions of creative thinking. Importantly, DS tasks typically involve open-ended constraints rather than single correct answers, creating conditions conducive to divergent and exploratory thinking.

Nevertheless, empirical studies on DS and creativity in higher education often rely on self-report measures or qualitative reflections, limiting the strength of causal claims. This methodological tendency underscores the importance of selecting assessment frameworks that can capture creative thinking as observable performance.

2.6.6 Assessment Frameworks for Creative Thinking

Assessing creative thinking poses persistent challenges due to its open-ended and context-sensitive nature. Common assessment approaches include self-report scales, expert judgement of creative products, and performance-based tests.

Self-report measures are efficient but vulnerable to social desirability bias and limited metacognitive awareness. Product-based assessments provide rich qualitative insight but often suffer from subjectivity and limited comparability across studies.

Performance-based assessments grounded in divergent thinking theory, such as the TTCT, offer a balance between structure and openness. The TTCT assesses creative thinking through tasks that elicit fluency, flexibility, originality, and elaboration, allowing for both quantitative analysis and qualitative interpretation (Torrance, 1974).

2.6.7 Rationale for Adopting the Torrance Tests of Creative Thinking

The Torrance Tests of Creative Thinking are among the most widely used and empirically validated instruments for assessing creative thinking across age groups and cultural contexts (Kim, 2006). Their sustained use in educational research reflects both methodological robustness and theoretical coherence.

There three considerations support the relevance of TTCT to this study. First, the TTCT conceptualises creative thinking as a process, not a fixed trait, aligning with the pedagogical aims of educational digital storytelling. Second, the TTCT's dimensions correspond closely with cognitive demands inherent in storytelling activities, such as generating ideas (fluency), exploring narrative alternatives (flexibility), producing novel representations (originality), and developing narrative detail (elaboration). Third, the figural form of TTCT is particularly appropriate for studies involving art, design, and multimedia learning. Figural tasks allow learners to express ideas visually and symbolically, reducing linguistic bias and aligning with the multimodal nature of digital storytelling (Kim, 2011).

2.6.8 Linking Digital Storytelling Processes to Creative Thinking Dimensions

Mapping DS processes onto TTCT dimensions reveals clear theoretical alignment. During story ideation, learners generate multiple narrative possibilities, supporting fluency. Perspective-taking and narrative restructuring foster flexibility. The creation of unique storylines and visual metaphors encourages originality, while refining narrative and media details supports elaboration.

This alignment does not imply that DS automatically enhances creative thinking. Rather, it suggests that when DS activities are pedagogically structured and theoretically grounded, they provide opportunities to engage core creative thinking processes. Instructional design therefore plays a mediating role in translating storytelling tasks into cognitive development.

2.6.9 Section Summary

This section has examined creative thinking through foundational and contemporary theoretical lenses, distinguishing it from broader notions of creativity. By situating creative thinking within higher education contexts and reviewing assessment frameworks, the review establishes a clear rationale for adopting the Torrance Tests of Creative Thinking, particularly the figural form, as an appropriate instrument for evaluating creativity-oriented digital storytelling interventions.

2.7 Empirical Evidence on Digital Storytelling and Creative Thinking

2.7.1 Overview of Empirical Research Trends

A growing body of empirical research has examined the relationship between DS and creative thinking across educational contexts. These studies span primary, secondary, and higher education, and employ diverse methodological approaches, including quasi-experimental designs, mixed-methods studies, and qualitative case analyses (Smeda et al., 2014; Wu & Chen, 2020).

Overall, the literature suggests a positive association between DS-based learning activities and creativity-related outcomes, such as idea generation, originality, and learner engagement. However, despite this apparent consensus, closer examination reveals considerable variation in research design, theoretical grounding, and assessment practices. These variations complicate attempts to draw robust conclusions regarding the effectiveness of DS in fostering creative thinking, particularly in higher education contexts.

2.7.2 Digital Storytelling as a Creativity-Supportive Learning Activity

Many empirical studies conceptualise DS as a creativity-supportive activity by virtue of its open-ended and expressive nature. For example, Smeda et al. (2014) reported that students engaged in DS projects demonstrated increased creative expression and motivation, attributing these outcomes to narrative autonomy and multimodal production.

Similarly, Ribeiro (2017) found that DS-based assignments encouraged students to explore alternative representations of knowledge, supporting flexibility and originality. These studies highlight the affordances of DS for creative engagement, particularly when learners are granted agency over narrative content and media choices.

However, most of these studies rely heavily on qualitative observations, reflective journals, or self-reported perceptions of creativity. While such data provide valuable insight into learner experiences, they offer limited evidence of cognitive development in creative thinking. As a result, claims regarding creativity enhancement are often descriptive rather than explanatory.

2.7.3 Studies Employing Quantitative Measures of Creative Thinking

A smaller subset of studies employs quantitative instruments to examine the impact of DS on creative thinking. Among these, divergent thinking tests and creativity scales are commonly used. For instance, Yang and Wu (2012) conducted a quasi-experimental study in higher education and reported statistically significant improvements in creative thinking among students who participated in DS-based instruction compared to a control group. Their findings suggest that structured storytelling activities can positively influence creativity-related cognitive skills.

Nevertheless, such studies often provide limited detail regarding how DS processes were designed or scaffolded. Without explicit alignment between instructional design and creativity constructs, it remains unclear which aspects of DS contributed to observed improvements. Furthermore, short intervention durations and small sample sizes constrain the generalisability of results.

2.7.4 Creative Thinking Assessment: Methodological Limitations

Assessment practices represent a major methodological challenge in DS–creativity research. Many studies equate creativity with learner engagement or satisfaction, using attitudinal surveys as proxies for creative thinking development (Hava, 2021). While engagement is an important prerequisite for creativity, it does not constitute direct evidence of creative cognition.

Even when performance-based assessments are employed, scoring procedures and validity evidence are often underreported. Few studies report reliability coefficients, inter-rater agreement, or content validity indices, limiting confidence in the findings. This methodological inconsistency undermines efforts to synthesise results across studies.

2.7.5 Contextual and Disciplinary Variations

Another limitation of existing empirical research lies in its contextual focus. A substantial proportion of DS–creativity studies are conducted in primary or secondary education settings, where learning objectives and cognitive demands differ markedly from those in higher education.

Within higher education, studies are often situated in language learning or general education courses, with relatively few investigations in art, design, or multimedia disciplines. Given the disciplinary specificity of creative processes, findings from other domains may not readily transfer to design-oriented contexts.

2.7.6 Instructional Design and Process Transparency

Across the literature, there is a notable lack of transparency regarding DS instructional processes. Many studies describe DS as an intervention without detailing how activities were structured, how feedback was provided, or how learning objectives were aligned with storytelling tasks.

This lack of process-level description makes it difficult to compare studies or replicate interventions. Moreover, it obscures the role of instructional design in mediating the relationship between DS and creative thinking. Without explicit process models, DS risks being treated as a "black box" pedagogy.

2.7.7 Synthesis of Empirical Findings

Taken together, empirical evidence suggests that DS holds promise as a pedagogical approach for supporting creative thinking. However, this promise remains under-theorised and under-validated. While many studies report positive outcomes, few offer clear explanations of the mechanisms through which DS influences creative cognition.

The literature reveals three recurring gaps:

i. Theoretical under-specification, where creativity is assumed rather than operationalised;
ii. Methodological inconsistency, particularly in creativity assessment;
iii. Process opacity, with limited attention to instructional design and storytelling stages.

These gaps indicate that existing research, while suggestive, does not yet provide a comprehensive or generalisable account of how DS can systematically enhance creative thinking in higher education.

2.7.8 Implications for the Present Study

In light of these findings, the present study seeks to address limitations in existing literature by adopting a structured, theory-integrated approach to digital storytelling, supported by explicit instructional design and validated creative thinking assessment. By focusing on higher education and employing process transparency, this research aims to contribute more robust empirical evidence to the field.

2.7.9 Section Summary

This section has critically reviewed empirical studies examining the relationship between DS and CTS. While existing research points to positive associations, methodological and theoretical limitations constrain the strength of current evidence. The absence of integrated, process-oriented, and theory-driven models underscores the need for further research that systematically aligns digital storytelling practices with creative thinking frameworks and rigorous assessment methods.

2.8 Synthesis of Literature and Identification of Research Gaps

2.8.1 Purpose and Scope of the Synthesis

The purpose of this section is to synthesise the preceding literature on DS, instructional design, and creative thinking, and to identify unresolved issues that warrant further investigation. In line with the function of a literature review, this section does not propose or justify a new model. Instead, it critically integrates existing theoretical, methodological, and empirical findings to clarify what is currently known, what remains ambiguous, and where systematic gaps persist.

2.8.2 The Synthesis of Literature

Across theoretical and empirical studies, several points of convergence can be identified.

First, DS is widely recognised as a multimodal, narrative-based learning practice that supports learner engagement, reflection, and meaning-making. Process-oriented perspectives emphasise that the pedagogical value of DS lies in its iterative stages of ideation, design, production, feedback, and revision, rather than in the final artefact alone (Lambert & Hessler, 2018; Smeda et al., 2014).

Second, CTS is increasingly conceptualised as a developable set of cognitive processes, rather than a fixed trait. Divergent thinking frameworks, particularly those proposed by Guilford and Torrance, remain influential due to their operational clarity and applicability in educational research (Guilford, 1967; Torrance, 1974).

Third, instructional design and learning theories provide a solid theoretical basis for integrating DS into higher education. Constructivism, humanistic learning, experiential learning, and project-based pedagogy collectively explain why storytelling activities can support creative engagement when appropriately designed and scaffolded.

Taken together, the literature suggests that digital storytelling has the potential to foster creative thinking, particularly in learner-centred, project-based contexts.

2.8.3 Conceptual and Theoretical Limitations in Existing Studies

Despite these strengths, the literature also reveals several conceptual limitations.

A key issue is the fragmentation of theoretical perspectives. Many studies cite learning theories, creativity frameworks, and DS models in parallel, without clarifying how these perspectives interact at the process level. As a result, DS is often treated as a theoretically "rich" but analytically diffuse pedagogy.

In particular, the relationship between storytelling processes and specific creative thinking dimensions (e.g., fluency, flexibility, originality, elaboration) is rarely articulated. While creativity is frequently claimed as an outcome, few studies explicitly map DS activities onto recognised creative thinking constructs.

2.8.4 Methodological Gaps in Empirical Research

Methodological inconsistency represents a second major limitation in the literature.

Many empirical studies rely on qualitative reflections, self-report surveys, or general engagement indicators as proxies for creative development. Although valuable for understanding learner experience, these approaches provide limited evidence of cognitive change. Even when quantitative measures are employed, details regarding validity, reliability, and scoring procedures are often insufficiently reported.

Furthermore, few studies adopt process transparency. Digital storytelling interventions are commonly described at a surface level, with limited attention to instructional sequencing, scaffolding strategies, or feedback mechanisms. This lack of clarity makes it difficult to compare findings across studies or replicate interventions in new contexts.

2.8.5 Contextual and Disciplinary Gaps

Another notable gap concerns research context. A substantial portion of DS–creativity research is situated in primary or secondary education, or within language learning contexts. Comparatively fewer studies examine DS as a structured pedagogical practice in higher education, particularly in art, design, and multimedia-related disciplines where multimodal expression is central.

Given that creative thinking is context-sensitive and discipline-dependent, findings from other educational levels or domains may not fully capture the cognitive demands and design complexities of higher education DS practices.

2.8.6 Absence of Integrated, Process-Oriented Frameworks

Perhaps the most significant gap identified through this review is the absence of integrated, process-oriented frameworks that systematically connect:

i. digital storytelling processes,
ii. instructional design principles, and
iii. creative thinking constructs.

Existing models tend to privilege one dimension, narrative meaning (Lambert), instructional sequencing (ADDIE-based approaches), or learner autonomy (project-based learning), without fully integrating these elements into a coherent pedagogical structure. Consequently, DS-based interventions often depend on ad hoc instructional decisions rather than theoretically grounded design.

2.8.7 Implications for Further Research

The synthesis presented in this chapter indicates that while DS is widely regarded as a promising pedagogical approach, its application to creative thinking development in higher education remains theoretically and methodologically underdeveloped. Existing studies often describe DS activities in isolation, with limited attention to how instructional design principles, learning processes, and creative thinking constructs are systematically aligned within a coherent pedagogical structure.

Figure 2.2 provides an overview of the theoretical orientation emerging from this literature synthesis. As illustrated, instructional design principles (represented by ADDIE) and pedagogical characteristics associated with learner-centred, process-oriented learning (represented by the 3P perspective) jointly inform the structuring of digital storytelling workflows. Rather than functioning as independent frameworks, these elements converge at the level of digital storytelling processes, emphasising the importance of instructional sequencing, learner engagement, and process transparency.

Within this theoretical orientation, the Digital Storytelling for Creative Thinking Skills (DSCTS) is conceptually positioned as an integrative construct that emerges from, rather than replaces, established theories and models. DSCTS is not introduced as a standalone theoretical claim within this chapter; instead, it is implied as a system-level articulation that connects instructional design inputs and pedagogical processes to creative thinking development through structured digital storytelling workflows.

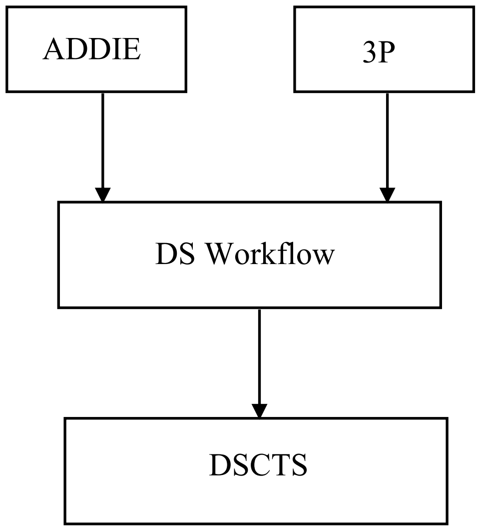


Figure 2.2. The Theoretical Framework

Importantly, this positioning reflects a key implication of the literature review: the need to move beyond fragmented applications of DS toward a framework that explicitly links design principles, learning processes, and creative thinking dimensions. The literature suggests that creative thinking development cannot be attributed to digital storytelling activities alone, but depends on how such activities are designed, sequenced, and enacted within instructional contexts.

Accordingly, subsequent chapters shift focus from reviewing existing literature to detailing the methodological and conceptual strategies through which this integrative orientation is operationalised in the present study. Building on the theoretical relationships outlined in Figure 2.2, the study examines how a structured DS workflow, informed by instructional design and pedagogical process considerations, can be systematically investigated in relation to creative thinking outcomes in higher education.

2.8.8 Section Summary

This section has synthesised key findings from the literature on DS, instructional design, and creative thinking, identifying critical conceptual, methodological, and contextual gaps. By clarifying what is currently established and what remains unresolved, the literature review provides a coherent foundation for the research design and analytical framework presented in the following chapters.

2.9 Chapter Summary

This chapter critically reviewed literature on digital storytelling (DS), multimedia design, instructional frameworks, and creative thinking within higher education (see Figure 2.3). Rather than providing a descriptive overview, the review adopted a process-oriented and analytical perspective to clarify conceptual boundaries and identify limitations in existing scholarship.

Digital storytelling was conceptualised as a multimodal design practice that integrates narrative construction with multimedia orchestration. Educational DS was distinguished by its pedagogical intentionality and emphasis on student-generated production, which supports higher-order cognitive engagement. Process models of DS were synthesised to reveal common structural stages, while instructional design theories and multimedia learning principles were examined to establish their cognitive and organisational roles. This alignment positioned DS as a structured instructional design system rather than merely a technical production activity.

Creative thinking was analysed through both foundational cognitive models and systemic frameworks, particularly Rhodes' 4P model and its contemporary refinements. While recent perspectives highlight contextual and motivational dimensions, challenges remain in operationalising these constructs for empirical intervention research. Consequently, creative thinking was framed as a developable construct requiring measurable performance indicators in higher education contexts.

A critical review of empirical studies linking DS and creativity revealed generally positive associations but also persistent gaps, including fragmented theoretical integration, inconsistent assessment practices, and limited process transparency.

Overall, the review identified a key research gap: the lack of an integrated, process-oriented framework that systematically connects digital storytelling workflow, multimedia design principles, instructional structure, and creative thinking development in higher education. This gap provides the theoretical and empirical rationale for the development and validation of the proposed DSCTS model in the following chapter.

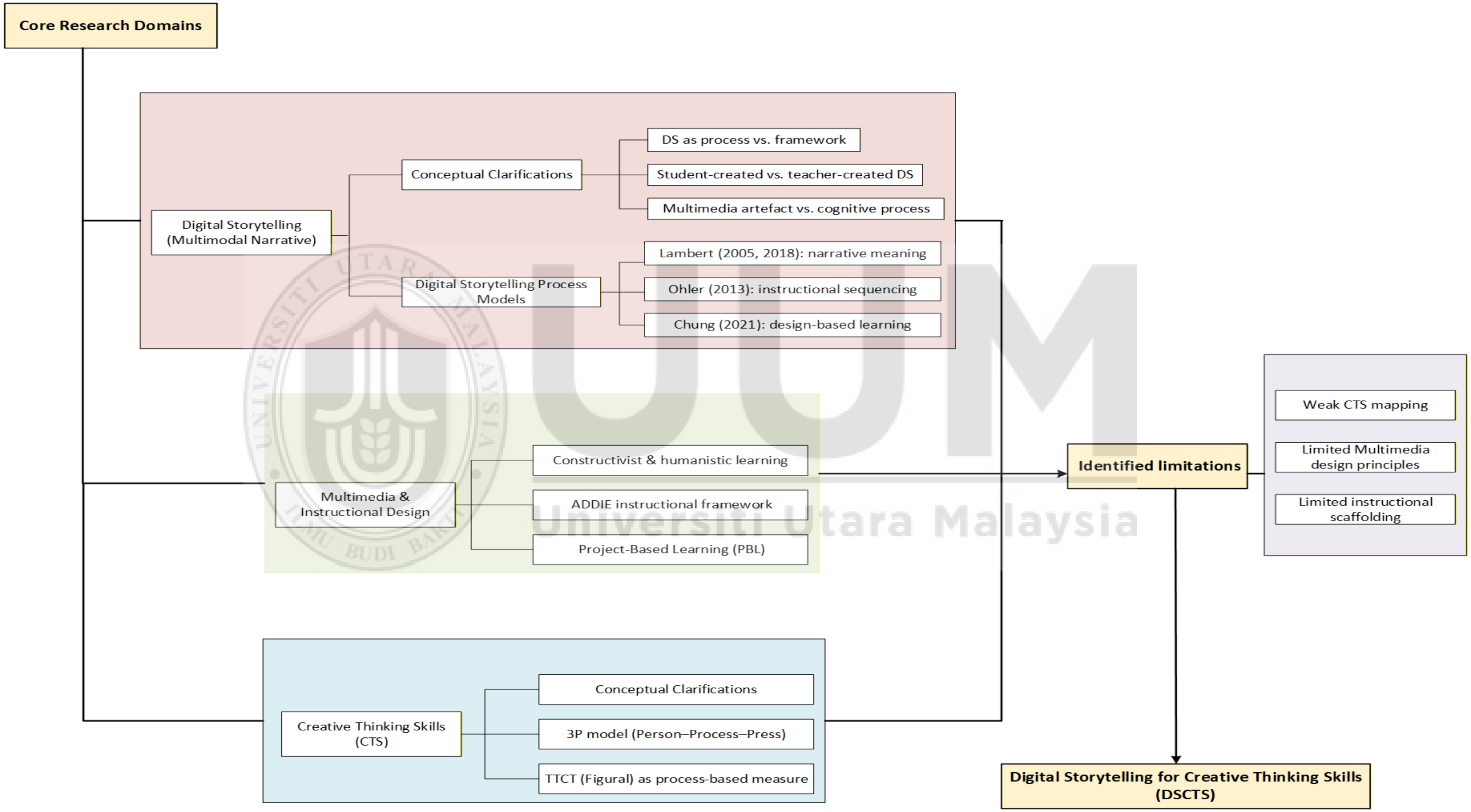


Figure 2.3. Overview of Literature Review

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Overview

This chapter provides a systematic overview of the methodological framework adopted in this study, aiming to achieve two core objectives: first, to demonstrate the systematic pathway for constructing a conceptual model using the DSR (Design Scientific Research) methodology; and second, to outline the research design for evaluating the practical effectiveness of the proposed model.

The framework encompasses an introduction of DSR, the framework of DSR, and the specific procedural stages of its application in this study. Among these, the evaluation stage is a critical component, involving research design, participant sampling, and the development of scales. While these activities are embedded within the DSR methodology, they are essential for ensuring the rigour and validity of the research outcomes. This chapter delves into the specific stages and evaluation details implemented to achieve the stated objectives, offering a comprehensive perspective on the methodological foundation of this study.

3.2 The Framework of Design Science Research

In the educational setting, all instructional efforts and services are ultimately directed toward cultivating students' competencies (Kunter, Baumert, & Köller, 2013). This research aligns with that overarching objective, positioning the development of CTS as a key educational outcome. Accordingly, all identified components are analysed from the perspective of educational practitioners, aiming to enrich pedagogical practice and enhance student learning.

The study is situated within the paradigm of DSR, which, under a pragmatist epistemology, prioritises prescriptive knowledge (λ-knowledge) over purely descriptive theories (Ω-knowledge) (Hevner et al., 2010). Unlike formal sciences, which construct abstract logical systems, or interpretive sciences, which develop explanatory theories, DSR legitimises knowledge creation through the design and evaluation of artefacts that address real-world problems. In this context, the DSCTS (Digital Storytelling on Creative Thinking Skills) model functions as both an educational intervention and a theoretically grounded artefact, with its value demonstrated through empirical evaluation. As Gregor and Hevner (2007) emphasise, in DSR "the artefact itself embodies theoretical innovation."

DSR, conceptualized by Simon (1969), is a problem-solving paradigm focused on creating innovative artefacts,including constructs, methods, models, and systems,to address complex real-world challenges. While its roots span disciplines like engineering, medicine, and management, DSR has evolved into a well-established methodological framework within Information Systems (IS), with seminal contributions emerging prominently in the 1990s.

DSR integrates human creativity into the development of practical artefacts that simultaneously solve problems and advance knowledge (Hevner et al., 2010). Its iterative nature facilitates continuous refinement of artefacts through cycles of design, evaluation, and optimization,a dynamic process distinguishing DSR from linear research approaches (Wieringa, 2014; Venable, Pries-Heje, & Baskerville, 2016). This emphasis on utility and innovation has spurred adoption across diverse fields, including business, healthcare, and administration (vom Brocke et al., 2020; Romme & Meijer, 2020).

Hevner et al. (2010) structure DSR around three interdependent cycles:

- **Relevance Cycle:** Defines the research context (e.g., stakeholders, organizational needs) to ensure practical significance.
- **Design Cycle:** The core iterative process of artefact creation, evaluation, and refinement.
- **Rigor Cycle:** Grounds the research in established knowledge and methodologies to ensure scholarly validity (vom Brocke et al., 2020).

In design science research (DSR), several structured process models provide methodological guidance for implementation. Peffers et al. (2007) propose a comprehensive six-phase approach encompassing problem identification, objectives definition, design and development, demonstration, evaluation, and communication. A more condensed framework is offered by Offermann et al. (2009), who focus on three core elements: problem identification, solution design, and evaluation. Meanwhile, Vaishnavi and Kuechler (2015) establish a five-phase iterative cycle including awareness of problem, suggestion, development, evaluation, and conclusion. Another perspective comes from vom Brocke et al. (2020), who structure DSR around the dynamic relationship between problem space and solution space connected through evaluation.

Among these established frameworks, the model by Vaishnavi and Kuechler (2015) has gained particularly wide adoption in technology-driven research contexts. While Peffers et al. provide greater procedural detail and Offermann et al. offer a more streamlined approach, Vaishnavi and Kuechler's model strikes an effective balance between clarity and adaptability. Its iterative nature and conceptual coherence make it especially suitable for guiding research in evolving technological environments, as illustrated in Figure 3.1 of the original text.While all DSR models share core emphases on problem-centricity and iterative evaluation, Vaishnavi and Kuechler's (2015) framework was selected for this study. Its strengths,conciseness, adaptability to ongoing artifact refinement, and inherent alignment with educational technology design contexts,make it particularly suited to guiding the development of pedagogical models like the DSCTS.

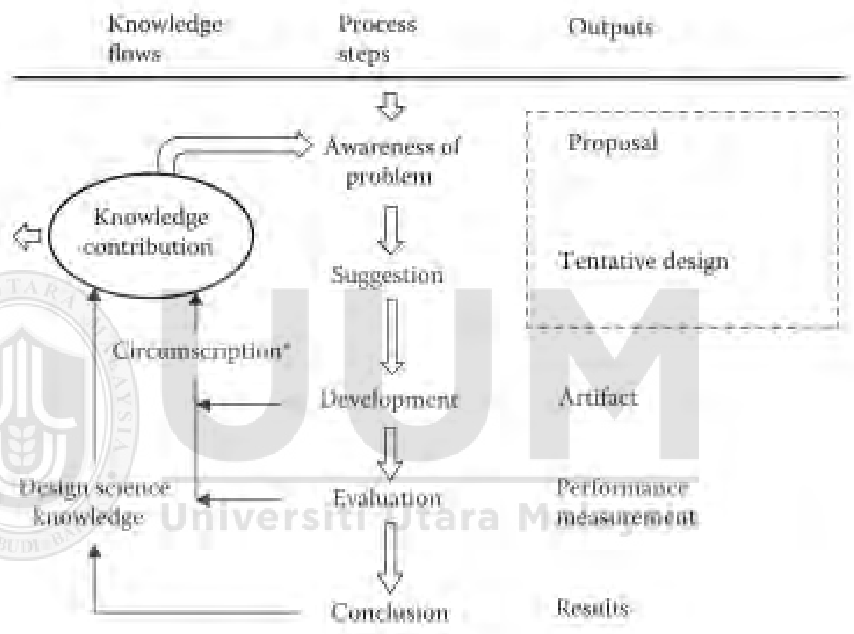


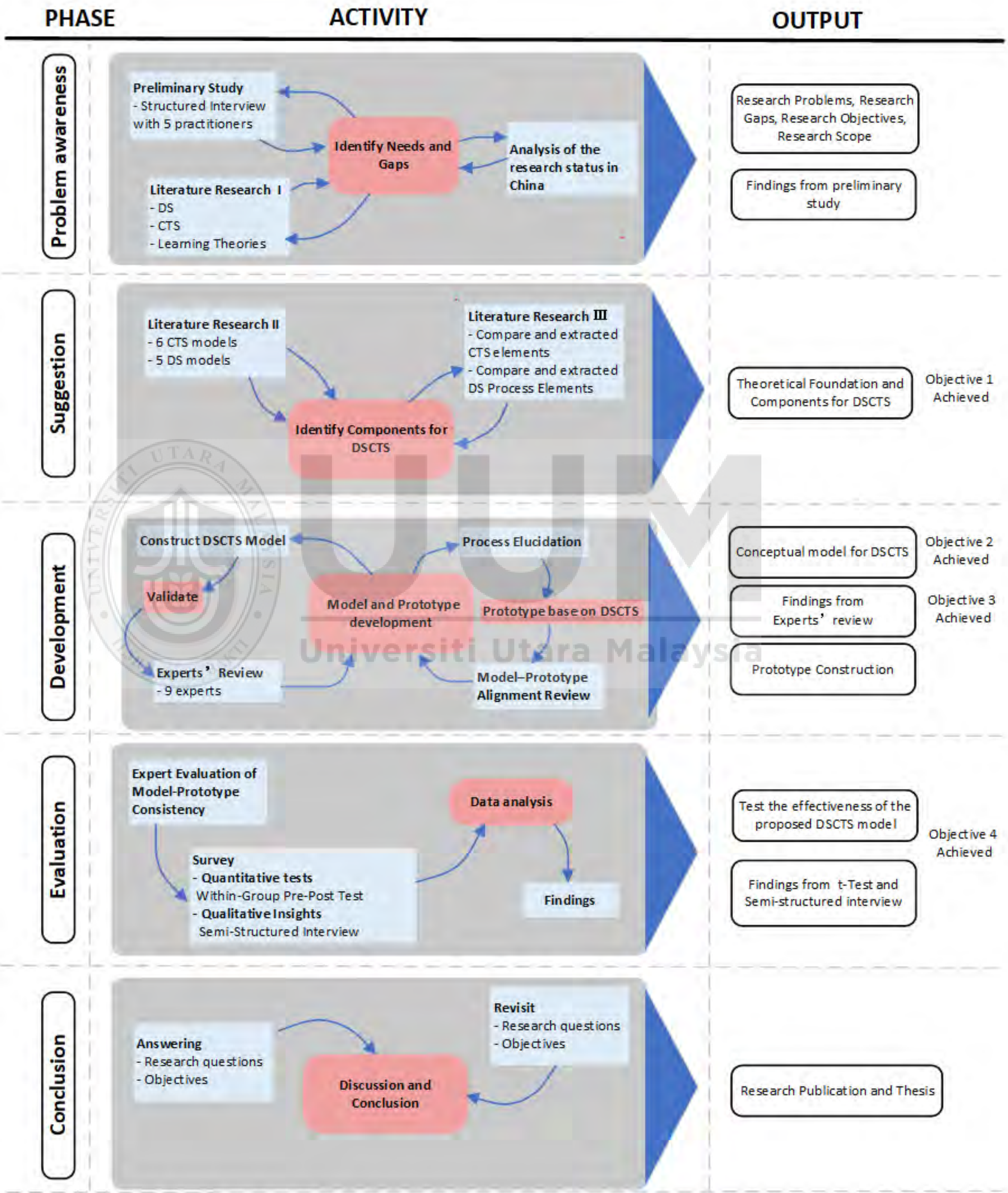
Figure 3.1. Design Science Research Framework (Source from Vaishnavi and Kuechler (2015))

Accordingly, this research employs Vaishnavi and Kuechler's (2015) framework to structure the iterative development of the *Digital Storytelling for Creative Thinking Skills (DSCTS)* model, ensuring the process remains systematic yet flexible to address real-world educational needs:

- **Awareness of problem:** Fragmented DS practices and causal ambiguity regarding how DS processes cultivate creative thinking in authentic settings were identified from the literature and practice.
- **Suggestion:** Requirements for a dynamic, process-integrated DSCTS model were specified by synthesising instructional-design and creativity frameworks.
- **Development:** The DSCTS conceptual model was designed and instantiated in several prototypes.
- **Evaluation:** A theory-aligned expert rubric was employed to assess the prototypes across four key dimensions: alignment with the proposed conceptual model, integration of CTS development mechanisms, design of learning activities, and depth of overall reflective components (see Chapter 4). Given the core objective of this study,to construct the proposed DSCTS model,verifying the model's capacity to enhance students' CTS is paramount. To this end, a mixed-methods approach (combining quantitative and qualitative analyses) was used to validate the model's practical utility.
- **Conclusion:** This phase involved reviewing whether the study's predefined objectives were achieved, with findings serving as a foundation for subsequent rounds of model iteration.

3.3 Research Phases

Aligned with the iterative DSR framework advanced by Vaishnavi and Kuechler (2015), this study implements a structured five-phase methodology (Figure 3.2). Each phase integrates purpose-driven research activities with clearly defined deliverables, collectively forming an integrated workflow designed to systematically address the research questions established in Chapter 1. This methodical progression ensures that outputs generated at each stage incrementally contribute to achieving the study's overarching objectives, while maintaining fidelity to DSR principles of rigor and relevance.



Note.
DS- Digital storytelling, CTS- Creative Thinking Skills,
DSCTS- Digital Storytelling conceptual model for Creative Thinking Skills

Figure 3.2. Research Design Flow Chart

3.3.1 Phase1: Problem Awareness

The research commenced with the identification of a real-world problem: how to foster students' CTS within higher education. DS was recognised as a tool with untapped potential, thereby rendering the problem more concrete: how to leverage DS to foster students' CTS. During this phase of the research, an extensive literature review was conducted, encompassing analyses of DS, CTS, and pertinent learning theories. Moreover, an examination of the current developmental status within Chinese and international contexts was undertaken to derive valuable insights. The viability and significance of this study are further underpinned by an investigation into preliminary research.

Subsequently, a gradual and systematic process facilitated the identification of research gaps, the formulation of precise research objectives, the delineation of pertinent sub-questions, and the establishment of the study's scope. Each step was executed meticulously, thereby ensuring a coherent and rigorous research framework. Figure 3.3 provides an illustrative depiction of this progressive endeavour, offering a visual representation of the research process's sequential development.

Figure 3.3. Awareness of Problem

3.3.1.1 Literature Research I

Content analysis is a method for systematically categorizing and analysing messages or data, allowing researchers to gain valuable insights from large volumes of information across different domains (Lindgren, Lundman, & Graneheim, 2020). This research utilizes content analysis to examine multiple facets of EDS, explore the way of cultivating CTS, and investigate the role of learning principles in supporting effective educational practices. This study scrutinizes prior research on the impact of DS on students' creative thinking abilities, while also conducting an in-depth analysis of the current state of research in China pertaining to this subject. Through these investigations, the study seeks to identify pertinent research questions, address existing gaps in the literature, establish clear objectives, and determine the appropriate research methods for accomplishing its aims.

3.3.1.2 Preliminary study

To validate the viability of the research, a semi-structured preliminary study was conducted. The role of the preliminary study is to provide a foundation, direction, and initial data support for subsequent in-depth research (Mishra & Alok, 2022). This preliminary investigation involved 5 practitioners, and the results of the study further confirmed the relevance of the study. By engaging with these individuals, the researcher was able to reaffirm the pertinence and significance of the present study under investigation. The respondents in this study were drawn from diverse academic backgrounds, representing various colleges and universities. They encompassed a wide array of disciplines and exhibited varying levels of educational attainment. The research findings stemming from their contributions were subjected to meticulous and comprehensive analysis as detailed earlier.

3.3.2 Phase 2: Suggestion

The primary objective in the suggestion phase was to delineate the components of the proposed DSCTS model. This was accomplished through a rigorous examination of six distinct EDS models. The process involved both content analysis and comparative analysis, with domain experts consulted to validate the identified components. The outcomes derived from this phase effectively address the first research question of this study, as depicted in Figure 3.4.

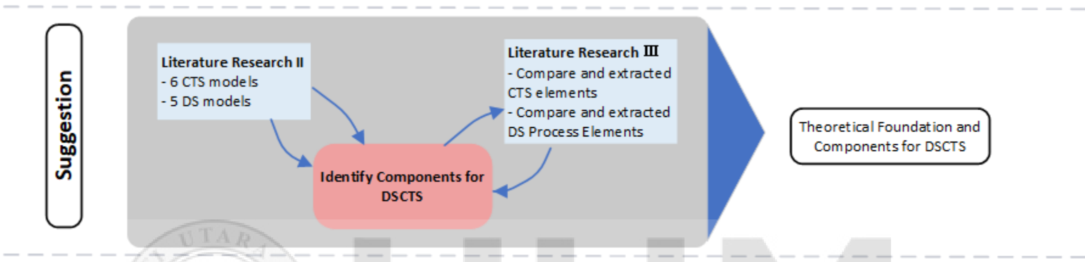


Figure 3.4. Suggestion

3.3.2.1 Literature Research II

A meticulous literature review was first conducted to select five pivotal DS models and six models specifically tailored for fostering CTS. Employing a rigorous analysis, these models were examined to uncover their unique characteristics. This process documented the strengths and weaknesses of each model, providing a clear overview of their attributes and limitations. By synthesizing these findings, the study contributed a valuable perspective to the academic discourse, distinguishing the features of DS models, CTS development models, and their integration into the DSCTS model. Subsequently, a deep analysis of the models was conducted using a horizontal approach, involving a detailed comparison of the selected models. This scrutiny aimed to discern the distinctive strengths and weaknesses of each model.

Furthermore, a systematic synthesis of shared elements among the models was undertaken, identifying common factors underlying their structures and functions. This analytical process facilitated a deeper understanding of the essential components contributing to the models' effectiveness and applicability within their respective contexts, thereby addressing the first research question effectively.

3.3.2.2 Literature Research III

The objective of this literature analysis **III** is twofold: to identify the core elements essential for fostering students' CTS, and to establish the key steps in creating a project-based DS production process. Following the preliminary exploration in Chapter 1 and comparison of selected models in Chapter 4, readers have gained an initial understanding of these models, as well as their respective strengths and limitations. Building upon the foundations laid in Chapter 2, this section delves deeper into the selected models by extracting their constituent elements. Through comparative analysis II, common elements are identified and subsequently categorized. This section is bifurcated into two branches: one focusing on the comparative analysis of CTS models, and the other on the comparative analysis of the production process of project-based EDS.

3.3.3 Phase 3: Development

Drawing upon the insights gleaned from the preceding analysis, the development phase revolves around the formulation of a conceptual design model for DSCTS, utilizing the elements extracted during the previous stage. This phase encompasses three ordered parts: firstly, the construction of the DSCTS model; secondly, the rigorous assessment and enhancement of the model's validity; and finally, the creation of a prototype grounded in this conceptual design framework. This stage assumes paramount importance as it addresses the second and third research questions, thereby constituting a central aspect of this study's focal objectives. Detailed elucidation of the activities undertaken during this phase is presented in Figure 3.5, encapsulating the pivotal endeavour embarked upon to realize the DSCTS conceptual design model.

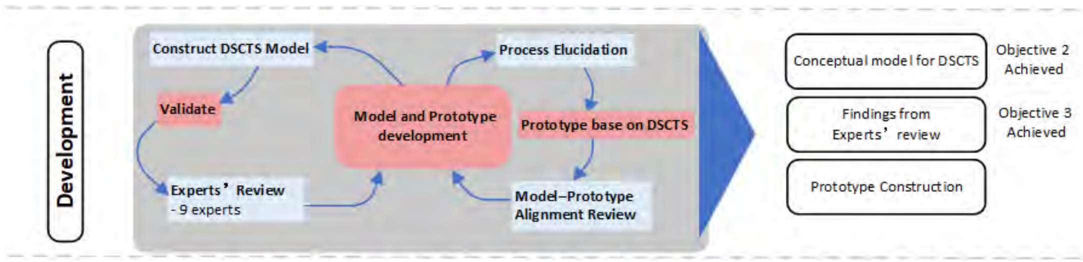


Figure 3.5. Development

3.3.3.1 The Construction of DSCTS Conceptual Design Model

According to Mayr and Thalheim (2021), the conceptual design model is an abstract representation used to understand the key components and interactions of a complex system or phenomenon. It provides a simplified framework for analysis and decision-making in various fields of research and practice. The DSCTS conceptual design model was systematically constructed to foster students' CTS, drawing upon the DS framework and aligning with specific curriculum content. The model's construction encompasses three key components: Learning components, CTS components, and the production process based on EDS. In this conceptual design model, the creation process and elements of DS serve as the supporting structure, within which the learning elements and CTS elements are integrated. It is important to note that the DSCTS model is not merely a confluence of these elements; rather, it represents an intricately organized and coherent integration, forming a rational and organic unity. This approach ensures that the model's implementation does not compromise the achievement of educational objectives, yielding a robust and effective framework for cultivating CTS in students.

The construction of the DSCTS conceptual model involves a systematic approach that draws from literature analysis of existing models. The culmination of these research endeavours and the integration of their findings will be expounded upon in Chapter 4 of the study.

3.3.3.2 Expert Review on DSCTS Conceptual Model

Expert review is essential to ensure the professionalism and relevance of the study (Mishra & Alok, 2022). In this study, ensuring the relevance of the DSCTS conceptual design model involved inviting 9 experts for comprehensive review.

The expert review process was carefully structured and organized. Three key sections were involved: preparation of review forms for the experts, conduct the reviews, and the analysis of review findings. The results of the experts' deliberations were diligently amalgamated to derive valuable insights and recommendations.

3.3.3.3 The development of prototype

This section, building upon the DSCTS conceptual design model, sought to implement a practical application to evaluate its efficacy. Prototyping is a critical step in verifying a conceptual model (De Sordi, 2021). To this end, prototypes were devised, integrating the DSCTS conceptual design model with the specific content of a third-year university course focused on folk arts. A detailed account of the prototype's creation is elaborated upon in Chapter Four.

Given that the curriculum, *Introduction of Folk Art,* is theoretical course often characterized by conventional teacher-led teaching methods, it commonly presents challenges in effectively amalgamating theory and practice, resulting in unengaging classroom experiences. In contrast, the DSCTS conceptual model, grounded in the five learning principles, artfully fuses the course content with DS. As a result, the learning process becomes more dynamic, enjoyable, and exploratory, bolstering student motivation and active participation.

3.3.4 Phase 4: Evaluation

This phase focused on evaluating the effectiveness of the DSCTS model in enhancing students' creative thinking skills (CTS) within Chinese higher education, directly addressing the core research question: "Does the implementation of the DSCTS model enhance students' CTS in Chinese higher education?" Prior to conducting efficacy testing of the model, domain experts were invited to evaluate the consistency between the prototype and the model, thereby ensuring methodological rigor. To achieve a rigorous and comprehensive assessment, a mixed-methods design was employed (as shown in Figure 3.6), integrating quantitative pre-test/post-test measurements of students' CTS and qualitative semi-structured interviews with practitioners.

The rationale for this design stems from its alignment with the research question's emphasis on the "extent of enhancement" of CTS through the DSCTS model. Quantitatively, pre-test and post-test comparisons within the experimental group directly address the "extent" of change, providing empirical data on whether and to what degree specific CTS dimensions (e.g., fluency, flexibility, originality) improve following model implementation. This approach aligns with established norms in educational research, where longitudinal measurements are critical to isolating intervention effects from baseline differences (Cohen, Manion, & Morrison, 2018). Qualitatively, interviews with practitioners complement these quantitative data by exploring how and why the model may (or may not) enhance CTS. For instance, they identify which model components (e.g., creative thinking prompts, digital storytelling stages) facilitate engagement and highlight contextual factors in Chinese higher education (e.g., pedagogical traditions, student-teacher dynamics) that shape effectiveness. This triangulation strengthens validity: quantitative data establishes the magnitude of change, while qualitative insights explain the underlying mechanisms, thereby addressing the research question's holistic inquiry into "extent" within a specific educational context (Creswell & Clark, 2017).

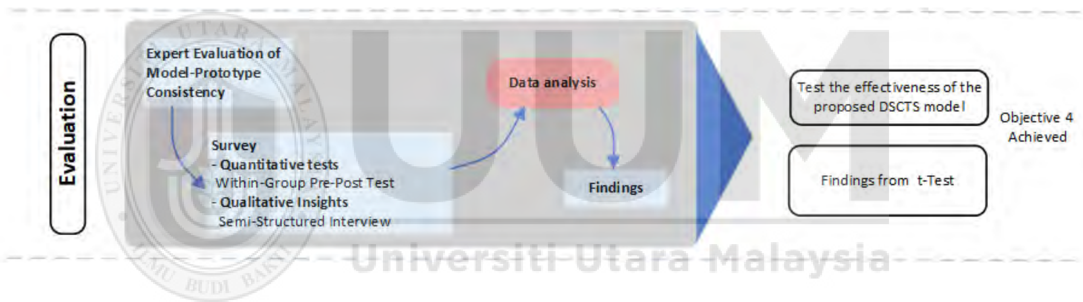


Figure 3.6. Evaluation

Together, this mixed-methods design balances rigor (via structured skill measurement) and depth (via contextualized practitioner perspectives), ensuring robust insights into the practical effectiveness of the DSCTS model.

3.3.4.1 Expert Evaluation of Model–Prototype Alignment

To ensure the reliability of expert rubric ratings (1-5 Likert scale for model-prototype alignment, DS process completeness, and creative thinking integration), five interdisciplinary experts (with backgrounds in design science, creative education, and educational measurement) independently rated the works of 31 participants.

Given the ordinal nature of the rubric scores (1-5 rating scale), inter-rater agreement was quantified using Krippendorff's α with 95% confidence intervals (CI) calculated via the bootstrap method (Koo & Li, 2016). The results indicated acceptable inter-rater consistency for Model-Prototype Alignment: Krippendorff's α = 0.79, 95% CI [0.67, 0.88]. This value exceeds the 0.70 threshold for "acceptable consistency" in educational assessment research, confirming no systematic bias in expert scoring for the core dimension of Model-Prototype Alignment (Krippendorff, 2019). The raw expert rating matrix and detailed bootstrap output are provided in Appendix G for reproducibility.

3.3.4.2 Survey Design for Quantitative Pre-Test and Post-Test Assessments

The survey design focuses on examining the influence of the model on students' CTS. To achieve this, a pre-post-test design within groups was adopted. This approach involved collecting and comparing CTS performance data from the experimental group before and after the implementation of the DSCTS model. Through this comparison, the study seeks to quantify the changes induced by the model and elucidate its specific impact on students' CTS.

i. **Pre-post Test Design within Group**

- **Purpose:** To assess the direct impact of the proposed model on students' CTS.
- **Scale:** TTCT Figure Test, Form A and Form B.
- **Approach:** In the experimental design, the study conducted pre- and post-tests on the experimental group to assess changes in their CTS. The Torrance Tests of Creative Thinking (2018 Edition), the Figural version, is recognized as the evaluation tool for assessing CTS in this study.

Before the experiment began, a baseline test (pre-test) was conducted using TTCT (Form A) as Scale A to establish the students' initial level of creative thinking. During the experimental period, the experimental students received ongoing interventions using the proposed DSCTS conceptual design model as the approach to learn new knowledge. After the intervention was completed, a second test (post-test) was administered using TTCT (Form B) to measure the impact of the intervention on students' CTS. The test was administered exclusively to the students in the experimental group. The TTCT (Form A) and TTCT (Form B) forms were assumed to have equivalent effects in terms of assessing creative thinking (Clapham, 1998). This design aims to reduce memory effects by using different test versions (Forms A and B), thereby enhancing the reliability of the tests and the comprehensiveness of the content, ensuring that the evaluation results are both accurate and reliable. The research flow is shown in Figure 3.7.

- **Analysis strategy:** Paired-sample T-tests were used to compare the changes in students' scores on the pre and post-tests, and the data was analyzed using Spss, so as to quantify the contribution of the model to the improvement of students' CTS.

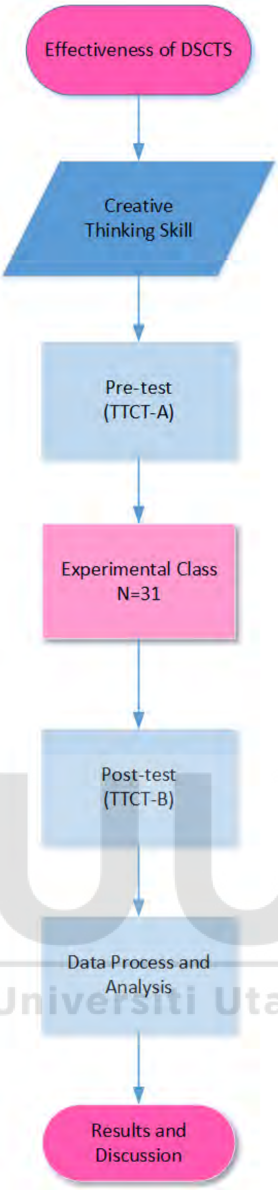


Figure 3.7. The Flowchart of Survey Design on students' CTS

ii. Population Sample

The study involved 31 junior students majoring in art and design at Henan University of Urban Construction, China. The demographic of the students is shown in Table 3.1. According to Cohen (1988), the sample size is sufficient. Both of the classes were at the same academic level and were introduced to identical new course content. The curriculum, titled '*Introduction to Folk Art*', is a compulsory 8 weeks, two-credit course offered in the fifth semester. Class 1, designated as the experimental group, was instructed using the proposed DSCTS model.

Table 3.1

Demographic Profile of Participants

Group	**Total Participants**	**Male**	**Female**
Experimental Group	31	14	17

iii. Instrument

The fourth objective was to evaluate the effectiveness of the DSCTS model in enhancing students' CTS.

- **The Torrance Tests of Creative Thinking Figural Test**

Snyder et al. (2019) identified the Torrance Tests of Creative Thinking (TTCT) as the most robust tool for assessing CTS. Developed by Torrance in 1966, the TTCT has been adapted into over 35 languages (Millar, 2002) and is widely validated in educational research. While available in verbal and figural forms, this study exclusively employed the figural test for three key reasons:

1) Alignment with DS's visual-narrative nature

DS fundamentally relies on visual creativity to construct narratives through imagery, symbolism, and spatial design (Center for Digital Storytelling, 2009) . The figural TTCT directly assesses these competencies via picture-based tasks (e.g., Picture Construction, Incomplete Figures) that measure:

- o Abstractness of titles: Ability to generate symbolic captions (Kim, 2006)

- Elaboration: Skill in adding contextual details to visual scenes (Kerr, 1991)
- Storytelling articulateness: Explicitly evaluated in figural streamlined scoring (Torrance, 1988)

In contrast, the verbal TTCT prioritizes lexical fluency and semantic flexibility (e.g., Unusual Uses, Product Improvement tasks) (Kerr, 1991) , which align less directly with DST's visual-semiotic demands.

2) Superior cross-cultural validity for visual tasks

Figural responses exhibit lower linguistic/cultural bias than verbal tasks (Wang, 2016) . This is critical given DST's global pedagogical applications and the TTCT's multilingual use (Millar, 2002). Evidence confirms that figural scores maintain construct validity across diverse populations, including Swahili-speaking children (Humble, Dixon, & Mpofu, 2018) , whereas verbal test performance correlates significantly with language proficiency (Wang, 2016) .

3) Psychometric robustness for intervention studies

The figural TTCT demonstrates:

- High predictive validity for visual creativity outcomes ($r > 0.57$; Gao et al., 2021)
- Longitudinal sensitivity to creativity training effects (Kim, 2006) , with its two-factor structure (Innovative: fluency/originality; Adaptive: elaboration/closure resistance) capturing DST-relevant skill growth (Said-Metwaly et al., 2018)
- Strong inter-rater reliability ($\alpha > .90$) despite moderate test-retest stability ($r = .50–.93$), attributable to creativity's state-dependent nature (Kim, 2006)

While the verbal TTCT measures narrative fluency (Kerr, 1991), DS requires integrating verbal and visual modalities, a process better reflected in figural tasks demanding contextual elaboration and symbolic titling (Torrance, 1974). Thus, the figural form provides a more ecologically valid and theoretically aligned assessment of DSCTS development.

The Figural TTCT (Forms A and B) is widely used in creativity assessment due to its comprehensiveness, accessibility, reliability, validity, and engaging format. Both forms measure similar constructs of creativity with proven reliability and validity, making them well-suited for assessing changes in creative thinking over time (Kim, 2006). Accordingly, this study employed Form A as the pre-test and Form B as the post-test to evaluate the impact of creativity-enhancing interventions. And the Form A is shown in Appendix H.

The TTCT Figure test consists of the following three main subtests:

- **Picture Construction:**

  Content: Presentation of an egg-shaped uncoloured picture or other basic figure from which the subject is asked to construct an imaginative picture.

  Purpose: To examine the subject's imagination, creativity, and graphic construction skills.

- **Incomplete drawings:**

  Content: Subjects are provided with ten abstract shapes outlined by simple lines and are asked to complete and name these shapes.

Purpose: To assess the subjects' graphic completion, creativity, and naming skills.

- **Circle (or Parallel Lines) Test:**

Content: A total of 30 circles (or 30 pairs of parallel lines) whereby subjects are asked to draw as many pictures as possible that are not identical to each other.

Purpose: To test subjects' divergent thinking, creativity and graphic diversity.

iv. Inter-rater Agreement for the Figural TTCT

To ensure the reliability and objectivity of the TTCT scoring results, three faculty members from the Department of Educational Psychology, who had received formal TTCT scoring training and passed the consistency calibration test, independently evaluated the pre-test (Form A) and post-test (Form B) works of all 31 participants. The inter-rater agreement was analyzed using the two-way mixed model (consistency type) to calculate the Intraclass Correlation Coefficient (ICC[2,k]) and its 95% confidence interval (CI). Here, “2” denotes the two-factor model (raters as fixed effects, participants as random effects), and “k=3” represents the number of raters, which is consistent with the standard for inter-rater reliability assessment in creative thinking research (Koo & Li, 2016).

The results indicated excellent inter-rater agreement for the overall TTCT score: ICC(2,3) = 0.86, 95%CI [0.75, 0.93]. For the four core dimensions of creative thinking measured by TTCT, the consistency coefficients were as follows: fluency (ICC = 0.83, 95%CI [0.70, 0.91]), flexibility (ICC = 0.81, 95%CI [0.68, 0.89]), originality (ICC = 0.88, 95%CI [0.78, 0.94]), and elaboration (ICC = 0.84, 95%CI [0.72, 0.91]). All ICC values exceeded 0.80, which is recognized as the threshold for “good inter-rater consistency" in educational measurement research (Koo & Li, 2016), confirming that the TTCT scoring results in this study are reliable and free from systematic rater bias.

The raw scoring data of the three raters, the detailed output of the consistency analysis (including SPSS operation logs), and the Bland-Altman plot (for visualizing the consistency between Rater 1 and Rater 2) are provided in Appendix D for peer review and reproducibility verification.

v. Findings

This study conducted a detailed analysis of the collected data, employing SPSS statistical software as the primary analytical tool. The first step involved a paired-sample t-test to compare the scores of TTCT among students in the experimental group before and after receiving specific interventions. The primary aim of this step was to determine whether the proposed conceptual model effectively enhances students' creative thinking abilities in practical application contexts.

3.3.4.3 Qualitative Interviews with Practitioners

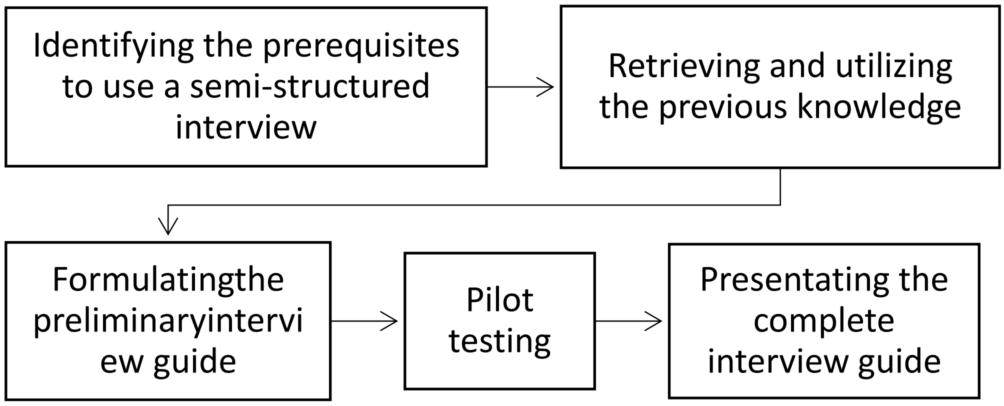
Semi-structured interviews with instructors and teaching assistants were strategically employed to complement quantitative findings, enabling an in-depth exploration of how and why the Digital Storytelling for Creative Thinking Skills (DSCTS) model influences creative thinking development within the unique context of Chinese higher education. This approach utilizes methodological triangulation (Creswell & Clark, 2017), where quantitative data primarily reveal the magnitude of changes in creative thinking indicators, while qualitative insights elucidate the underlying mechanisms, contextual factors, and key pedagogical components driving these changes. This convergence directly addresses the research focus on the "extent" and "nature" of the model's impact.

i. The Semi-Structured Interview Design

The credibility of qualitative findings is inherently tied to the rigor of interview design and implementation. To uphold the trustworthiness of the study (Lincoln & Guba, 1985), a series of targeted methodological strategies were integrated into the interview development process, as detailed below.

First, pilot testing and iterative refinement were conducted to optimize the interview guide. Following best practices for semi-structured interview development (DeJonckheere & Vaughn, 2019; Smedema, 2023), the initial guide was piloted with a small group of educators not included in the main study. This pilot phase identified ambiguities in question phrasing, evaluated the logical flow of questions, and tested the effectiveness of probe prompts that informed iterative revisions to enhance the guide's clarity, relevance to the research context, and comprehensiveness of topic coverage (see Figure 3.8).

Second, all interview questions were explicitly aligned with the study's core research objectives, which focused on participants' perceptions of the model, its feasibility for implementation, evaluations of its effectiveness, and observations of student outcomes. This alignment ensures design validity by confirming that the questions collectively capture all critical dimensions of the phenomenon under investigation (Teddlie & Tashakkori, 2003; Bryman, 2012). A rigorous review process was also conducted to eliminate redundant questions, ensuring each item contributes uniquely to addressing the research aims.



Note. Adapted from Systematic methodological review: developing a framework for a qualitative semi-structured interview guide (Kallio, et al., 2016).

Figure 3.8. Development of Semi-Structured Interview Questions

Third, the guide balanced structural consistency with methodological openness. It was built around a set of predefined, open-ended core questions derived from literature on creative thinking pedagogy and digital storytelling, which guaranteed coverage of essential topics (i). Crucially, flexibility was embedded through intentional prompts for elaboration, clarification, and concrete examples， such as "How did you observe this in your classroom?" and "Can you share a specific instance that illustrates this point?" This balance enabled standardized collection of core data while creating space for unanticipated insights and context-rich details to emerge, thereby enhancing credibility by capturing participants' authentic experiences (DeJonckheere & Vaughn, 2019; Silverman, 2016).

Fourth, attention was paid to linguistic clarity and bias mitigation. Questions were drafted using plain, unambiguous language tailored to educators' professional contexts, with technical jargon avoided to ensure accessibility. Leading phrasing that could skew responses was also excluded (Bryman, 2012), and double-barreled questions, those asking two distinct things in a single item, were rigorously eliminated to prevent confusion and ensure response accuracy.

Fifth, questions probing the effectiveness of DS were designed to center on behavioral evidence. Practitioners were explicitly asked to ground their assessments in observable data, such as student work samples, classroom behaviors, or specific incidents, rather than relying on general impressions. This focus on tangible evidence strengthens the confirmability and dependability of the data, as it reduces subjectivity and provides verifiable anchors for participants' claims (Lincoln & Guba, 1985; Bryman, 2012).

Finally, the guide was structured to elicit contextual richness, which supports the transferability of findings. Questions inherently prompted participants to detail the specific context of DS implementation within Chinese higher education—including institutional constraints, disciplinary differences, and student characteristics. This emphasis on "thick description" (Lincoln & Guba, 1985) enables readers to assess how applicable the findings might be to other similar educational settings.

This systematic approach to interview design, rooted in established qualitative methodology, enhances the internal validity of the qualitative component of the study and strengthens its contribution to the overall convergent validity of the mixed-methods findings (Tashakkori & Teddlie, 1998; Creswell & Clark, 2017). By triangulating quantitative trends with the explanatory insights derived from these interviews, the study achieves a more comprehensive and credible understanding of the DSCTS model's impact.

ii. Interview Guide:

The purpose of this interview is to investigate the practical implementation of the Digital Storytelling for Creative Thinking Skills (DSCTS) model in higher education contexts, empirically examine its effectiveness in cultivating students' CTS, and extract targeted insights for model optimization, all grounded in the direct instructional experiences of educators who have engaged with the model. To ensure the depth and empirical richness of the information collected, interviewers are required to employ targeted follow-up inquiries to deepen participants' responses: for instance, prompting with questions such as "Could you elaborate on this point by combining a specific teaching case from your application of the DSCTS model?" or "How did you observe this phenomenon in your actual instructional practice?" Such follow-up strategies are intended to avoid superficial accounts, guide participants to anchor their reflections in concrete teaching scenarios, and thereby enhance the authenticity and explanatory power of the interview data.

Based on the previous analysis, the interview questions and functions are listed in Table 3.2.

Table 3.2

List of Interview Questions

No.	Items	Function
Q1	Prior to this study, were you already familiar with the concept of using Digital Storytelling (DS) for teaching?	Assess DS teaching cognition; lay foundation for model acceptance analysis
Q2	Have you successfully integrated the DSCTS model into at least one of your courses?	Verify model application; confirm implementation feasibility
Q3	Was the overall structure of the DSCTS model (Learning, Creative Thinking, Development Process) clear and understandable to you?	Evaluate model framework clarity; ensure core logic comprehension
Q4	Did you explicitly use the ADDIE framework to structure your DS lesson plan?	Check tool adoption; assess pedagogical tool practicality
Q5	Did you find the focus on project-based learning within the model practical to implement?	Evaluate PBL feasibility; include course/student adaptability
Q6	Did you consciously try to foster the "Person" factors (e.g., student risk-taking, rule-breaking) outlined in the model?	Confirm "Person" strategy use; assess strategy operability

Table 3.2 *continued*

Q7	Did you explicitly create a classroom environment ("Press") designed to stimulate creativity as per the model's guidelines?	Verify "Press" strategy implementation; assess environment practicality
Q8	Did you observe students demonstrating noticeably more divergent thinking during DSCTS activities compared to traditional classes?	Collect CTS change observations; supplement quantitative data
Q9	Did your students proceed through all four stages (Pre-production, Production, Post-production, Distribution) as defined in the model?	Check DS workflow implementation; identify omissions/adjustments
Q10	Was the iterative nature of the process (e.g., going back to a previous stage for refinement) beneficial for student learning?	Evaluate iterative design value (practitioner perspective)
Q11	Based on your observation, did the DSCTS model effectively enhance your students' creative thinking skills?	Collect CTS effect evaluation; provide qualitative evidence
Q12	Did you encounter any significant barriers (e.g., time, resources, technical skills) when implementing the model?	Identify implementation challenges; guide model refinement
Q13	Would you be willing to use the DSCTS model again in a future course?	Assess model reuse willingness; reflect sustainability
Q14	Would you recommend the DSCTS model to a colleague?	Measure model value recognition; evaluate promotion potential

3.3.5 Phase 5: Conclusion

Figure 3.9 presents the conclusion section of this study, serving as a comprehensive review and summary of the extent to which the previously mentioned problems were addressed and the experimental objectives were achieved. This section carefully examines and synthesizes all the results and findings obtained throughout the study. Ultimately, the paper documenting this research endeavour has been completed, reported, and published.

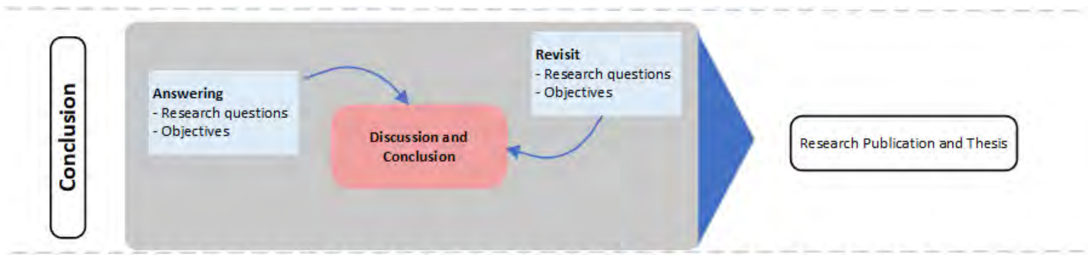


Figure. 3.9. Conclusion

3.4 Chapter Summary

The methodological framework developed in this chapter integrates the in-depth application of DSR with the precision of mixed research, providing a robust foundation for comprehensively and scientifically addressing the research questions. Specifically, for the first three research objectives,namely, the theoretical foundation and component extraction, the construction of the conceptual model, and the establishment of validation criteria,this study adopts DSR methodogy. It aims to systematically analysis theory, extract and integrate key elements, and scientifically establish validation standards to comprehensively address these core questions.

CHAPTER FOUR

MODEL DEVELOPMENT, PROTOTYPING, AND EFFECTIVENESS TESTING

4.1 Overview

Building upon the foundation laid by the literature review and the analysis and comparison of related models explored in Chapter Two, this chapter delves into the systematic process of creating a robust conceptual design model for DSCTS (Digital Storytelling for Creative Thinking Skills) and testig its effectiveness. According to the research methodolgy detailed in chapter 3, this chapter conduct to addresses the first, second, third, and fourth research questions highlighted in Chapter One. Therefore, it contains four parts. In the first part, the components of the proposed model are extracted; in the second part the construction of the proposed model. The third part is to validate the model, focusing on the method and criteria. The final section outlines the process of developing prototypes based on the proposed DSCTS model and evaluating the effectiveness of the model.

4.2 Components of the Proposed Model

Building on the theoretical foundation outlined in Chapter 2, this section introduces the components of the proposed DSCTS conceptual model. It is divided into two parts: first, the identification of learning components; second, the extraction of CTS components.

4.2.1 Learning Components

This section delineates the learning components underpinning the DSCTS model, justifying their integration by aligning with theoretical rigor, pedagogical relevance, and the goal of cultivating students' CTS in higher education. Drawing on the conceptual structure in the provided figure in Chapter 2, this section articulates how learning theories, models, and approaches synergistically address the complexities of CTS development, leveraging a breadth of scholarly work to fortify the argument.

4.2.1.1 Theoretical Pillars: Anchoring in Constructivism and Complementary Frameworks

i. Constructivist Learning Theory

At the core of the DSCTS model lies **Constructivist Learning Theory**, which posits that knowledge is actively constructed through experiential engagement, social interaction, and integration of new information with prior schemas (Duffy & Jonassen, 1991; Efgivia et al., 2021). This paradigm rejects passive information transmission, prioritizing student-centered practices that foster creative thinking, collaboration, and reflective inquiry. DS aligns inherently with constructivist principles:

- **Active Knowledge Construction**: DS requires students to create multimedia narratives, prompting analysis, synthesis, and creative expression (Robin, 2008). For example, storyboarding and multimodal content creation demand translating abstract concepts into concrete, self - generated narratives, a process that mirrors the active knowledge - building tenets of constructivism.

- **Social Mediation**: Collaborative DS projects (e.g., peer feedback, group storytelling) facilitate knowledge co-construction, mirroring constructivism's emphasis on dialogue and shared meaning-making (Nasir et al., 2024). Such interactions allow students to challenge and refine their ideas through social discourse, a key aspect of constructivist learning.

- **Contextual Relevance**: By connecting stories to real-world issues or personal experiences, DS embeds learning in authentic contexts, enhancing meaning - making and CTS application (Meletiadou, 2022). This contextual grounding is central to constructivist pedagogy, as it helps students see the relevance of knowledge and apply it in meaningful ways.

To strengthen theoretical breadth, two complementary frameworks are incorporated into this study,humanistic learning theory and the cone of learning,alongside constructivism. While constructivism provides a solid foundation for understanding how learners actively construct knowledge through participation, it has limitations. Specifically, constructivism often foregrounds cognitive processes but pays insufficient attention to affective, motivational, and multimodal dimensions, which are equally vital for cultivating CTS. This theoretical gap necessitates the inclusion of additional perspectives that better account for the holistic, student-centred, and experiential aspects of DS).

ii. Humanistic Learning Theory

Humanistic learning theory, rooted in the works of Maslow and Rogers, offers a corrective to the limitations of purely constructivist models by placing greater emphasis on autonomy, affect, and personal growth (Feigenbaum, 2024; Sumiyana & Saputr, 2023). The central goal of this study is to enhance students' CTS. Because creativity is not simply a cognitive capacity but also an affective and motivational phenomenon, ignoring the humanistic dimension risks reducing DS to a purely technical or instrumental pedagogy.

- **Student-Centred Pedagogy:** In contrast to more prescriptive learning approaches, DS foregrounds students as co-creators of meaning, granting them agency to select topics, shape narratives, and explore multimodal expression (Demirbaş & Şahin, 2023). Such practices resonate with Rogers' notion of "meaningful learning," in which transformative experiences lead to deeper shifts in values, attitudes, and problem-solving skills. If constructivism ensures that students "do," humanism ensures that what they do is personally meaningful and emotionally engaging. Without this affective anchor, creative thinking risks being shallow or short-lived.

- **Teacher as Facilitator:** Humanistic theory also challenges traditional hierarchies by redefining educators as facilitators rather than transmitters of knowledge (Staley & Freeman, 2017). In the DSCTS model, instructors provide scaffolding, constructive feedback, and encouragement, but avoid stifling students' autonomy. This is not a trivial shift: it addresses the well-documented problem that rigidly teacher-led classrooms suppress risk-taking, a key condition for creativity. By contrast, humanistic pedagogy ensures a supportive environment where learners can take intellectual and emotional risks,conditions Torrance (1977) identified as prerequisites for creativity.

Taken together, humanistic learning theory fills a theoretical blind spot in constructivism by making explicit the role of autonomy, emotional safety, and self-actualisation in creative learning environments. Without this addition, DSCTS would risk underestimating the central role of the learner's motivation and affective engagement in the creative process.

iii. Cone of Learning

The cone of learning (Dale, 1969) further addresses the limitations of constructivism by emphasising the modes and modalities of learning. Constructivism recognises that learners must be active, but it does not sufficiently theorise how different types of activities and sensory inputs affect learning retention and creative development. This omission is particularly problematic in the context of DS, where multimodality is not incidental but intrinsic.

- **Multimodal Engagement:** DS integrates text, audio, images, and video, creating opportunities for diverse cognitive and sensory engagement. According to the cone of learning, learners retain more knowledge and engage more deeply when interacting with multimodal and experiential tasks. Ignoring this principle would reduce DSCTS to an abstract framework and fail to explain why multimodal design strengthens CTS dimensions such as originality and elaboration.
- **Experiential Learning and Retention:** Dale's model also highlights the superiority of "doing" over passive observation in fostering deep learning. In DSCTS, students are not mere recipients of content but active producers of narratives, requiring experimentation, decision-making, and problem-solving. This experiential foundation directly supports the cultivation of CTS dimensions, such as flexibility and fluency, that cannot be meaningfully developed through observation alone. Without incorporating this perspective,

the DSCTS framework risks undervaluing the epistemic and creative power of hands-on practice.

By integrating humanistic learning theory and the cone of learning, the DSCTS model transcends the limitations of a constructivist-only foundation. Constructivism ensures active engagement, but it under-theorises affective and multimodal dimensions. Humanistic theory addresses the affective domain, reinforcing student-centred autonomy and psychological safety, while the cone of learning provides a rationale for multimodal and experiential practices that deepen learning and creativity.

4.2.1.2 Instructional Models: Structuring Design and Implementation

To operationalise theory within the DSCTS model, three instructional models, **ADDIE**, **TPACK**, and **SAMR**, are strategically integrated, addressing complementary dimensions of design, pedagogy, and technology. While Chapter 2 introduced ADDIE as a foundational instructional design framework, it is insufficient on its own to capture the pedagogical and technological complexities inherent in digital storytelling for creative thinking development. Therefore, TPACK and SAMR are incorporated to broaden the theoretical scope and enhance the model's capacity for systematic, technology-enriched learning design.

i. ADDIE Model (Analysis, Design, Development, Implementation, Evaluation)

The ADDIE framework (Dick, Carey, & Carey, 2009) provides a systematic, iterative structure for instructional design that remains widely used across educational contexts. Within DSCTS, ADDIE ensures that digital storytelling tasks are goal-oriented, learner-centred, and continuously refined:

- **Analysis:** Instructors examine students' prior knowledge, interests, and technical readiness to ensure DS activities are accessible and contextually relevant.
- **Design/Development:** Student-centred tasks, such as narrative construction and multimedia editing, are aligned with CTS objectives through careful instructional planning.
- **Implementation/Evaluation:** Projects are deployed with formative assessment (e.g., rubrics measuring fluency, originality, elaboration) and feedback loops, ensuring iterative improvement.

ADDIE's systematic sequencing is valuable for addressing implementation challenges in Chinese higher education, where large class sizes, assessment pressures, and uneven digital literacy require structured instructional guidance (Reiser, 2001). However, ADDIE alone does not prescribe how technology should interact with pedagogy and content, nor does it evaluate the depth of technology integration,hence the integration of TPACK and SAMR.

ii. TPACK Framework (Technological, Pedagogical, Content Knowledge)

The TPACK model (Koehler & Mishra, 2009) extends ADDIE by focusing on the intersection of content, pedagogy, and technology. In DSCTS, TPACK ensures that digital tools are not added superficially but are purposefully aligned with disciplinary goals and creative thinking outcomes:

- **Content Knowledge (CK):** DS narratives embed subject-specific concepts, ensuring creative expression is anchored in academic rigour (e.g., telling a scientific discovery story).
- **Pedagogical Knowledge (PK):** Instructional strategies, such as peer critique and reflective discussion, scaffold higher-order thinking and evaluative judgement, core aspects of CTS.
- **Technological Knowledge (TK):** Digital tools (e.g., Adobe Spark, Canva) are selected to enhance expressive possibilities without overshadowing pedagogy.

By emphasising the dynamic interplay between these domains, TPACK addresses a common critique of digital storytelling research: the overemphasis on technology without sufficient pedagogical or disciplinary grounding (Lachner et al., 2021). Instructors thus gain a framework for designing pedagogically meaningful, content-relevant, and technologically supported DS activities.

iii. SAMR Model (Substitution, Augmentation, Modification, Redefinition)

Whereas TPACK identifies what forms of knowledge are needed for effective technology integration, the SAMR model (Puentedura, 2006) provides a developmental continuum for evaluating how deeply technology reshapes learning tasks. Within DSCTS:

- **Substitution/Augmentation:** Technology enhances traditional storytelling (e.g., replacing essays with narrated slideshows), offering incremental improvements in engagement.

- **Modification/Redefinition:** Technology enables fundamentally new practices, such as collaborative cross-media storytelling or immersive AR/VR narratives, transforming the scope and depth of CTS cultivation.

SAMR's emphasis on transformation is critical for DSCTS, since fostering creative thinking requires moving beyond substitution toward tasks that challenge students to redefine problems, innovate solutions, and generate original multimodal artefacts. Without such transformative use, DS risks becoming a superficial digital add-on rather than a driver of creativity.

By integrating these models, DSCTS achieves both **systematic rigour** (ADDIE) and **pedagogical–technological synergy** (TPACK), while ensuring **transformative learning potential** (SAMR). This triadic approach not only strengthens theoretical coherence but also ensures practical applicability in higher education contexts, particularly in China, where policy imperatives stress innovative pedagogy and creative talent cultivation.

4.2.1.3 Pedagogical Approaches: Cultivating CTS Through Multimodal Engagement

Educational DS is inherently grounded in project-based learning, as students engage in extended, inquiry-driven tasks that culminate in a tangible artefact,a digital story (Robin, 2008). PBL provides an authentic learning context where students identify problems, plan narratives, integrate multimodal resources, and iteratively refine outputs. Such processes cultivate higher-order thinking, originality, and problem-solving capacities (Chen et al., 2022). In DSCTS, the project nature of digital storytelling transforms abstract ideas into meaningful products, situating creativity development within real-world relevance. It embeds four leaerning approaches, reinforcing CTS development, and each is supported by relevant literature:

- **Multisensory Learning:** Engages visual, auditory, and tactile modalities (e.g., animations, voiceovers), stimulating divergent thinking (Edelen & Skukauskaitė, 2022). By engaging multiple senses, students are able to make more diverse connections and generate a wider range of ideas, which is essential for divergent thinking and CTS development.
- **Student-Centered Learning:** Empowers students to lead narrative creation (theme selection, methods), fostering autonomy and creative ownership (Zhang, 2022). When students have control over their learning process, they are more likely to be engaged and invested in their work, leading to greater creativity and the development of CTS.
- **Collaborative Learning**: Group DS projects (co-writing, peer feedback) promote communication, teamwork, and idea co-construction (Johnson & Johnson, 2009). Collaborative learning provides opportunities for students to share ideas, learn from one another, and build on each other's creativity, all of which contribute to the development of CTS.
- **Interdisciplinary Integration**: Embeds knowledge from multiple disciplines (e.g., science, art, language) in narratives, enhancing comprehensive problem-solving (Hmelo-Silver, 2004). By integrating knowledge from different disciplines, students are able to approach problems from multiple perspectives and develop more innovative solutions, which is a key aspect of CTS.

4.2.1.4 Rationale for Integration: Addressing Complexity via Design Science Research

DSR demands holistic, context-aware solutions to complex problems (Hevner et al., 2010). By integrating:

- **Theoretical foundations** (constructivism, humanistic theory, Cone of Learning) to ensure cognitive and social - emotional relevance. These theories provide the underlying principles that guide the development of CTS through DS, ensuring that the model is grounded in established educational research.

- **Methodological frameworks** (ADDIE, TPACK, SAMR) to structure design, technology, and implementation. These frameworks provide the tools and processes needed to effectively design, implement, and evaluate DS activities, ensuring that they are aligned with pedagogical goals and technological capabilities.

- **Pedagogical strategies** (multisensory, collaborative, interdisciplinary approaches) to operationalize CTS development. These strategies provide the practical methods for engaging students in DS activities and fostering the development of CTS.

This synthesis addresses the "whole learning ecosystem":

- **Cognitive**: Constructivism and the Cone of Learning ensure deep, active knowledge construction. These theories promote the kind of learning that is necessary for the development of CTS, such as critical thinking, problem - solving, and creativity.

- **Social**: Humanistic theory and collaborative learning foster peer and teacher - student interactions. Social interactions are crucial for the development of CTS, as they provide opportunities for students to share ideas, receive feedback, and learn from others.

- **Technological**: TPACK and SAMR align tools with pedagogical goals, avoiding tech - for - tech's - sake. By ensuring that technology is used purposefully, these frameworks help to maximize the potential of DS to cultivate CTS.

Each framework addresses gaps in DS scholarship (e.g., fragmented theory - practice connections). By synthesizing these components, DSCTS provides a scalable, theoretically robust model for enhancing CTS,grounded in research, including works by Duffy & Jonassen, 1991; Efgivia et al., 2021; Robin, 2008; Nasir et al., 2024; Meletiadou, 2022; Feigenbaum, 2024; Sumiyana & Saputr, 2023; Demirbaş & Şahin, 2023; Staley & Freeman, 2017; Dale, 1969; Dick et al., 2009; Reiser, 2001; Koehler & Mishra, 2009; Lachner et al., 2021; Puentedura, 2006; Edelen & Skukauskaitė, 2022; Zhang, 2022; Johnson & Johnson, 2009; Hmelo-Silver, 2004; Hevner et al., 2010) and practical needs.

In conclusion, the learning components in DSCTS are justified by their alignment with constructivist principles, complementary theories, instructional models, and student-centered approaches. This integration, supported by a wide range of scholarly literature, ensures the model is theoretically sound, contextually relevant, and capable of advancing creative thinking pedagogy in higher education. By drawing on these diverse sources, we have constructed a comprehensive argument for the inclusion of these learning components in the DSCTS model, demonstrating their collective potential to cultivate CTS in university students.

Figure 4.1 illustrates the learning components of the proposed model, including the learning theories, learning models, and learning approaches.

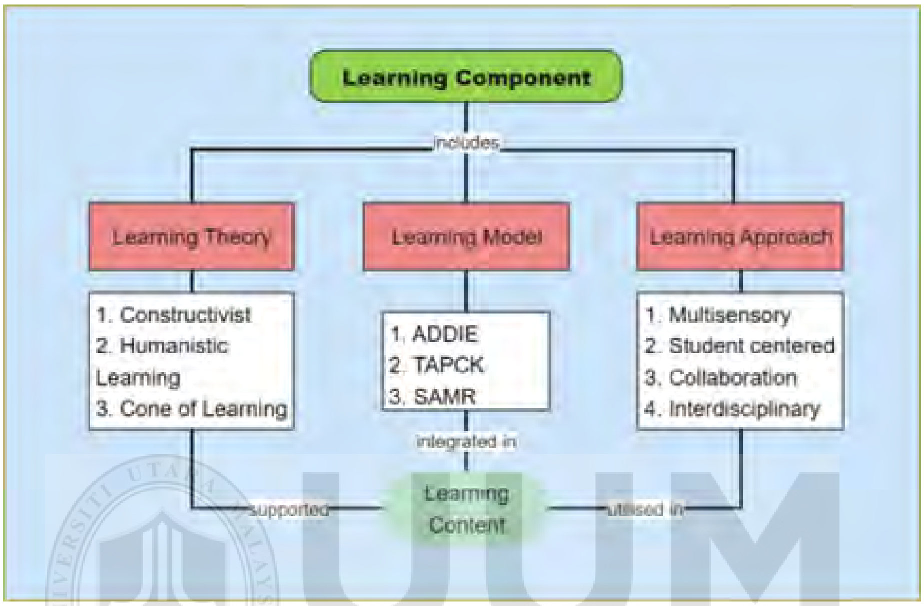


Figure 4.1. Components of the Learning

4.2.2 Creative Thinking Components

This section addresses two key aspects: first, the identification and extraction of the primary components of creative thinking; and second, the delineation of their associated sub-components.

4.2.2.1 The Identification And Extraction Components Of Creative Thinking

Literature on creativity development presents a rich tapestry of theoretical orientations, primarily diverging into two prominent streams: cognitive - process paradigms and compositional - attribute frameworks. Cognitive - focused scholarship, as pioneered by Torrance (1966) and further developed by Guilford (1986), meticulously dissects the epistemological mechanisms underlying creative ideation. Torrance's seminal work, for instance, operationalized creative thinking through the Torrance Tests of Creative Thinking (TTCT), which measure aspects like fluency, flexibility, and originality in idea generation. However, this approach predominantly focuses on the mental processes within the individual, often overlooking the role of external factors in shaping creativity.

On the other hand, compositional-focused perspectives, as espoused by Sternberg (2003) in his Triarchic Theory of Intelligence and Csikszentmihalyi's (1999) concept of flow, shift the emphasis towards the ontological properties of creative output. Sternberg argues that creativity is a function of analytical, creative, and practical intelligence, while Csikszentmihalyi highlights the importance of the interaction between the individual, the domain, and the field. These theories, though valuable in elucidating the characteristics of creative products and the contextual factors influencing creativity, tend to underplay the cognitive processes that drive the generation of such products.

The dichotomy between these two approaches creates a theoretical gap, further evidenced by empirical research. A meta - analysis by Plucker (2021) found that interventions based on cognitive - process theories, while effective in enhancing short - term idea - generation skills, often failed to translate into sustained creative performance in real - world contexts. Similarly, research by Beghetto and Kaufman (2013) indicated that compositional - attribute - based approaches, despite their focus on the quality of creative products, struggled to account for the dynamic nature of creativity development over time.

In response to these challenges, this study transcends such disciplinary silos by adopting a holistic integrative framework. Drawing on the strengths of both theoretical traditions, this framework synthesizes process - oriented, agent - centered, and ecological dimensions of CTS development. By doing so, it aims to address the limitations of previous research and provide a more robust foundation for enhancing students' CTS in educational environments.

To bridge the theoretical gap and develop a more comprehensive framework for CTS development, this section undertakes a rigorous sequential comparative analysis of six seminal models. The methodology commences with a second - round cross - model evaluation, during which meta - analytic techniques are employed to systematically analyze and synthesize the findings from these models. This process not only identifies epistemological congruences, highlighting areas of agreement among the models, but also uncovers theoretical dissonances, revealing critical areas where the models diverge.

Subsequently, a taxonomic synthesis of the core components of each model is conducted. This involves a detailed examination of elements such as instructional strategies, assessment metrics, and ecological enablers, providing a nuanced understanding of how each model operationalizes CTS development. Finally, through a grounded - theory - driven abstraction process, the study distills the transversal elements, or universally applicable constructs, across these theoretical traditions.

This approach not only addresses the fragmentation in existing literature but also contributes to the field in several ways. By identifying the commonalities and differences among the models, the study provides a clearer understanding of the key factors influencing CTS development. Moreover, the derived conceptual foundation for the DSCTS intervention offers a practical and theoretically informed framework that can guide future research and educational practice in enhancing students' creative thinking skills.

4.2.2.2 Basis for Selecting Creative Thinking Models

The The extraction of creative thinking components requires a theoretically justified and methodologically transparent foundation. Rather than relying on a single creativity framework, this study adopts a comparative model-based approach to identify recurring and transferable elements that are relevant to educational interventions in higher education.

Six creativity-oriented models were selected for analysis: the Dynamic Creativity Framework (Corazza, Agnoli, & Mastria, 2022), the Creative Thinking Model for Learning and Assessment (Rosen, Stoeffler, & Simmering, 2020), the Creative Thinking and Innovation Framework (Lansing-Stoeffler & Daley, 2023), the Conceptual Framework of Creative Pedagogy (Lin, 2011), Project-Based Learning and Studio-Based Learning (Cennamo et al., 2011). These models were chosen based on three explicit criteria:

i. **theoretical grounding** in established creativity or learning theories;
ii. **empirical relevance** demonstrated through application in educational contexts; and
iii. **practical operability**, providing actionable guidance for instructional design.

Collectively, these models represent the major strands of creativity research relevant to education, encompassing cognitive–process models, pedagogical frameworks, and environment-oriented learning approaches. Their inclusion ensures that the extraction of creative thinking components is not confined to a single disciplinary or theoretical perspective.

4.2.2.3 The Content of the Slected Models

i. The Dynamic Creativity Framework

The Dynamic Creativity Framework (Corazza et al., 2022) conceptualizes creativity as emerging from dynamic interactions between cognitive-affective processes and environmental contexts. Grounded in dynamic systems theory, this framework identifies four progressive stages, drive, information gathering, idea generation, and evaluation, where cognitive and emotional processes continuously interact, consistent with neuroscientific evidence of creative cognition (Beaty et al., 2016). The model's concept of "organic creativity" emphasizes person-environment interactions, aligning with sociocultural perspectives (Glăveanu, 2013).

The framework establishes a symmetrical relationship between internal factors (cognition, emotion, motivation) and external factors (cultural influences, social contexts). Cognitive processes enable information integration (Runco, 2014), emotional states regulate engagement (Baas, De Dreu, & Nijstad, 2020), motivational factors sustain effort (Hennessey, 2010), while environmental conditions facilitate or constrain expression (Amabile & Pratt, 2016). This integrative approach addresses multiple dimensions simultaneously, advancing beyond traditional models (Barbot, Besançon, & Lubart, 2015).

However, the framework's emphasis on dynamic processes limits its attention to domain-specific expertise (Kaufman & Baer, 2005) and provides insufficient practical guidance for implementation. Further empirical validation is needed to enhance its applicability across diverse cultural contexts (Lubart et al., 2019).

ii. Creative Thinking Model for Learning and Assessment

The Creative Thinking Model for Learning and Assessment (Rosen et al., 2020) provides an integrated framework for cultivating and evaluating creative thinking skills in educational contexts. Grounded in the Four C model of creativity (Kaufman & Beghetto, 2009), it combines conversational and visual representation tasks to create authentic learning scenarios. The framework comprises four core components: task characteristics, domain knowledge, facilitation strategies, and motivation systems, implemented through investigation, production, improvement, and assessment phases.

A key strength lies in its emphasis on integrating creativity development within regular curriculum rather than treating it as an isolated skill (Beghetto & Kaufman, 2014). The framework also balances individual creative development with social dimensions, acknowledging creativity as both personal capacity and socially-mediated process (Sawyer, 2018). For assessment, the model advocates authentic evaluation methods including project-based assessments that mirror real-world creative work (Barbot et al., 2015). However, the model requires further validation across diverse educational contexts to establish its generalizability (Plucker & Makel, 2010).

iii. The Creative Thinking and Innovation Framework

The Creative Thinking and Innovation Framework (Lansing-Stoeffler & Daley, 2023) presents a novel conceptualization that positions conventionality as a fundamental dimension of creative thinking. This framework integrates five interconnected thinking skills that collectively foster creative development: traditional thinking skills that establish foundational cognitive patterns; divergent thinking skills that enable multi-perspective ideation (Runco & Jaeger, 2012); associative thinking skills that facilitate novel connections between disparate concepts (Mednick, 1962);

transformative thinking skills that allow for conceptual restructuring; and social thinking skills that leverage collaborative intelligence (Glăveanu, 2010).

The framework's primary strength lies in its inclusive approach to creative development, acknowledging diverse expressions of creativity while establishing reliable assessment parameters. By valuing both conventional and innovative thinking patterns, it creates supportive environments for creative growth across varied backgrounds. However, the model currently lacks substantial empirical validation, particularly regarding the practical implementation of its multidimensional components in educational settings (Beghetto & Kaufman, 2014). Further research is needed to establish its efficacy across different learning contexts and develop concrete instructional strategies for educators.

iv. The Conceptual Framework of Creative Pedagogy

Lin's (2011) conceptual framework for creative pedagogy offers a structured approach to implementing creativity-focused education through three interconnected concepts: creative teaching, teaching for creativity, and creative learning. The framework centers on three core elements, the teacher as facilitator, the student as active creator, and the teaching process as design mechanism, providing a comprehensive structure that spans curriculum design, instructional strategies, and assessment methods.

The framework's strengths include its strong theoretical grounding in established creativity research (Beghetto & Kaufman, 2014) and its practical utility through specific recommendations for classroom implementation. However, its broader application faces challenges due to limited empirical validation of its effectiveness across different educational contexts (Craft, 2005). The framework would benefit from more detailed guidance on adapting its principles to diverse cultural settings and age groups, along with concrete examples to support practical implementation (Sawyer, 2018).

v. The Project-based learning on development of students' CTS

Chen et al. (2022) study demonstrates project-based learning's efficacy in developing creative thinking skills among engineering students, particularly enhancing ideational fluency and cognitive flexibility. Their findings reveal that PBL participants outperformed lecture-based counterparts on standardized creativity measures while reporting higher learning satisfaction, suggesting that well-structured project environments effectively stimulate creative development.

However, the study's contributions should be considered alongside methodological constraints. Its singular focus on engineering education limits generalizability across disciplines (Hennessey, 2019), while unaccounted individual differences in baseline creativity may have influenced outcomes. The research also leaves unanswered questions regarding PBL's longitudinal impacts (Beghetto & Karwowski, 2023) and lacks comparative analysis with alternative pedagogical approaches that could identify optimal creative development strategies (Barbot et al., 2015).

vi. Studio-based learning on development of students' CTS

Cennamo et al. (2011) propose a studio-based learning model that effectively bridges creative pedagogy with technical education in computer science design studios. Drawing from ethnographic research across architecture, industrial design, and human-computer interaction disciplines, the model demonstrates how structured design projects coupled with iterative critique sessions foster creative insights and expand students' cognitive boundaries. This approach aligns with established creative pedagogy principles (Sawyer, 2018) while addressing the unique demands of technical education.

The model's primary contributions lie in its successful integration of design thinking methodologies within computer science education, emphasizing user-centered problem-solving and collaborative iteration. Through scaffolded learning experiences that balance creative exploration with technical constraints, the model provides a structured yet flexible framework for developing creative thinking skills in technical domains (Beghetto & Kaufman, 2014). However, the framework would benefit from more robust empirical validation across diverse educational contexts and technical disciplines (Barbot et al., 2015), particularly regarding its long-term impact on students' creative development and professional practice.

4.2.3.4 Analytical Role of the Selected Models

The selected models differ in emphasis but converge on a shared assumption: creative thinking is a developable capability shaped by interactions among learners, tasks, and learning environments. Process-oriented models, such as the Dynamic Creativity Framework and the Creative Thinking and Innovation Framework, focus primarily on internal cognitive and affective mechanisms, including ideation, associative thinking, motivation, and emotional regulation (Corazza et al., 2022; Lansing-Stoeffler & Daley, 2023). In contrast, pedagogical models such as Project-Based Learning, Studio-Based Learning, and Creative Pedagogy foreground instructional structure, collaboration, authentic tasks, and facilitative teaching practices (Lin, 2011; Cennamo et al., 2011).

However, analysis also reveals that no single model sufficiently addresses the multidimensional nature of creative thinking development. Cognitive frameworks often lack concrete instructional guidance, while pedagogical models frequently describe learning conditions without explicitly articulating the cognitive processes they intend to cultivate. This fragmentation necessitates an integrative synthesis that transcends individual models.

Importantly, digital storytelling is positioned in this study as a mediating practice capable of operationalising cognitive creativity theories within structured pedagogical contexts. Prior studies have shown that multimodal storytelling supports ideation, perspective shifting, symbolic representation, and iterative refinement—core processes identified across the analysed models (Robin, 2008; Mishra & Koehler, 2006). This makes digital storytelling a theoretically coherent and practically viable context for extracting and applying creative thinking components.

Based on the comparative analysis, this study adopts a structured element-extraction procedure. First, each model was analysed to identify its explicitly stated components related to learner characteristics, task processes, and environmental conditions. Second, these components were coded and compared across models using theory-informed dimensions commonly adopted in creativity research, including cognitive traits, motivational factors, learning processes, and contextual enablers (Runco & Jaeger, 2012; Lucas, Claxton, & Spencer, 2013).

To synthesise these findings into a coherent framework, the extracted elements were then reorganised using the 3P creativity framework, Person, Process, and Press (Rhodes, 1961; Runco & Kim, 2020). This framework was selected because it accommodates both internal cognitive mechanisms and external pedagogical conditions, aligning closely with the multidimensional nature of creative thinking identified in the reviewed models.

Through this process, overlapping and functionally equivalent elements were consolidated, while model-specific or context-dependent features were retained only when they demonstrated clear relevance to educational digital storytelling. The outcome of this synthesis is a set of core creative thinking components that are theoretically grounded, empirically informed, and pedagogically actionable.

4.2.2.5 Categorization of components within the selected models

In the subsequent analysis, the six selected models are examined to identify and summarise their core conceptual elements and to categorise their shared pedagogical components. These components are extracted through a theory-informed analytical framework grounded in widely accepted criteria for evaluating creativity models in education,namely: cognitive traits, motivational factors, learning processes, environmental conditions, and instructional strategies (Runco & Jaeger, 2012; Lucas et al., 2013). These dimensions are consistently emphasised in both domain-general and education-specific creativity literature as the key determinants of creative thinking.

The extraction process also draws upon the componential theory of creativity (Amabile, 1996), which highlights the interaction between domain-relevant skills, creative-thinking processes (e.g., openness, risk-taking, incubation), and task motivation. Additionally, creativity assessment rubrics and competency models, such as those developed by OECD (2019) and Partnership for 21st Century Skills (P21), inform the categorisation into student traits, instructional design features, and learning context.

By synthesising these sources, the analysis operationalises each model's elements through recurrent themes, including curiosity, motivation, ambiguity tolerance, real-world problem-solving, interdisciplinary engagement, and supportive learning environments,factors shown to consistently support the development of creativity in both project-based and technology-enhanced learning contexts (Beghetto & Kaufman, 2014; Mishra, Koehler, & Henriksen, 2011). The categorised core elements of each model are summarised in Table 4.1, which illustrates both unique features and shared constructs across the six frameworks.

Table 4.1

Summary of Models for Developing Creative Thinking Skills

Models of Developing CTS					
The Dynamic Creativity Framework	**CT Model for learning and assessment**	**CT and Innovation Framework**	**A conceptual Framework for Creative Pedagogy**	**Project-based Learning**	**Studio-based Learning**
Curious mindset and Open-minded tendencies)		Openness to Experience	Curiosity		
		Tolerance of Ambiguity			
		Risk Tolerance	Risk-taking		
Experience	Domain Knowledge	Domain Readiness		Professional knowledge	
				Real world Problem	Real world Problem
Task-focused attention	Engineering effective task		Task-oriented		Project-based assignments
Mind Wandering	Incubation	Unconventional idea			Getting out of the task
Emotion			Playfulness	Individual interesting project	
Motivation	Motivation	Motivation	Learning Motivation		
	Across domain knowledge			Interdisciplinary	Cross-disciplinary knowledge
			Autonomous exploration		Self-directed learning
	Facilitation (Encourage environments and feedback)		Supportive Climate	Supportive and flexible learning environment	Supportive environment and Critiques
	Authentic Context				Immersive environment
	Collaboration (brainstorm, Engagement)	Collaboration	Collaboration (Active Engagement)	Group Collaboration (Active Learning)	Collaborative environments
	Technology-enhanced	Technical Assistance	Technical Support		
	Scenario and visual representations			Visualization	

Rhodes (1961) conceptualized creativity through four key aspects, collectively known as the 4Ps: Person, Process, Product, and Press. These elements are interrelated, with the product arising from the dynamic interaction between the Person and the Process within the organizational context (Press). Recent insights from Runco and Kim (2020) further nuanced this framework, introducing a hierarchical perspective. He categorized **Person**, **Process**, and **Press** under creative potential, while the **Product** was designated as part of creative performance. Given the focus on enhancing CTS in the educational setting, this study directs its attention to exploring and stimulating students' creative potential. As a result, the identified elements are organized into Person, Process, and Press. Building on the extraction and categorization of elements from related models in the previous section, these analogous elements are amalgamated. Table 4.2 illustrates the categorization of the provided elements under the 3P framework.

Table 4.2

The Classified Creative Potential Components

Person		
Personal Traits		
	Curiosity	Corazza et al., 2022; Lin, 2011.
	Open Mind	Corazza et al., 2022; Lansing-Stoeffler & Daley, 2023.
	Ambiguity Tolerance	Lansing-Stoeffler & Daley, 2023.
	Risk Tolerance	Lin, 2011; Lansing-Stoeffler & Daley, 2023.
	Emotion	Corazza et al., 2022; Lin, 2011.
	Motivation	Corazza et al., 2022; Lansing-Stoeffler & Daley, 2023; Lin, 2011.
	Reflection	Rosen et al., 2020; Lin, 2011; Cennamo et al., 2011.
Personal knowledge		
	Domain Knowledge	Corazza et al., 2022; Lansing-Stoeffler & Daley, 2023.
	Interdisciplinary Knowledge	Rosen et al., 2020; Cennamo et al., 2011.
Process		
Task Setting Characteristics		
	Real World Problem	Cennamo et al., 2011.
	Task-oriented	Corazza et al., 2022; Rosen et al., 2020; Lin, 2011; Cennamo et al., 2011.
Task Completion		

Table 4.2 *continued*

Process Specifications		
	Autonomous Exploration	Lin, 2011; Cennamo et al., 2011.
	Mind-wandering	Corazza et al., 2022; Rosen et al., 2020; Lansing-Stoeffler & Daley, 2023; Cennamo et al., 2011.
	Collaboration	Rosen et al., 2020; Lansing-Stoeffler & Daley, 2023; Lin, 2011; Cennamo et al., 2011.
	Scenario and Visual representations	Rosen et al., 2020; Lansing-Stoeffler & Daley, 2023.
Press		
Supportive Environment		
	Supportive and Flexible Atmosphere	Rosen et al., 2020; Lin, 2011; Cennamo et al., 2011.
	Authentic Situations	Rosen et al., 2020; Cennamo et al., 2011.
Mentoring		
	Encouragement	Rosen et al., 2020; Cennamo et al., 2011.
	Feedback	Rosen et al., 2020; Cennamo et al., 2011.

4.2.2.6 An Elaboration of Core Components in Creative Thinking Models from an Educational Practitioner Perspective: Grounded in the 3P Framework

In the educational setting, all instructional efforts and services are ultimately directed toward cultivating students' competencies (Kunter et al., 2013). This research aligns with that overarching objective, positioning the development of CTS as a key educational outcome. Accordingly, all identified components are analysed from the perspective of educational practitioners, aiming to enrich pedagogical practice and enhance student learning.

Drawing on well-established frameworks such as the 3P model of creativity,Person, Process, and Press (Rhodes, 1961; Runco & Kim, 2020),the core elements extracted from the reviewed creativity models are categorised and elaborated in Table 4.3. This structure enables a systematic interpretation of how creativity operates within educational environments, highlighting both individual and contextual contributions to creative skill development.

Research in educational psychology underscores that personal traits such as curiosity, open-mindedness, tolerance of ambiguity, playfulness, and intrinsic motivation are strongly correlated with students' creative potential (Beghetto & Kaufman, 2014; Silvia, Kaufman, & Pretz, 2011). Furthermore, fostering domain-specific and interdisciplinary knowledge provides the cognitive resources necessary for students to generate novel and meaningful ideas (Baer & Kaufman, 2005).

Table 4.3

The Elaboration Of Main Components Of Creative Thinking Models

Components	Description
PERSON	
Personal Traits	Creative personal traits include curiosity, open-mindedness, tolerance for ambiguity, risk tolerance, emotion, personal interest projects, playfulness, motivation, and reflection. These characteristics are adaptable and can be nurtured through intentional practices, varied experiences, and educational strategies.
Personal Knowledge	To foster creative thinking skills in students, they should possess a foundation of knowledge that encompasses both specialized expertise and interdisciplinary understanding. This preparation involves acquiring in-depth knowledge in specific fields while also being equipped with a breadth of knowledge that spans across various disciplines.
PROCESS	
Task Setting Characteristics	Focusing on real-world problem-based tasks is crucial as it immerses students in authentic scenarios, prompting the application of creative thinking to identify, analyze, and solve complex issues. This approach not only allows students to apply theoretical knowledge but also fosters a deeper understanding of the relevance and impact of their creative solutions in real-life contexts.
Task Completion Process Specifications	The process differs from traditional assignments by promoting self-driven inquiry, unconventional thinking, active teamwork, scenario visualization, and dynamic problem-solving beyond typical academic routines.
PRESS	
Supportive environment	The supportive environment involves presenting authentic situations, flexible learning styles, and promoting motivation. This atmosphere cultivates a culture of experimentation and open-mindedness, enabling creative exploration and effective problem-solving.
Mentoring	In fostering creative thinking skills, instructors play a pivotal role by imparting essential knowledge while encouraging students to explore independently. Timely feedback and evaluation create a symbiotic relationship where student self-learning and teacher support reinforce each other, fostering a dynamic and interactive learning cycle.

The process dimension centres on engaging students in real-world problem-based tasks, known to activate creative cognition by challenging learners to apply and synthesise knowledge in unfamiliar contexts (Barrett, 2010; Sawyer, 2011). Self-directed inquiry, collaborative engagement, and scenario visualisation are among the most effective strategies for fostering creativity during task execution (Henriksen et al., 2016).

As for the press (environmental) factors, empirical evidence suggests that supportive learning environments,characterised by psychological safety, autonomy, and constructive feedback,significantly enhance students' willingness to take risks and explore novel ideas (Anderson, Morris, & Keating, 2022; Torrance, 1988). Moreover, teacher mentoring plays a critical role in shaping creative outcomes, particularly when it balances scaffolding with opportunities for autonomous exploration (Craft, 2005; Chan & Yuen, 2014).

4.2.2.7 The Sub Elements of the Extracted Components

As a result of the above analysis, the elements included in the proposed creative thinking skills model are depicted in Figure 4.2.

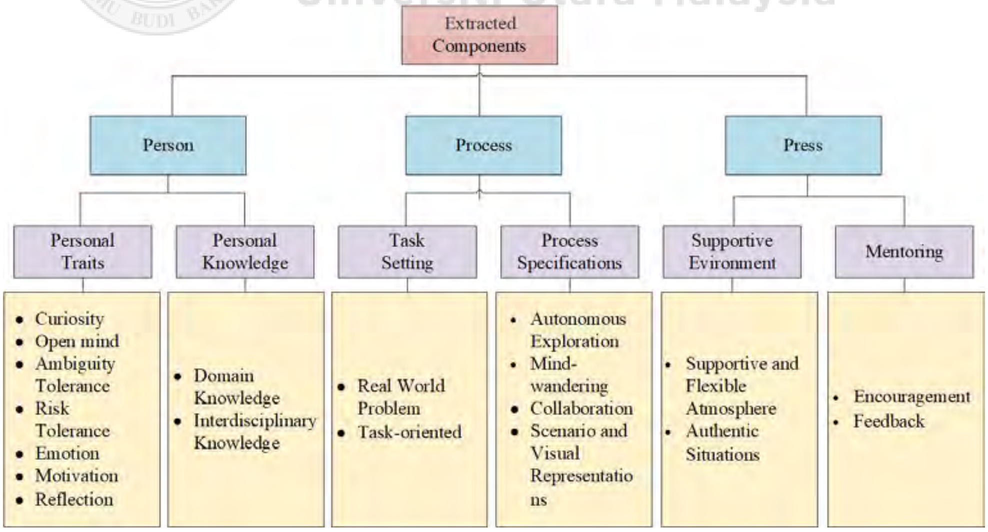


Figure 4.2. Components of the Creative Thinking

Based on the analysis above, these sub-elements will be thoroughly described in the framework of 3P to provide a clear and lucid understanding of the proposed model.

i. Person

Each person harbors the inherent potential for creativity (Treffinger, Isaksen, & Stead-Dorval, 2023; Runco & Pritzker, 2020). In education, the creativity of students can be stimulated by means of instruction (Ritter et al., 2020; Rahimi & Shute, 2021; Calavia, Blanco, & Casas, 2021). Hence, it is crucial to understand the characteristics possessed by creative talents, which mainly contain the following two points: personal traits and knowledge base.

- **Personal Traits**

Personal traits refer to the personality attributes possessed by people whose CTS are evident. According to the literature analysis, it includes seven sub-elements:

Curiosity

Curiosity refers to a strong desire to know, learn, and understand. In cultivating students' creative thinking, curiosity plays a vital role by fostering a natural inclination to explore, question, and seek understanding. It stimulates independent learning, encourages exploration of diverse ideas, and promotes a mindset of continuous discovery, all of which are essential components of creative thinking (Corazza et al., 2022; Lin, 2011). Curiosity is a powerful force for students, driving them to explore, question, and approach learning with an open mind and passion.

Open Mind

Open Mind involves receptivity, flexibility, and a willingness to consider diverse perspectives (Corazza et al., 2022; Lansing-Stoeffler & Daley, 2023). In cultivating students' creative thinking, an open mind is crucial as it promotes adaptability, critical thinking, resilience in the face of failure, curiosity, and collaborative creativity.

Ambiguity Tolerance

Ambiguity tolerance refers to the ability to accept and navigate situations that are unclear, uncertain, or have multiple interpretations. In cultivating students' creative thinking, ambiguity tolerance is crucial as it enables students to embrace uncertainty, think flexibly, and consider diverse perspectives (Lansing-Stoeffler & Daley, 2023). It encourages a willingness to explore unconventional ideas, take risks, and adapt to changing circumstances, fostering an environment where creativity can thrive amid complex and ambiguous challenges.

Risk Tolerance

Risk tolerance refers to the willingness to take on uncertainties and potential challenges without fear of failure. It encourages students to step outside their comfort zones, fostering resilience, and promoting a culture of learning from failures for more inventive thinking (Lansing-Stoeffler & Daley, 2023; Lin, 2011). Educators play a crucial role in creating an environment that encourages students to take creative risk in the learning process.

Emotion

Personal emotion encompasses an individual's subjective feelings and reactions within the creative process, playing a vital role in fostering creative thinking in students. Positive emotions like enthusiasm and passion contribute to sustained concentration and innovative thinking (Corazza et al., 2022; Lin, 2011). Consequently, educators should employ strategies to keep students emotionally engaged in their learning, promoting motivation and self-directed learning.

Motivation

Motivation refers to the internal or external factors that drive individuals to initiate and sustain goal-oriented behaviors. In cultivating students' creative thinking, motivation plays a pivotal role by influencing their willingness to explore, take risks, and persist in the face of challenges (Corazza et al., 2022; Lansing-Stoeffler & Daley, 2023; Lin, 2011.). A motivated student is more likely to engage deeply in the learning process, seek out new ideas, and exhibit a proactive approach to creative endeavors. Educators can enhance creative thinking by fostering and sustaining students' intrinsic motivation, encouraging autonomy, and providing meaningful and challenging tasks that align with their interests and aspirations.

Reflection

Reflection involves contemplating and critically thinking about personal experiences, ideas, and learning. This includes analyzing both successes and setbacks, considering alternative perspectives, and identifying areas for improvement (Rosen et al., 2020; Lin, 2011; Cennamo et al., 2011.). Reflection enhances metacognition, making students more aware of their thinking patterns and creative strategies. This self-awareness supports continuous learning, adaptability, and the refinement of CTS. Educators can facilitate reflection through activities that prompt students to analyse and articulate their thoughts, fostering a more intentional and insightful approach to creative endeavours.

- **Personal Knowledge**

Domain Knowledge

Domain knowledge refers to a person's expertise or understanding within a specific subject area or field. In cultivating students' creative thinking, domain knowledge plays a crucial role by providing a foundation for innovative ideas and solutions. A solid understanding of the subject matter allows students to make meaningful connections, identify patterns, and think critically within a particular domain (Corazza et al., 2022; Lansing-Stoeffler & Daley, 2023). This knowledge serves as a springboard for creative exploration, enabling students to push boundaries, challenge existing concepts, and generate novel insights. Educators can enhance creative thinking by ensuring students acquire and apply relevant domain knowledge, empowering them to approach challenges with depth and insight.

Interdisciplinary Knowledge

Interdisciplinary knowledge involves integrating insights and methods from multiple disciplines to gain a comprehensive understanding of a topic or solve complex problems. In cultivating students' creative thinking, interdisciplinary knowledge plays a vital role by encouraging a holistic and flexible approach to learning and problem-solving. It allows students to draw connections between different fields, fostering a broader perspective and promoting innovative thinking (Rosen et al., 2020; Cennamo et al., 2011). Exposure to diverse disciplines helps students break down traditional silos, encouraging a synthesis of ideas and methodologies. Educators can nurture creative thinking by incorporating interdisciplinary approaches into the curriculum, enabling students to develop a more adaptive and creative mindset that extends beyond the boundaries of individual subjects.

ii. Process

In this section, the term "Process" does not pertain to the procedural steps, which will be explicated in a subsequent dedicated section. Instead, it delineates the attributes associated with the cultivation of students' CTS, comprising two principal facets: the attributes inherent in the task setting and the distinctive features characterizing the process of task completion.

- **Task Setting Characteristics**

Real-world Problem

A "Real-world Problem" refers to an issue or challenge that mirrors situations encountered in practical, everyday contexts. In cultivating students' creative thinking, real-world problems play a crucial role by providing authentic and meaningful scenarios for problem-solving. These problems often lack clear-cut solutions, requiring students to think critically, consider multiple perspectives, and devise innovative approaches (Cennamo et al., 2011). Incorporating real-world problems into education enhances students' creativity by connecting theoretical learning to practical scenarios, preparing them for the complexities they may encounter in various professional and personal settings.

Task-oriented

Task-oriented refers to an approach that prioritizes the accomplishment of specific objectives or goals. And it aligns with the concept of a "real-world problem" discussed earlier. Task-oriented activities promote engagement and focus, allowing students to channel their creativity toward accomplishing specific goals or objectives (Corazza et al., 2022; Rosen et al., 2020; Lin, 2011; Cennamo et al., 2011). This approach helps students develop a practical and goal-driven orientation, fostering creativity within the parameters of specific tasks and objectives.

- **Task Completion Process Specifications**

As stated earlier, the process of completion featured here does not refer to the dynamic processes of completion, but rather to the common features that these processes exhibit, including: Autonomous Exploration, Mind-wandering, Collaboration, Scenario and Visual representations.

Autonomous Exploration

Autonomous Exploration refers to the independent and self-directed investigation or inquiry into new ideas, concepts, or problem-solving approaches (Lin, 2011; Cennamo et al., 2011). It aligns with task-oriented learning by encouraging students to independently navigate and solve Real-world Problems, contributing to a more comprehensive and self-motivated development of CTS. This approach empowers students to independently seek out information, question assumptions, and explore various perspectives, fostering a sense of ownership and curiosity.

Mind-wandering

Mind-wandering serves as a valuable complement to autonomous exploration, creating a space for free and unstructured thinking. This mental state plays a significant role in the creative process, enabling the mind to explore unrelated ideas, make unexpected connections, and generate novel insights (Corazza et al., 2022; Rosen et al., 2020; Lansing-Stoeffler & Daley, 2023; Cennamo et al., 2011). By providing a mental break from focused tasks, mind-wandering fosters a relaxed and associative thinking mode that contributes to creative problem-solving. In the context of cultivating students' creative thinking, this spontaneous mental exploration allows individuals to delve into unconventional associations, generate novel ideas, and make unexpected connections, enhancing the overall depth and flexibility of CTS.

Collaboration

Collaboration, the cooperative effort between individuals or groups, plays a crucial role in cultivating students' creative thinking. It fosters diverse perspectives and collective problem-solving, complementing individual exploration and idea generation (Rosen et al., 2020; Lansing-Stoeffler & Daley, 2023; Lin, 2011; Cennamo et al., 2011). In conjunction with autonomous exploration and mind-wandering, collaboration contributes to a well-rounded approach, enhancing adaptability, effective communication, and a deeper understanding of complex topics.

Scenario and Visual Representation

Scenarios offer real-world contexts, while visual representations enhance comprehension and stimulate students' creative thinking. The approaches involve creating or envisioning narratives and visual elements to convey ideas or solutions (Rosen et al., 2020; Lansing-Stoeffler & Daley, 2023). It encourages students to use scenarios, stories, or visual aids to communicate complex ideas, fostering creative expression and enhancing communication skills.

iii. Press

According to Israel-Fishelso and Hershkovitz (2022), “Press” refers to the external factors or influences that impact the creative thinking process, including the environment, culture, and external pressures that may shape or hinder creativity. Based on the previous literature analysis, from the perspective of educators, Press is discussed in two aspects, Supportive Environment and Mentoring in the context of education.

- **Supportive environment**

Supportive and Flexible Atmosphere

In education, cultivating a "Supportive and Flexible Atmosphere" is essential for fostering students' creativity. Educators play a pivotal role in constructing this environment by encouraging positive interactions, adapting to diverse learning styles, and engaging students actively (Rosen et al., 2020; Lin, 2011; Cennamo et al., 2011). This involves creating an inclusive culture that values diverse perspectives, promoting a willingness to take intellectual risks, providing autonomy for individual exploration, offering constructive feedback, and facilitating collaborative opportunities. This multifaceted approach ensures a dynamic and conducive atmosphere for fostering creativity within the educational setting.

Authentic Situations

Authentic situations are scenarios created by educators to replicate real-world contexts, fostering practical learning (Rosen et al., 2020; Cennamo et al., 2011). In promoting creative thinking, educators design realistic scenarios, implement problem-based learning, and integrate hands-on activities. While the Real-world problems mentioned previously are specific topics students work on, emphasizing problem-solving within defined contexts. In contrast, authentic situations offer a more comprehensive view, presenting broader real-life scenarios crafted by educators for a holistic learning approach that goes beyond specific problem-solving tasks.

- **Mentoring**

Encouragement

In the context of education, encouragement involves providing positive support and motivation to students (Rosen et al., 2020; Cennamo et al., 2011). Educators can promote creative thinking by recognizing efforts, creating a positive environment, offering constructive feedback, and empowering student autonomy. This fosters a supportive atmosphere that encourages students to explore and take creative risks.

Feedback

"Feedback" is the process of providing constructive information to students about their work. In promoting creative thinking, educators play a vital role by offering constructive critique, specific guidance, and timely responses (Rosen et al., 2020; Cennamo et al., 2011). Encouraging students to iterate and refine their work based on feedback fosters continuous improvement and enhances their creative thinking. Timely and continuous feedback is crucial, creating a dynamic learning process that supports students in developing and refining their creative abilities.

4.3 Development Process of the Proposed Model

In Chapter 2, this research established the conceptual foundations of DS, its integrated production process (anchored in multimedia design theory), and the synergies between EDS, multimedia design, and creative thinking skills (CTS) development. Building on the foregoing analysis, this section presents an in-depth critical analysis of empirically-grounded Educational Digital Storytelling (EDS) models with a central focus on their treatment of multimedia design as a core component of CTS cultivation. To meaningfully investigate the role of EDS in fostering CTS, the selection of models for analysis has been deliberately limited to those substantiated by empirical research, implemented and evaluated within authentic course settings, and with a stated focus on linking EDS to creative or cognitive skill development. A common thread across these studies is their conclusion (direct or implied) that DS methodologies contribute positively to the development of CTS, yet all exhibit gaps in their systematic integration of multimedia design theory, a critical limitation this study addresses in the development of the Digital Storytelling for Creative Thinking Skills (DSCTS) framework.

4.3.1 The Analysis on Educational Digital Storytelling Models

Having established the conceptual foundations, typological classifications, and multimedia design-integrated production processes of DS in the preceding sections, this study now turns to a focused examination of EDS models. The selected frameworks include: the Movement Oriented Design (MOD) model (Sharda, 2005), **valued for its structured multimodal movement design**; the E-learning through

Digital Storytelling (eLDiSt) model (Smeda, Dakich, & Sharda, 2010), **included for its integration of multimedia elements with constructivist e-learning**; the Student Experience Digital Storytelling (SEDS) model (Bryant, 2023), representing **a contemporary learner-centred approach to multi-modal EDS;** the Problem-based Interactive Digital Storytelling learning model (Poonsawad, Srisomphan, & Sanrach, 2022), selected for its merger of **problem-based pedagogy with interactive multimedia storytelling**; and the Leading, Active learning, Opinion sharing and Reflective thinking (LAOR) model (Jitsupa et al., 2022), included for its emphasis on **metacognitive and social dimensions of multimodal EDS**. Each model is analyzed for its **multimedia design strengths, limitations, and contributions to CTS development**, with a critical focus on **how its treatment of multimodal composition supports or hinders creative thinking cultivation**.

4.3.1.1 The Movement Oriented Design (MOD) Model

Sharda's (2005) Movement Oriented Design (MOD) model establishes **kinetic multimedia design** as the fundamental organizing principle for constructing compelling digital narratives, a unique contribution to EDS that aligns with core multimedia design and cognitive theories. By systematically integrating camera, character, and object movement into digital storytelling, the framework enhances both visual engagement and emotional resonance, with its kinetic design principles directly reflecting Mayer’s (2009) dual coding theory and Lowe and Boucheix’s (2011) cognitive theories of visual perception (which emphasize dynamic visual processing as a driver of knowledge construction). In educational contexts, the model organizes digital stories through two complementary dimensions: an affective narrative component designed to elicit emotional engagement, and an instructional knowledge component that conveys subject matter content (Sharda, 2007), *with kinetic* *multimedia design serving as the bridge between these two dimensions*.

The model operationalizes this approach through three interconnected mechanisms that center on multimedia design: (1) visual impact achieved through dynamic techniques that capture and sustain viewer attention, consistent with visual perception research; (2) emotional engagement amplified through choreographed movement patterns that deepen audience connection, reflecting findings in affective computing (McCloud, 1993); and (3) narrative enhancement that uses kinetic elements to emphasize plot points and establish rhythmic flow, building on narrative theory (Bordwell & Thompson, 2017). These kinetic multimedia design elements work synergistically to transform static content into immersive learning experiences, fostering creative thinking by requiring students to design dynamic multimodal narratives that convey both emotion and disciplinary knowledge.

Practical implementation of the MOD model, however, reveals two key **multimedia design limitations**: (1) its overemphasis on kinetic visual design neglects the synergy between dynamic visual elements and audio design, with little guidance for applying Mayer's (2009) modality principle to kinetic-audio integration; (2) its focus on pre-planned movement design offers limited scaffolding for interactive kinetic multimedia (e.g., VR/AR), a critical gap for AI-era EDS. Additionally, the model requires significant technical proficiency in animation and video editing, which may create barriers for students with limited multimedia design literacy, highlighting the need for scaffolded kinetic design learning in EDS. The model demonstrates particular efficacy in visually-rich educational content, though its adaptation to text-heavy or abstract subject matter may require creative multimedia design mediation to preserve its pedagogical effectiveness for CTS development.

4.3.1.2 The E-learning through Digital Storytelling (eLDiSt) Model

The E-learning through Digital Storytelling (eLDiSt) model (Smeda, Dakich, & Sharda, 2010) provides a structured approach to integrating digital storytelling in online education, with **multimedia element integration** as a core component of its constructivist design. This framework combines narrative techniques with a diverse range of multimedia elements (images, audio, video, interactive text) to create engaging online learning experiences, aligning with the TPACK framework (Mishra & Koehler, 2006) by linking technological (multimedia) knowledge to pedagogical and content knowledge.

The model comprises four core components, all of which embed multimedia design considerations: (1) a coherent narrative structure that guides learners logically through content, with multimedia elements selected to reinforce narrative flow; (2) strategic integration of images, audio, and video to reinforce learning objectives, with implicit adherence to Mayer's (2009) non-redundancy principle; (3) interactive multimedia elements (e.g., clickable visuals, audio prompts) that foster collaboration and discussion; and (4) reflective practices that promote metacognitive development, with students asked to critique their own multimedia design choices for effective online communication. A key strength of the eLDiSt model is its recognition of **online multimedia design specificity**: it accounts for the unique cognitive demands of online learning (e.g., reduced attention spans) by prioritizing concise, high-impact multimodal elements that reduce extraneous cognitive load (Sweller, 2010)—a critical consideration for CTS development in online EDS.

The eLDiSt model's primary **multimedia design limitation** is its lack of systematic, evidence-based multimedia design scaffolding: while it encourages multimedia element integration, it provides no explicit guidance for applying core multimedia design principles (e.g., spatial/temporal contiguity) to online EDS, leaving students to make ad-hoc multimodal design choices. Additionally, its interactive multimedia elements are limited to basic clickable features, with no guidance for more complex interactive design (e.g., branching narratives) that fosters higher-order creative thinking (Runco & Kim, 2020). Successful implementation of the model benefits from adequate technical infrastructure, appropriate time allocation for multimedia resource development, and foundational storytelling and multimedia design skills among participants, highlighting the need for explicit multimedia design instruction in online EDS for CTS cultivation.

4.3.1.3 The Student Experience Digital Storytelling (SEDS) Model

Bryant's (2023) Student Experience Digital Storytelling (SEDS) model innovatively integrates DS with Participatory Action Research (PAR) methodology through a structured four-phase cycle of design, communication, analysis, and sharing—*with **learner-centred multimodal engagement** as its core multimedia design principle*. This framework systematically captures student experiences to inform curriculum development through collaborative dialogue and co-design processes, aligning with established principles of participatory educational research (Kemmis, McTaggart, & Nixon, 2014) and Jewitt's (2008) multi-modal literacy theory which emphasizes learner choice in multimodal expression as a driver of creative thinking.

The model operates through four interconnected components that collectively enhance learning experiences and CTS development, all grounded in multi-modal multimedia design: (1) narrative integration that weaves personal stories throughout curriculum elements, with students selecting multimodal channels (visual, audio, written, performative) that best express their personal experiences; (2) multimodal engagement utilizing diverse media formats to accommodate varied learning preferences, fostering creative self-expression by centering student agency in multimedia design; (3) reflective practice structured to foster metacognitive development through guided introspection (Flavell, 1979), with students reflecting on how their multimedia design choices shape audience understanding of their stories; and (4) collaborative group storytelling that promotes peer learning and collective knowledge construction, with group members specializing in different multimedia design roles (e.g., visual design, audio engineering) to create a cohesive multimodal narrative.

Key strengths of the SEDS model from a multimedia design and CTS perspective include: (1) significantly enhanced student engagement through authentic narrative connections and learner-centred multimodal design; (2) robust support for individualized learning trajectories by allowing students to leverage their existing multimedia design strengths; and (3) meaningful opportunities for creative development through digital media, as students experiment with multimodal expression to convey personal and disciplinary meaning. The model's primary **multimedia design limitation** is its lack of structured feedback on evidence-based multimedia design: while it encourages learner choice in multimodal expression, it provides no scaffolding for students to evaluate their design choices against core multimedia design principles (e.g., modality, contiguity), potentially limiting the communicative efficacy of their EDS and the development of evidence-based creative thinking. Implementation requires adequate technical infrastructure to support diverse digital creation tools and thoughtful assessment strategies that holistically evaluate both learning outcomes and **multimodal design quality**, reflecting contemporary approaches to digital literacy assessment (Mills, 2010) and CTS evaluation (Beghetto & Kaufman, 2014).

4.3.1.4 The Problem-based Interactive DS Learning Model

Poonsawad et al. (2022) present a Problem-Based Interactive Digital Storytelling Learning Model that synthesises problem-based learning (PBL) methodologies with **interactive multimedia storytelling design**, a critical integration that links problem-solving (a core CTS component) to multimodal expression. This pedagogical framework is structured around three sequential phases (preparation, teaching activities, assessment), with interactive multimedia design embedded into every phase to transform problem-based inquiry into a multimodal storytelling process. The model aligns with Kolb's (2015) experiential learning principles and the TPACK framework (Mishra & Koehler, 2006), as it requires students to integrate disciplinary problem-solving with multimedia design and pedagogical knowledge to create interactive EDS that addresses authentic problems.

The preparatory phase encompasses six foundational elements, with two explicitly focused on multimedia design: the development of multimedia instructional materials (lesson plans, interactive visuals, audio prompts) and the curation of multimedia problem-solving resources. The teaching phase incorporates a cyclical process comprising problem-based inquiry, reflective practice, **interactive story creation (multimedia design)**, and game-based interaction, with interactive multimedia design serving as the core vehicle for students to express their problem-solving processes and solutions (e.g., creating a branching narrative video that explores different solutions to a scientific problem). The final assessment phase employs a tripartite evaluation system measuring problem-solving competence, academic achievement, and learner satisfaction, *with interactive multimedia design efficacy as an implicit (but unmeasured) component of problem-solving expression*.

This model demonstrates particular efficacy in developing analytical reasoning and creative thinking through authentic problem scenarios, with **interactive multimedia design** amplifying EDS's educational value by requiring students to: (1) translate abstract problem-solving processes into concrete multimodal expression; (2) design interactive elements that invite audience engagement with the problem and its solutions; and (3) collaborate with peers to create a cohesive interactive multimedia narrative, all core CTS practices. Its primary **multimedia design limitations** are: (1) the lack of explicit evaluation criteria for interactive multimedia design, with the model prioritizing problem-solving outcomes over the multimodal design choices that shape their expression; (2) limited scaffolding for adaptive interactive multimedia design, with little guidance for modifying interactive elements for different audience or platform contexts; and (3) a focus on technical interactive design (e.g., branching narratives) at the expense of evidence-based cognitive design principles, potentially leading to extraneous cognitive load for audiences (Sweller, 2010). Its implementation requires consistent pedagogical guidance throughout the problem-solving and multimedia design process and adequate technological infrastructure to support interactive digital story creation, aligning with contemporary digital literacy frameworks (Mishra & Koehler, 2006) and CTS development best practices (Runco & Acar, 2012).

4.3.1.5 The Leading, Active learning, Opinion sharing and Reflective thinking (LAOR) Model

The LAOR model (Jitsupa et al., 2022) establishes a structured pedagogical framework for digital storytelling that organises learning through four interrelated components: leading, active learning, opinion sharing, and reflective thinking—*with **scaffolded multimodal expression** as a core practice that links each component to CTS development*. Within this framework, instructors adopt a facilitative leadership role

(Vygotsky, 1978) to provide scaffolding for both narrative creation and multimedia design, establishing clear learning objectives while guiding the pedagogical and multimodal design process within a supportive environment.

The model's efficacy stems from its carefully scaffolded progression through core developmental stages, all of which integrate multimedia design with CTS cultivation: (1) students initially engage in active knowledge construction through hands-on narrative and **multimodal creation**, applying basic multimedia design principles to convey disciplinary content; (2) students then develop communicative competence through structured opinion sharing and perspective exchange (Bandura, 1997), critiquing peers' multimedia design choices and refining their own based on feedback; (3) the culminating reflective thinking component enables learners to integrate new understandings with prior knowledge through systematic metacognitive analysis (Schön, 1983), reflecting on how their multimedia design choices shape the expression of creative and disciplinary ideas. A key strength of the LAOR model is its **scaffolded multimedia design learning**: it meets students at their current digital literacy level, providing incremental guidance for evidence-based multimodal design and fostering creative thinking by linking design choices to narrative and pedagogical goals.

This integrated approach demonstrates particular strength in fostering higher-order thinking capabilities, with empirical evidence indicating positive impacts on creative expression, critical analysis, and collaborative communication skills, all amplified by its scaffolded multimedia design component. The model's primary **multimedia design limitation** is its focus on basic multimedia elements (images, audio, video) with little guidance for advanced or AI-augmented multimedia design (e.g., animation, immersive media), a gap that limits its applicability for AI-era CTS development. Additionally, its effectiveness may vary across different disciplinary and demographic settings (Biggs, 1999), with visually-rich disciplines (e.g., art, design) benefiting more from its multimedia design scaffolding than text-heavy disciplines (e.g., literature, history), suggesting the need for disciplinary-specific multimedia design adaptation. The LAOR model thus represents a structured yet adaptable approach to integrating digital storytelling into learning environments that value both content acquisition and cognitive development, *with scaffolded multimedia design as a core, yet underdeveloped, component of its CTS cultivation strategy*.

4.3.1.6 Implication of the Comparative Analysis to the Study

The EDS models examined in this section provide critical theoretical and practical foundations for understanding the operational mechanisms of Educational Digital Storytelling, *and their collective strengths and limitations in integrating multimedia design with CTS cultivation*, which directly informs the development of the proposed **Digital Storytelling for Creative Thinking Skills (DSCTS) framework**. A core finding of this critical analysis is that all five EDS models (MOD, eLDiSt, SEDS, Problem-based Interactive DS, LAOR) recognize multimedia design as a key component of EDS, yet none systematically integrate **evidence-based multimedia design theory** with CTS cultivation principles (e.g., the 3P Person-Process-Press framework (Rhodes, 1961; Runco & Kim, 2020)). This gap is the central challenge the DSCTS framework addresses: embedding systematic, evidence-based multimedia design into every phase of EDS, with multimodal design practices directly aligned with the 3P CTS components to ensure that EDS's multimedia design process is also a CTS cultivation process.

To develop the DSCTS framework, this study systematically embeds **multimedia design elements and scaffolding** from the five established EDS models, selected for their specific applicability to the research objectives and theoretical alignment with 3P creative thinking development:

i. **MOD model (Sharda, 2005)**: Extract kinetic multimedia design principles and integrate them with Mayer's (2009) modality principle to create a balanced dynamic visual-audio design framework, aligned with the *Process* component of the 3P model (task completion process specifications).
ii. **eLDiSt model (Smeda, Dakich, & Sharda, 2010)**: Adopt its online multimedia design specificity (cognitive load reduction, concise multimodal elements) and integrate explicit multimedia design principles to address its scaffolding gap, aligned with the *Press* component (supportive environment for online EDS).
iii. **SEDS model (Bryant, 2023)**: Retain its learner-centred multimodal engagement and peer multimedia design roles, and add evidence-based multimedia design feedback scaffolding to address its evaluation gap, aligned with the *Person* component (personal traits: autonomy, collaboration) and *Process* component (collaboration).
iv. **Problem-based Interactive DS model (Poonsawad et al., 2022)**: Integrate its interactive multimedia storytelling design with problem-based learning, and add explicit interactive multimedia design evaluation criteria, aligned with the *Process* component (task setting: real-world problems) and *Press* component (mentoring for problem-solving and design).
v. **LAOR model (Jitsupa et al., 2022)**: Build on its scaffolded multimedia design learning and reflective practice, and extend its multimedia design guidance to AI-augmented and disciplinary-specific multimodal design, aligned with the *3P model in its entirety* (Person: reflection; Process: autonomous exploration; Press: mentoring).

While each of these five EDS models possesses distinct conceptual scope and implementation principles, not all elements were incorporated into the DSCTS framework. The selection of multimedia design and EDS components was guided by two core criteria: (1) **alignment with the 3P creative thinking framework** (Rhodes, 1961; Runco & Kim, 2020), ensuring that every component fosters CTS development; and (2) **evidence-based multimedia design** (Mayer, 2009; Mishra & Koehler, 2006), ensuring that multimodal design practices are grounded in cognitive and educational theory. The detailed integration of these multimedia design and EDS elements, and their explicit alignment with the 3P CTS components in the DSCTS framework.

2.8.2 Theoretical Scaffold for DSCTS Model Development: Multimedia Design and EDS Integration

Instructional models based on DS should contain not only a story component but also a knowledge component (Sharda, 2007a), with **multimedia design serving as the critical bridge between these two components** that transforms narrative and knowledge into actionable, creative multimodal expression. The production process of an instructional model based on DS is synchronized with the story and knowledge throughout, *and this synchronization is only possible through intentional multimedia design*, which ensures that every narrative and knowledge element is conveyed through appropriate, evidence-based multimodal channels. To establish the development process of the proposed DSCTS model, Section 2.4.6 outlines DS in four phases (pre-production, production, post-production, distribution) with systematic multimedia design integration, offering key advantages over alternative methods by providing a clear, logical sequence that simplifies EDS implementation for creators *and ensures that multimedia design is a core CTS cultivation practice* at every phase.

For the purpose of analysis and model development, this study uses the four stages of DS production (anchored in multimedia design) as a scaffold to incorporate the steps of the five selected educational models (Sharda, 2007a; Smeda et al., 2010; Jamiludin & Darnawati, 2022; Poonsawad et al., 2022; Bryant, 2023). This scaffolding strategy addresses the core limitation of the five models, their fragmented treatment of multimedia design—by embedding their EDS strengths into a **unified, multimedia design-integrated DS production process** that aligns with the 3P CTS framework and ADDIE learning model.

The selection of the five DS models proposed by Sharda (2007a), Smeda et al. (2010), Jamiludin and Darnawati (2022), Poonsawad et al. (2022), and Bryant (2023) is grounded in their relevance, representativeness, **complementary multimedia design contributions**, and alignment with the multidimensional nature of creative thinking cultivation in educational contexts. These models were deliberately chosen to reflect both the evolution of DS pedagogy and the growing importance of multimedia design in AI-era CTS development, with each model contributing a unique multimedia design perspective that addresses a gap in the others:

- **Sharda (2007a)**: Offers one of the earliest structured DS models that integrates multimedia composition with narrative structure, with a focus on kinetic visual design. This foundational model is selected for its clarity in linking narrative development to cognitive engagement *via multimodal design*, which is vital for creativity-oriented pedagogy and the *Process* component of the 3P model.
- **Smeda et al. (2010)**: Expands DS design to incorporate game-based interaction and user agency (reflecting a shift toward non-linear storytelling and experiential learning), with a focus on online multimedia design specificity. Their model underscores the role of learner control and immersive multimedia design, which aligns with current creativity research highlighting autonomy and choice as drivers of original thinking (Runco & Acar, 2012) and the *Person* component of the 3P model.
- **Jamiludin & Darnawati (2022)**: Presents a DS framework specifically designed for language and literacy education, with a strong emphasis on student voice, personal expression, and **culturally responsive multimedia design**. This model brings context specificity and validates the importance of learner-centred storytelling through multimodal design, which supports both motivation and creative fluency—two core targets of the DSCTS model and the *Person* component of the 3P model.
- **Poonsawad et al. (2022)**: Proposes a DS instructional model built within a constructivist and project-based learning framework, embedding collaboration, feedback, and **interactive multimedia design** across the production process. This model is instrumental in operationalising creative process stages (e.g., preparation, incubation, elaboration) through DS, and directly supports the integration of 3P (Person, Process, Press) creative thinking components by linking interactive multimedia design to real-world problem-solving.
- **Bryant (2023)**: Introduces a contemporary DS model situated in hybrid learning environments, incorporating cloud technologies, digital fluency, and **collaborative multimedia design critique** mechanisms. This model was selected for its relevance to current technological affordances in higher education and its structured approach to fostering creative iteration and reflection—both essential in evaluating and improving creative performance (Beghetto & Kaufman, 2014) and aligned with the *Press* component (mentoring, feedback) of the 3P model.

Together, these five models provide a comprehensive foundation of EDS best practices, with their complementary multimedia design contributions enabling the development of a DSCTS framework that embeds **evidence-based, scaffolded, and learner-centred multimedia design** into every phase of EDS, ensuring that the DSCTS model is not only a pedagogical framework for EDS but also a systematic tool for cultivating

AI-era creative thinking skills through multimodal design. Collectively, these five models capture a diverse yet complementary range of DS pedagogical strategies, from traditional narrative construction to dynamic, interactive, and collaborative storytelling practices. Their integration provides a robust foundation for the development of the DSCTS model, ensuring it is pedagogically sound, technologically relevant, and creativity-driven.

Table 4.4 compares and analyzes the production process of the five selected EDS models, filtering and comparing the main aspects. Table 4.5 displays the analysis of the selected steps. However, it's important to note that in practice, the production process for educational models utilizing DS may involve additional details tailored to specific pedagogical objectives.

Table 4.4

Steps 0f the Instructional Models Based on Digital Storytelling

	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**
Authors	**Sharda (2007a)**	**Smeda et al. (2010)**	**Jamiludin & Darnawati (2022)**	**Poonsawad et al. (2022)**	**Bryant (2023)**
Pre-production	• Brain Storm on learning concept • Create story plot • Emotional content • Storyboarding	• Dramatic question • Plot • Narrative • Story Characters • Emotional content	• Content analysis • Montage with icons	• Prepare the content • Design learning activities • Make groups • Brain storm	•Objective setting • Co-design •Identifying storytellers • Script writing •Storyboarding
Production	• Develop content set (text, video, graphics, sound)	• Hardware and software for multimedia elements	• collected data in the form of images, video or sound	• Digital storytelling production	• Student-led digital storytelling creation
Post-production	• Author the content	• Content detail (simple not excessive)	• Mastered the material	• Gamification environment.	• Refine
Distribution	• Presentation • Discussion • Question & Answer	• Presentation • Feedback	• Presentation • Discussion • Question & Answer	• Evaluation • Presentation • Question & Answer	• Sharing (Internal and External)

Table 4.5

Analysis of the Selected Steps

Phases	Steps	Model 1	Model 2	Model 3	Model 4	Model 5
Pre-production	• Content analysis	✓	✓	✓	✓	✓
	• Story design	✓	✓			✓
	• Script writing	✓	✓			✓
	•Storyboarding	✓		✓		✓
Production	• Collecting multimedia elements	✓	✓	✓	✓	✓
Post-production	• Editing and Preview	✓	✓	✓		✓
Distribution	• Presentation	✓	✓	✓	✓	✓
	• Feedback	✓	✓	✓	✓	
	• Question & answer	✓		✓	✓	

Based above analysis, Figure 4.3 illustrates the development of the proposed conceptual model.

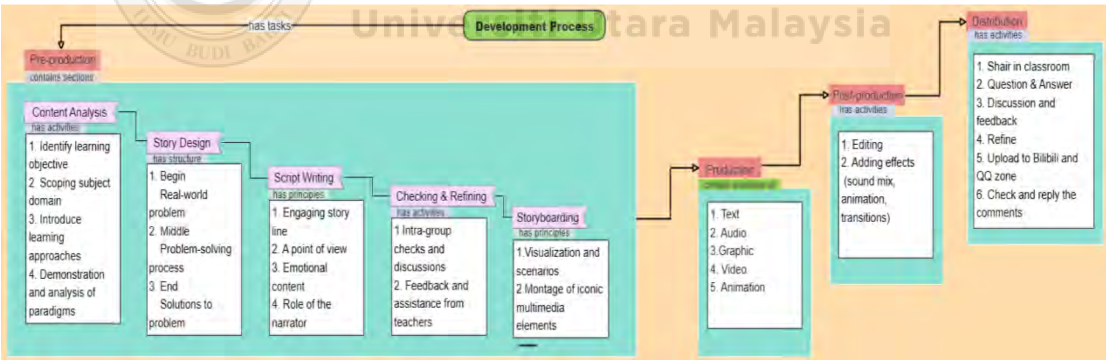


Figure 4.3. Development Process and Elements of Creating a Project-Based DS

4.4 The Proposed Conceptual Model of DSCTS

Building upon the preceding theoretical and empirical discussions, the proposed **Digital Storytelling for Creative Thinking Skills (DSCTS)** conceptual model is structured into three interconnected modules: (1) the **Learning Component**, (2) the

Creative Thinking Component, and (3) the **Development Process**. Each module comprises a coherent set of sub-components or elements that collectively contribute to the overarching objective of fostering students' creative thinking skills (CTS).

The Learning Component establishes the first module of this study, reflecting the principle that all instructional efforts are ultimately directed toward the cultivation of learners' cognitive and creative competencies (Kunter et al., 2013). This module consists of three key dimensions: **Learning Theory**, **Learning Model**, and **Learning Approach**.

From a theoretical perspective, this research draws upon **Constructivist Learning**, **Humanistic Learning**, and **Dale's Cone of Experience**. These paradigms are chosen for their shared emphasis on learner-centred and experience-based instruction. Constructivism focuses on connecting students' prior knowledge to new content through active engagement (Piaget, 1976), while Humanism underscores the emotional and environmental conditions required for authentic learning (Rogers, 1969). Complementing these, Dale's Cone of Experience (1969) supports the use of **multi-modal learning strategies**, offering a rationale for engaging students through sensory-rich and experiential formats.

In terms of instructional design, the model incorporates three influential frameworks:

- The **ADDIE model** (Analysis, Design, Development, Implementation, and Evaluation), which provides a structured, iterative approach to curriculum and resource design (Abuhassna & Alnawajha, 2023);

- The **TPACK framework** (Technological Pedagogical Content Knowledge), which addresses the integration of technology, pedagogy, and subject knowledge to enrich learning experiences (Mishra & Koehler, 2009);

- And the **SAMR model** (Substitution, Augmentation, Modification, Redefinition), which encourages a transformative use of digital tools in educational practice (Puentedura, 2014).

These models collectively form the instructional foundation for integrating digital storytelling into higher education, enabling educators to design learning experiences that not only meet content objectives but also support the cultivation of CTS.

The Learning Component further includes four pedagogical approaches: **multi-sensory learning**, **collaborative learning**, **student-centred learning**, and **interdisciplinary learning**. These were selected through an analytical synthesis of relevant learning theories and instructional models, and are embedded into the DSCTS framework to optimise learning engagement and creative output.

The second module, the Creative Thinking Component, is informed by the **3P model of creativity**: **Person**, **Process**, and **Press** (Runco & Kim, 2020). Through iterative content and comparative analysis, this module categorises the conditions and traits necessary for fostering creativity in education.

- **Person** encompasses both **personal traits**, such as curiosity, openness, ambiguity tolerance, risk-taking, motivation, and emotion, and **personal knowledge**, which includes domain-specific and interdisciplinary understanding (Amabile, 1996).

- **Process** refers to two elements: task characteristics (e.g., real-world relevance, problem orientation), and process specifications such as **autonomous exploration**, **mind-wandering**, **collaboration**, and **scenario visualisation** (Barrett, 2010).

- **Press** represents the external environment. A **supportive learning climate**,characterised by encouragement, authenticity, and flexibility,is essential, as is the role of **teacher mentoring**, which includes feedback, assistance, and motivational guidance (Craft, 2005).

These components are foundational for constructing the learning environments in which creative thinking can flourish and are thus integral to the DSCTS conceptual framework.

The third module, the **Development Process**, integrates the previous two components into a coherent pedagogical pathway based on **digital storytelling**. This process is divided into four phases: **Pre-production**, **Production**, **Post-production**, and **Distribution**.

- The **Pre-production** phase is educator-led and includes learning objective design, content analysis, and story planning. It demands critical thinking, project planning, and instructional scaffolding.

- The **Production** and **Post-production** phases shift towards student-led creation and refinement, involving multimodal text integration (audio, visuals, narration) and creative editing.

- The final **Distribution** phase emphasises peer engagement, classroom presentation, online sharing, and iterative improvement through feedback.

This phase-based process not only enables systematic implementation of DS but also provides learners with a dynamic environment for developing and applying creative competencies.

These three modules function **interdependently**. The Learning Component and Creative Thinking Component furnish the theoretical and pedagogical foundation, while the Development Process serves as the **operational bridge**, integrating them into classroom practice through the medium of DS projects. Together, they form a holistic model aimed at advancing students' **creative thinking during the process of learning disciplinary knowledge**.

This conceptual model thus addresses a critical gap in the literature: the need for a theoretically grounded, practically applicable, and **creativity-oriented** instructional framework that integrates **digital storytelling** with **pedagogical design**. The structure of the proposed DSCTS conceptual model is illustrated in Figure 4.4.

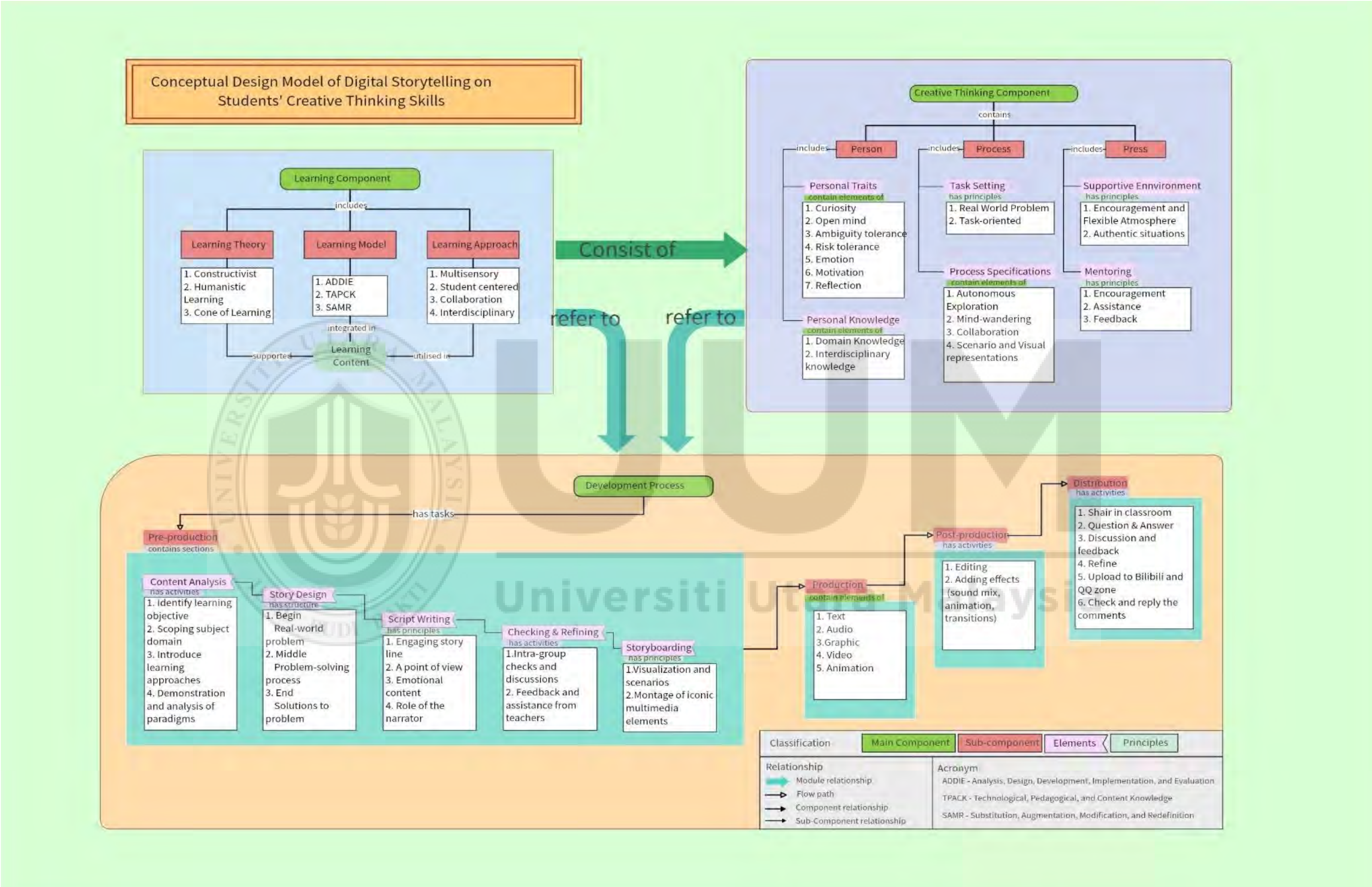


Figure 4.4. Proposed Conceptual modal of DSCTS

4.5 The Validation of the Proposed Model

The proposed conceptual model of DSCTS was extracted through comprehensive literature analysis. Its validity needs to be assessed by experts. This section also answers the third research question mentioned in the first chapter of the thesis: What methods and criteria are most effective for validating the proposed DSCTS model?

Expert review is essential for validating proposed models, ensuring accuracy, credibility, and robustness. Experts offer specialized insights, identifying flaws and enhancing reliability (O'Keefe & O'Leary, 1993). Their feedback refines the model, optimizing utility and meeting rigorous standards. For the selection of experts, the reference criteria for this study were as follows:

- Have at least five years of teaching experience in higher education in disciplines such as creative multimedia, educational technology, as well as other related disciplines.

- Be academically qualified, i.e., possess a master's degree or higher.

According to Dorussen, Lenz, and Blavouko (2005) and Almanasreh, Moles, and Chen, (2019), a total of six experts is sufficient to validate the proposed conceptual framework. The demographic profile of the experts is listed in Table 4.6. As shown in the Table, the invited experts come from a variety of academic institutions, both China and international. And the number of experts met the requirements of the study. All of the experts hold doctoral degrees and have dedicated at least 10 years to teaching, during which they have honed their skills in effectively imparting knowledge. Moreover, their expertise extends specifically to creative multimedia, educational technology – domains crucial to the proposed model's success. Their perspectives hold immense value in refining and elevating the model's efficacy. Thus, entrusting them with the evaluation process ensures thorough scrutiny and facilitates meaningful improvements to the model.

Table 4.6

Demographic Profile of Experts

Expert	Gender	Education Level	Field of Expertise	Experience (Year)	Affiliations
A	F	PhD	Educational technology; Digital Storytelling	23 years	Polytechnic University of Milan
B	M	PhD	VR, IVR	10 years	UTM
C	F	PhD	Multimedia studies, AR, VR	18 years	UTM
D	F	PhD	HCI	25 years	UiTM
E	M	PhD	Creative media, Game-based learning, Edutainment	20 years	UUM
F	F	PhD	Multimedia, Educational technology, HCI	24 years	UiTM
G	F	PhD	Creative Education; Fine Arts	25 years	Henan Agricultural University
H	M	PhD	Educational technology	21 years	Henan Normal University
I	M	PhD	Multimedia Art, Animation	10 years	Henan University of Urbern Construction

4.5.1 Review Procedure and Instrument

This section will provide a comprehensive, step-by-step account of the procedures followed to engage and collaborate with domain experts, alongside a detailed explication of the assessment scales utilized to measure the key constructs under investigation.

4.5.1.1 Procedure

The expert review for this study was conducted primarily via formal academic emails,an approach selected for its ability to accommodate experts' schedules through asynchronous communication while ensuring a clear, traceable record of all exchanges. The specific procedure unfolded as follows:

i. **Initial Contact:**

An email is sent to qualified experts to gauge their interest in reviewing DSCTS (Appendix A). This serves as the first step in initiating the expert review process.

ii. **Consent and Documentation:**

Interested experts receive a consent form (Appendix C) to formalize their agreement to participate in the review process.

Subsequently, an official appointment letter from UUM (Appendix B) is sent to selected experts to establish their affiliation with the review process.

iii. **Review Instrument:**

Experts are provided with a review instrument (Appendix F), which could include guidelines and evaluation criteria, to aid them in the review process.

iv. **Response Time:**

Experts are typically expected to respond within 3 months after the initial contact, confirming their willingness to participate.

v. **Collection and Analysis:**

Responses from the experts are collected, organized, and summarized to extract meaningful insights and observations.

4.5.1.2 Instrument

This study developed an expert evaluation instrument to assess the feasibility, coherence, and design consistency of the proposed Digital Storytelling for Creative Thinking Skills (DSCTS) model, and its alignment with digital storytelling (DS) prototype development for tertiary art and design education. The instrument was adapted and contextually refined from a validated expert review scale for educational multimedia design model evaluation (Yahaya, 2023), ensuring psychometric rigor and alignment with the core evaluation dimensions of design model assessment (component relevance, element understandability, logical coherence, and readability) established in prior scholarship.

All items of the instrument are explicitly mapped to the original scale by Yahaya (2023), with clear rationale for contextual adaptation to fit the DSCTS model's focus on digital storytelling pedagogy and creative thinking skill cultivation. A detailed item-reference traceability matrix is presented in **Appendix E**, specifying the origin of each item and adaptation rationale for the DSCTS research context. The full version of the expert evaluation instrument, including embedded source citations, scoring criteria, and administrative instructions, is provided in **Appendix F**, enabling full traceability of all instrument components as requested.

To ensure the scientific rigor and psychometric soundness of the adapted expert evaluation instrument (rooted in Yahaya, 2023) for assessing the DSCTS model, a comprehensive validation process of its psychometric properties and evaluation implementation standards was conducted in line with academic norms for educational assessment tools. Multiple core validation dimensions were covered, including content validity, internal consistency reliability, expert reviewer qualification screening, and full instrument transparency disclosure, with all validation outcomes meeting or exceeding the widely accepted threshold criteria in the field. Key validation results are summarized as follows:

- Content Validity: Ensured via iterative expert feedback (pre-test with 5 domain specialists), achieving a Content Validity Index (CVI) > 0.80 for all items
- Reliability: Measured through Cronbach's α ($\alpha = 0.89$) from pilot data, exceeding the 0.70 threshold .
- Expert Authority: Only reviewers with $Cr \geq 0.85$ (calculated via judgment basis and familiarity scores) were included .
- Transparency: Full instrument available in Appendix F, detailing item origins and modifications in Appendix E.

The Expert Review Instrument is shown in **Appendix F**.

4.5.2 Findings of Expert Review

Table 4.7 presents the data from the experts' review. This included the frequency of response (n = 9) regarding the suitability and relevance of the instrument used to retrieve data from the experts. According to Davis (1992), the number of experts is in line with the requirements.

Table 4.7

Responses from Experts

Instrument Items		Responses frequency(n=9)		
Q1. The relevance of learning components proposed are relevant		***Definitely NOT relevant***	***Maybe NOT relevant***	***Relevant***
Learning Theory	Constructivist Learning	0	0	9
	Humanistic Learning	1	2	6
	Cone of Learning	0	1	8
Learning Model	ADDIE	0	0	9
	TPACK	2	1	8
	SAMR	2	2	5
Learning Approach	Multisensory	0	2	7
	Student Centered	0	1	8
	Collaboration	0	2	7
	Interdisciplinary	0	2	7
Q2. The proposed Creative Thinking components are relevant		***Definitely NOT relevant***	***Maybe NOT relevant***	***Relevant***
Person				
Personal Traits	Curiosity	0	0	9
	Open mind	0	0	9
	Ambiguity tolerance	0	2	7
	Risk tolerance	1	1	7
	Emotion	1	1	7
	Motivation	0	0	9
	Reflection	0	1	8
Personal Knowledge	Domain knowledge	0	0	9
	Interdisciplinary knowledge	0	0	9
Process				
Task Setting	Real-world problem	0	1	8
	Task-oriented	0	1	8
Process Specification	Autonomous exploration	0	1	8
	Mind wondering	1	1	7
	Collaboration	0	1	8
	Scenario and visual representation	0	2	7
Press				
Supportive Environment	Encouragement and flexible atmosphere	0	0	9
	Authentic situations	0	2	7
Mentoring	Encouragement	0	0	9
	Assistance	0	1	8
	Feedback	0	0	9

Table 4.7 *continued*

Q3. The development process of the DSCTS is clear		***Need further detail explanation***	***Need some explanation***	***Relevant***
Pre-production				
	Identify learning objective	0	0	9
	Scope subject domain	0	0	9
	Introduce learning approaches	0	1	8
Content Analysis	Demonstrate and analyze of paradigms	1	0	8
Story Design	Begin	2	1	6
	Middle	2	1	6
	End	2	1	6
Script Writing	An engaging storyline	0	0	9
	A point of view	0	4	5
	Emotional content	2	3	4
	Role of narrator	0	4	5
Checking & Refining	Intra-group checks and discussions	0	0	9
	Feedback and assistance from instructors	0	0	9
Storyboarding	Visualization and scenarios	0	1	8
	Montage of iconic multimedia elements	0	1	8
Production				
	Text	0	1	8
	Audio	0	2	7
	Graphic	0	1	8
	Video	0	1	8
	Animation	0	2	7
Post-Production				
	Editing	0	1	8
	Adding effects	0	3	6
Distribution				
	Share in classroom	0	2	7
	Question & answer	0	1	8
	Discussion and feedback	0	3	6
	Refine	0	1	8
	Upload to website and platform	0	3	6
	Check and reply comments	0	3	6

	Yes	*No*
Q4. The term use is easy to understand.	9	0
Q5. The relationship and flows of all components and sub-components are logical.	8	1
Q6. Overall, the design model is readable.	7	2

Note: Q = Question ADDIE = Analysis, Design, Development, Implementation, Evaluation. TPACK= Technological Pedagogical Content Knowledge. SAMR = Substitution, Augmentation, Modification, Redefinition.
DTCTS = Digital Storytelling for Creative Thinking Skills

As evidenced by the data presented in the Table 4.8, the majority of experts concur that the proposed model comprises relevant components, subcomponents, and elements. Furthermore, the model's flow is both clear and logical, and its terminology is straightforward and comprehensible. Overall, the model holds significant theoretical and practical value. However, some experts suggested that certain terminology required further clarification and expressed uncertainty about the inclusion of some elements. Notably, there was considerable redundancy surrounding the production process stage. Furthermore, the experts provided comments on the model based on their professional expertise and experience. Table 4.8 lists the experts' comments.

Table. 4.8

Feedback from Experts

Expert	Sections	No.	Comments & Feedback
A	Learning theories/ Humanistic Learning	1	Humanistic learning can be relevant in digital storytelling under specific conditions, particularly if the activity is carried out individually and tasks emphasize self-expression.
	Learning Model/ SAMR	2	In my experience, the SAMR model is not particularly relevant to DST. In DST, the focus is not on substituting, augmenting, modifying, or redefining, but on creating a communicative artifact using multimedia technologies. As to learning approach, the four approach can be included into one.
	Person/ Ambiguity tolerance	3	I would need to understand better what is meant, but I do not see the ability to tolerate ambiguity as being closely connected to DST.
	Process/Mind wondering	4	I'm not clear about what you mean with this.
	Press/ Authentic situations	5	Depends on the instructional design.
	Press/ Assistance	6	Depends on the students' age.
	Pre-production/ Introduce learning approaches	7	Do you mean that in the development process you need to introduce students to the learning approaches used?
	Pre-production/ Demonstrate and analyze of paradigms	8	Unclear.
	Pre-production/ Emotional content	9	Some stories can be "documentary" style.
	Pre-production/ Role of narrator	10	Especially with multiple students collaborating, the "narrator" may not exist".
B	Learning theory	1	These theories provide theoretical frameworks that

Table 4.8 *continued*

		align with the active, experiential, and student-centered approach advocated by the model. However, try to include multimedia learning theory to this model since it involved Digital Storytelling.
Learning model/ SAMR	2	The SAMR model can help ensure that technology integration in DSCTS goes beyond mere substitution and truly enhances the learning process, aligning with the model's goal of leveraging digital storytelling to foster creative thinking skills.
Learning approach/ Multisensory	3	Incorporating multimedia elements (e.g., images, audio, video) into digital storytelling projects can appeal to various learning styles and preferences, making the learning experience more inclusive and effective. However, all of the above are embedded in a learning approach based on a digital storytelling project, and therefore it is recommended that they be merged in order to keep the model concise.
Learning approach/ interdisciplinary	4	It will cause confusion if multidisciplinary approaches are use in digital storytelling since each discipline has unique perspective and guidelines.
Personal traits	5	These creative thinking components are essential for nurturing students' creative potential, fostering innovation, and promoting deeper learning in the context of digital storytelling. By integrating these components into the design model of DSCTS, educators can create a supportive and enriching learning environment that empowers students to develop their creative thinking skills and express themselves authentically through storytelling.
Personal Knowledge	6	Both relevant because it provides a solid foundation for digital storytelling projects, enabling students to create authentic, engaging, and intellectually stimulating narratives that reflect their understanding.
Process	7	Clearly defining the steps and processes involved in digital storytelling projects can help students understand and navigate the creative process more effectively, promoting systematic thinking and organization.
Press	8	Providing guidance, support, and mentorship from knowledgeable instructors or peers can help students develop their creative thinking skills by offering valuable feedback, insights, and encouragement.
Creative thinking components	9	Overall, each of the listed items is relevant to the process of promoting creative thinking skills through digital storytelling, as they contribute to creating a conducive and supportive learning environment that encourages exploration, collaboration, reflection, and innovation.
Pre-production	10	Overall, each of these elements are relevant and plays a crucial role in the development process of digital storytelling project within the DSCTS model, contributing to the creation of engaging, meaningful, and impactful narratives that foster students' creative thinking skills and understanding of the curriculum.
Production	11	Need to specify what type of text, graphic, animation, such as 2D/3D.
Post-production/ Editing	12	Need to be clear what editing involved in this phase.
Post-production /Adding effects	13	Effect in term of what? At least put some explanation about the effect for digital storytelling.

Table 4.8 *continued*

	Distribution	14	The distribution section are clear and relevant to be included in the design model.
	Overall	15	1. The first item is confusing. What does it mean by All Relevant. Just put "Relevant is enough." 2. Please improvise the flow and the arrangement of the production, post-production, and distribution in the development process section. (Interface Layout). 3. Consider incorporating a more robust assessment framework into the design model. This could include both formative and summative assessment methods tailored to evaluate students' creative thinking skills, storytelling abilities, and content understanding throughout the digital storytelling process.
C	Learning components/ Learning theory	1	Is the developer need to integrate all this learning theories or has option?
	Learning model/ SAMR/TPACK	2	Is the developer need to integrate all this learning approaches or has option?
	Creative Thinking Components/ Press	3	what do you mean by Press in the context of this study?
	Creative Thinking Components/ Press Development Process Over all	4	All components are acceptable.
D	Learning theory/ Constructivist Learning	1	Indicate which Constructivist Learning that this study is referring. Consider adding cooperative learning theory.
	Learning theory/ Humanistic learning	2	The learning theory focus on the psychology aspects of students. Should make it clear in terms of its application of this study or it may not be relevant. Consider about design thinking as learning model. Should focus on project-based learning to enhance the learning experience.
	Creative thinking components/ Personal traits	3	Consider rule breaker personal traits in order to get outstanding creative thinking.
	Creative thinking components/ process	4	Brain storming? How to consider those who are introvert?
	Pre-production/ Story design	5	It is not clear to use those terms.
	Pre-production/ Emotional content	6	Why emotional content?
	Distribution	7	List distribution channel and platform.
	Overall	8	Creative thinking components should be included CT tools to stimulate students CT and ideation process. Creative thinking model should be part of process in order to govern the thinking process.
E	Learning model/ SAMR	1	Not sure
	Learning approach	2	Focus on project-based learning, and can combine the four approaches together. The connections and flows of all components are logical, but need detail explanation.
	Distribution	3	The steps involved in this phase are complex and may cause confusion. It is recommended to focus on and list only the core and essential steps to ensure clarity and efficiency in the process.
	Overall	4	The model is usable to the development of students' creative thinking skills

Table 4.8 *continued*

			Overall, the conceptual model is readable but need more explanation.
F	Press	1	Need further explanation for the term "Press".
	Pre-production/ Scope subject domain	2	Scope of subject domain.
	Pre-production/ Role of narrator	3	Need further explanation.
	Overall	4	Term Press - not all may understand the meaning of this term in the context of your study. Provide the figure in this form, much easier to refer. Rearrange the figure to make it clear and easy to understand.
G	Learning model/ TAPCK	1	Overlap?
	Learning model/ SAMR	2	How?
	Production/ Audio	3	Not a necessity.
	Production/ Animation	4	Not a necessity.
	Overall	5	The model is innovative in its integration of creative thinking components into the creative process of digital storytelling. however, some terminology needs to be further clarified and some items need to be merged to make the model clearer and more concise. The relationship between the three modules is proposed to be modified 1.The "integration", with 'refer to' replaced by "integration", based on the proposed model of integrating learning and creative thinking components into the process of digital storytelling development. "is more appropriate. 2. The connection between the Learning Components and Creative Thinking Components was revised from "Consist" to "Complementary."
H	Learning theories/ Humanistic Learning	1	Humanistic learning aims to develop the whole person, but creative thinking is only one of the aspects.
	Learning theories/ Cone of Learning	2	Does it involve active participation and application of knowledge?
	Learning model/ TAPCK	3	One model is enough.
	Learning Model/ SAMR	4	Confusing.
	Learning Approach/ Multisensory	5	Digital storytelling is inherently multi-sensory learning, and this is a bit repetitive?
	Learning Approach/ Student Centered	6	All features are related, but all fall under the umbrella of project-based learning.
	Person/ Emotion	7	Does the process of learning knowledge require emotional engagement?
	Process/Mind wondering	8	Is it because of unclear study goals?
	Pre-production/ Story Design/ Begin/ Middle/ End	9	Not clear
	Production/ Text / Audio/ Graphic/ Video/ Animation	10	Do all these elements have to be present at the same time? Need further explaination.
	Overall		It can be seen that this model incorporates a great deal of effort from the researcher, however, from my

Table 4.8 *continued*

			perspective there are the following problems: 1). The three proposed learning theories support the proposed model from different perspectives, but they are not comprehensive enough, since it is based on the new media of DS, why is there no incorporation of multimedia cognitive theory? Since it is project-based learning, why is it not supported by co-operative learning principles? 2). A model can be supported by more than one principle, but it is better to have only one learning model, otherwise it will cause confusion. Suggest keeping one is sufficient. 3). The process of creating digital storytelling is too complex and needs to be clear.
I	Person/ Emotion	1	A little bit confusing.
	Post-production/ Adding effects	2	Is this a compulsory element?
	Overall	3	The model incorperates learning components and the creative thinking components into the developmental process of digital storytelling in an innovative way. It is suggested that the model could be simplified and optimised to make it easier for practioners to follow.

The Table above shows that the experts evaluated all three modules of the proposed model in a specific and detailed way and gave suggestions for modifications. Based on their evaluations, the proposed DSCTS conceptual design model was identified to have issues in the following three key areas:

- **Learning Component Module**

The experts indicated that the theoretical foundations of this module required enhancement. While constructivism, humanistic learning theory, and the cone of experience were acknowledged as core theoretical bases, some experts recommended incorporating collaborative learning and multimedia learning principles. However, to maintain the model's clarity and usability, it was advised that these additional principles be implicitly embedded rather than explicitly illustrated.

Furthermore, the learning model itself was deemed overly complex. Experts suggested removing the TPACK and SAMR frameworks and retaining only the ADDIE model to reduce cognitive load and improve practicality for educators.

Regarding learning approaches, while multisensory, student-centered, collaborative, and interdisciplinary methods were integrated, experts E and H recommended consolidating these under a unified project-based learning framework to avoid redundancy and strengthen conceptual coherence.

- **Creative Thinking Component Module**

Several conceptual and terminological terms were raised concerning this module. Expert D proposed incorporating "rule breaker" as a personal characteristics element, supported by evidence that rule-breaking can foster innovative thinking (Petrou, Linden, & Salcescu, 2020).

Additionally, the term "press" caused confusion due to its non-standard usage within the model. It was suggested that its meaning, referring to external influences on creativity such as environment, interpersonal relations, and training, be clearly explained within the diagram.

The element of "encouragement" was also flagged as redundant, since it appeared both within the supportive environment and mentor subsections. Its removal was recommended to improve terminological precision and structural clarity.

- **Development Process**

The four-stage DS-based framework (Pre-production, Production, Post-production, Distribution) required simplification and operational refinement.

During Pre-production, elements such as “case demonstration” and “emotional content” were considered superfluous and were recommended for removal. Experts also advised merging “story design” and “scriptwriting” into a single element to reduce complexity. The interface layout was suggested to be reorganized for better usability.

For the Production stage, experts recommended incorporating two-dimensional and three-dimensional element types. The Post-production phase was advised to include preview and optimization functionalities. The Distribution stage was considered in need of simplification to streamline the overall workflow.

Finally, experts emphasized that the development process should allow reversibility between stages, supporting an iterative and cyclic learning process consistent with Design Science Research (DSR) principles, thereby facilitating continual improvement in students’ creative and cognitive abilities.

Overall, the professional and meticulous reviews conducted by these experts provided crucial basis for further optimizing the proposed DSCTS model. The specific justification and enhancements are presented in the Table 4.9.

Table 4.9.

Justification and Modifications for DSCTS

Expert	No	Justification and Enhancements
A	1	Although the creation of digital storytelling in this study was done collaboratively in groups, Humanistic Learning is still applicable. This is because the intra-group division of work respects individual differences, promotes personalised development, and strengthens communication and collaboration, enhances a sense

Table 4.9 *continued*

		of responsibility and teamwork, and ultimately improves students' overall quality and creativity.
	2	Accept the suggestion to remove SAMR.
	3	"Ambiguity tolerance" is explained in Chapter 4 as an element of developing students' creative thinking skills. In digital storytelling, ambiguity tolerance means that creators are able to embrace and deal with uncertainty and ambiguity in the creative process, such as multiple possibilities of plot development and complexity of characterization. This ability facilitates the flow of creativity and enhances the richness and depth of the story.
	4	This term is explained in Chapter 4. Since what is presented to the expert is only the model and basic information, it may cause some confusion. In the process of developing creative thinking skills, "mind wandering" can typically be understood as a state of mental drifting or wandering thoughts. It has multiple roles, such as stimulating new ideas, facilitating subconscious processing, enhancing problem-solving skills, boosting creativity and imagination, and promoting emotional regulation and mental health. To integrate mind wandering into digital storytelling, it needs a relaxed environment, stimulate the starting point of creativity, run through the whole process of creation, encourage reflection and summarisation, and enhance creative thinking skills through practice.
	5	This study was carried out based on an actual project, so the learning environment was authentic.
	6	This study was carried out on art and design students in their third year of university, who already have some digital technology skills. However, in the process of creating project-based digital storytelling works, they often encounter some confusion, such as how to present the chosen theme, how to obtain valuable materials, and how to carry out effective field research, all of which require the teacher's advice and assistance.
	7	Yes, the instructors need to tell the students the dos and don'ts to ensure that they don't deviate from the topic on the one hand, and on the other hand, that this is different from ordinary digital storytelling, but a project-based model of digital storytelling that incorporates elements of creative thinking.
	8	This is a key part of the process, and by analysing and explaining typical cases, students can make clear what essential features are present in a compliant piece of work. Every teacher naturally performs " introducing learning pproaches"and "Demonstration and analysis" sections before a course begins, so including them in the model is unnecessary and may cause confusion. ● Agree to remove points 3 and 4 from the content design.
	9	● Delete the component "emotional content". There are indeed digital storytelling works in the documentary genre. This is a genre that cannot be ignored for project-based digital storytelling.
	10	● Delete the component "role of narrator". While the narrator can augment the compelling nature of digital storytelling, it isn't a compulsory factor.
B	1	This suggestion is valuable and the inclusion of multimedia learning theory further strengthens the theoretical basis of this study.
	2	Agree.
	3	● Accept the recommendation to integrate multi-sensory, student-centered, collaborative, interdisciplinary into project-based learning approaches.
	4	Educational digital storytelling combines professional knowledge with interdisciplinary skills, such as linguistic expression and digital technology, and it is closely integrated with the specific content, creating interactions with other domains. In short, no knowledge from any discipline can exist in isolation, and this is even more evident in educational digital storytelling.
	5/6/7/8/9/10	Agree.
	11	This suggestion covers the types of text, images and animations that can make multimedia elements more comprehensive. ● Complementing the types of text, images and animation, i.e. **2D/3D**.

Table 4.9 *continued*

	12	Editing is the process of selecting, choosing and combining the collected and created materials according to the content of the script, and finally producing a coherent and smooth work. The details of what is involved are described in detail in Chapter 4.
	13	Digital storytelling enhances the visual and auditory experience by adding effects that make the story more vivid and emotionally rich. For example, animation effects can be added to text or pictures, including movements such as zooming, rotating, and fading in and out. These effects are all related to digital technology and cannot be conveniently demonstrated in a static model. And the explanation is in Chapter 4. The reason for the confusion is that the session is missing one of the core aspects of post-production, the overall preview and adjustments.
	14	Yes, but the steps were optimized in conjunction with Expert E's recommendations.
	15	● The renamed “All Relevant” by “Relevant”. ● Based on the recommendations, the interface layout of the processes and arrangements for the production, post-production and distribution parts of the development process have been optimised. ● Chapter 4 of this study is dedicated to creating a prototype based on the model and evaluating its effectiveness. The evaluation methodology was tailored to the specifics of the study rather than a one-size-fits-all approach, so the model itself is not described in detail.
C	1	The response to the two critiques is that all of these learning theories and models are the theoretical underpinnings that support this study. As the outcome of this study is itself a learning framework for developing students' creative thinking. And the establishment of the framework requires the extraction of supporting elements from the various pre-existing theories and models, which provide resources and foundations for the establishment of the proposed model. These principles and models are demonstrating the basis for the construction of the proposed learning framework.
	2	• Accept the suggestion to remove the secondary learning models “TPACK” and “SAMR”. It would be confusing to put these three learning models together; the TPACK and SAMR models emphasize the role of technology in the learning process, whereas the learning model is mainly based on ADDIE; therefore, ADDIE is retained.
	3	In conjunction with Expert B's recommendations, incorporating all of these learning approaches into the project-based learning approach This comment is in line with Expert F's query. Although this term has been explained in detail in Chapter 4, it is unrealistic to make the details of this study clear to everyone. Therefore, in order to facilitate the use of the model by developers, the proposed model is refined. ● The "Press" would be annotated in the figure of the proposed model.
D	1	This review is based on the fact that the expert was only informed about the model and gauges of the study, which is a result of the incomplete information shared by the researcher to the expert. The scope of constructivist theory in the study highlighted by Expert A has been covered in Chapters 2. However, in order to ensure the comprehensibility of the model, this study only retains constructivism as the theoretical foundation for education.
	2	Humanistic Learning emphasises the importance of intrinsic motivation, self-motivation, self-awareness and self-actualisation of the learner. These attributes are the key theoretical underpinnings of this study and are explained in Chapter 4. This is an insightful suggestion. However, the design science research methodology used in this study overlaps to some extent with design thinking, which is embedded throughout the model and is therefore not singled out in the creative thinking element. ● To ensure the readability of the model, all educational principles will no longer be included in it. Multi-sensory, student-centred, collaborative and inter-disciplinary are learning approaches that are well represented and applied in project-based learning based on digital storytelling. These learning styles complement and reinforce each other, and together they form an effective, interesting and challenging way of learning. Therefore, considering the simplicity of the model, these approaches are merged into the digital storytelling project-based learning approach.

Table 4.9 *continued*

		● Combine these learning styles into: Project-based learning.
	3	● Responding to the suggestion to add a new element, “Rule breaker”. The necessity of this element was reconfirmed by reviewing the sources. People with the personality traits of a Rule breaker are often able to think outside the box, are adept at trying new things, and use innovative ways to validate ideas through practice, thus driving creativity to fruition. ● Adding personal traits element: Rule breaker.
	4	In response to this comment, “Brain storming” is one of the important elements of the process specificity. ● Adding process specification element: Brainstorming. In order to actively engage introverts in the process, the following strategies are used: create a safe atmosphere, provide opportunities for advance preparation, use group discussions, encourage written contributions, actively listen to feedback, and set clear rules for goals. These techniques will be used throughout the process to ensure that students are fully engaged.
	5	Since these terms are often used by screenwriters, they seem a bit abrupt here. And more than one expert has given feedback that separating script story design from scripting is too finely divided and can cause unnecessary problems for newcomers. So, to avoid confusion, story design and script writing have been combined into one step. ● Combine “story design” and “script writing”.
	6	In this study, "emotion" differs from its everyday meaning. It serves as a core driver of intrinsic motivation in “humanistic learning” and as a “personal trait” in creative thinking. The appeal of digital storytelling lies in its power to evoke emotions, inherently embedding emotional factors in the creative process. As with the question posed by Expert A, the necessity of deleting this element is evident.
	7	In this study, storytelling works were posted on the platform named “Superstar Learning”. However, this platform is only open in mainland, China and does not have wide significance. Therefore, the name of the platform was not specified. Each region can choose the appropriate platform to publish according to the actual situation.
	8	An in-depth analysis of the Creative Thinking Skills Model has been done in Chapter 4. The components shown in the proposed model were extracted from several classical models, which contain techniques, processes, etc. of creative thinking.
E	1	This query by Expert E is consistent with Expert A's second comment.
	2	● Delete “SAMR”and “TAPCK”. The response to this suggestion is twofold: firstly, due to the limited information given to the experts, it may lead to confusion for some of the terms that have already been explained in Chapters 2 and 4; and secondly, for some of the terms that differ from their literal meanings, such as "Press", this study accepts the experts' suggestion to explain them in the figure as necessary.
	3	● Recommendation accepted. Streamline and reorganize the steps in the release phase, retaining only the core steps.
F	1/4	The term "Press" is explained in Chapter 4. However, due to its specificity, it is annotated in the figure. The layout of the figure will also be refined in accordance with expert advice.
	2	The researcher ignored this grammatical error to keep the scale neatly formatted. ● Correction: Adding “of” in the Instrument Scale, ie, Scope of subject domain
	3	● Delete the component “role of narrator”. As the expert A commented, while the narrator can augment the compelling nature of digital storytelling, it isn't a compulsory factor.
G	1	I accept your suggestion. Indeed, there is some overlap among the ADDIE, TPACK, and SAMR models. While TPACK and SAMR can emphasize certain technological dimensions of the model, to ensure greater clarity and simplicity, I will retain only the ADDIE learning model. • Correction: Removing TPACK and SAMR.
	2	Following your feedback to reduce potential confusion, I have removed the SAMR model from the proposed conceptual framework. This streamlines the design and ensures clarity by focusing on more distinct, non - overlapping components to underpin the digital storytelling - based creative thinking skills development.

Table 4.9 *continued*

	3	The research emphasizes that collaboration and communication skills are integral to fostering students' creative thinking and innovative capabilities. For instance, group - based brainstorming sessions can spark more inspirations and innovative solutions. While individual project completion is permitted, this study strongly encourage students to engage in collaborative approaches. This aligns with the goal of nurturing not only creative thinking but also teamwork competencies essential for innovative talent development.
	4	You are absolutely correct, audio and animation are not mandatory components of DS. For instance, silent films or documentary - style narratives may forego sound or animation entirely. In the proposed model, these elements are presented as **optional creative tools** rather than requirements. Creators retain full discretion to select, adapt, or exclude production components based on their project's thematic goals, artistic vision, and contextual needs. This flexibility ensures the framework accommodates diverse storytelling modalities while empowering students to make intentional, context - driven design choices.
	5	• Correction: Change to "Integration" (from "Refer to") to reflect how learning/creative thinking blend with digital storytelling. Revise Learning↔Creative Thinking connection to "Complementary" (from "Consist").
H	1	You're right that humanistic learning targets whole - person development, with creative thinking being just one aspect. In the proposed model, humanistic principles create an environment that respects student autonomy and nurtures intrinsic motivation, which are crucial for creative risk - taking. While it focuses on enhancing creative thinking skills, humanistic learning also supports the development of self - awareness, empathy, and collaboration. These broader competencies indirectly boost creative thinking by fostering the conditions necessary for creative expression. Thus, humanistic theory both guides whole - person growth and specifically promotes creative thinking development.
	2	Absolutely. The Cone of Learning, as proposed by Dale (1969), emphasizes active participation and knowledge application. The theory posits that learning experiences at the base of the cone, including real - life task performance and simulated experiences, outperform passive methods like lectures. These hands - on activities enhance knowledge retention and enable practical application. In our study, we leverage this principle to design learning activities. For example, students actively engage in digital storytelling projects, applying theoretical knowledge to foster creative thinking, which aligns with the theory's core tenet that active learning promotes better understanding and practical use of knowledge.
	3/4	Combining the opinions of the previous experts, the proposed model removes TPACK and SAMR and retains only ADDIE.
	5/6	The elements of multisensory learning, student - centered approach, collaboration, and interdisciplinary integration have been merged under the overarching concept of project - based learning. As discussed in chapter 2, these components are inherently embedded within the process of project - based learning. This streamlining not only addresses the redundancy concern but also strengthens the theoretical coherence of our learning approach, ensuring that all aspects of the design are more systematically aligned and clearly presented. • Correction: Merge the multisensory learning, student - centered approach, collaboration, and interdisciplinary under the overarching concept of project - based learning.
	7	Yes, emotional engagement is crucial. As highlighted in humanistic learning theories, emotional investment drives active participation in knowledge acquisition. In the DS - based project - based learning, storytelling inherently evokes students' emotions, which in turn sparks learning motivation and fosters deeper engagement with the content. This emotional connection aligns with the principle that meaningful learning occurs when it resonates with learners' affective states.
	8	The "Mind Wandering" element in the Creative Thinking Component is not due to unclear study goals. Instead, it is a deliberate cognitive strategy that encourages students to step outside their current frame of reference, relax their minds, and examine problems from different perspectives. This process stimulates creative thinking, enabling students to approach problem-solving in innovative ways. Mind

Table 4.9 *continued*

		wandering is supported by educational theories like constructivism and humanistic learning, as well as the Cone of Learning, which emphasize active participation and personal reflection. Thus, it is an essential part of fostering creative thinking skills.
	9	The "Pre-production/ Story Design/ Begin/ Middle/ End" structure refers to the typical components of story content design. While it is common knowledge that stories generally include these three parts, incorporating them into the design principles can make the framework appear overly detailed and cluttered. To emphasize the creative thinking elements more effectively, the structure has been revised to focus on "A well-defined Topic" and "An Engaging Storyline." This modification allows for a more streamlined and focused approach to DS, highlighting the importance of creative thinking in the initial stages of story design. By concentrating on selecting an interesting topic and developing an engaging plot, students can better utilize their creative thinking skills to produce compelling digital stories. This approach aligns with the overall goal of fostering creative thinking skills through digital storytelling projects.
	10	These elements are not required to be present simultaneously in every DS project. Instead, they are optional components that can be selected based on the specific needs and context of each project. The inclusion of these elements is flexible and can be tailored to suit the learning objectives, content requirements, and resources available. For instance, a project may focus primarily on text and audio elements if the story is more narrative-driven and requires minimal visual components. Conversely, a project that aims to create a more immersive and dynamic experience may incorporate graphics, videos, and animations to enhance visual engagement. This flexibility allows educators and students to adapt the digital storytelling process to various scenarios and learning goals. By providing a range of options, the model supports creativity and innovation, enabling students to explore different forms of expression and storytelling techniques. This approach aligns with the principles of constructivist and humanistic learning, which emphasize student-centered and personalized learning experiences.
I	1	Several experts have raised questions about the role of "emotion" in the learning process, and it is crucial to address this concern. I have to clarify that this refers to emotional investment rather than emotional instability. While the process of learning knowledge is indeed a rational process, it is not solely driven by rationality. Human beings are not machines; they are complex entities with both cognitive and emotional dimensions. The inclusion of "emotion" in the learning process acknowledges the importance of emotional investment in fostering effective learning and creative thinking. When learners are emotionally engaged, they are more motivated, focused, and open to new ideas. This emotional investment can lead to increased creativity, as learners are more likely to explore different perspectives and think outside the box. Positive emotions can create a supportive and encouraging learning environment, which is conducive to the development of creative thinking skills.
	2	This is not a compulsory element. The inclusion of effects such as fades in and out, or even visual effects like rain, thunder, and lightning, is optional and can be added based on the specific needs and context of the project. The decision to add effects also depends on the students' digital technology skills. Students with more advanced skills may choose to incorporate more complex effects, while others may opt for simpler ones. The flexibility in adding effects allows for a personalized and creative approach to DS, catering to the diverse abilities and preferences of students.

In conclusion, through expert validation and systematic revision, the DSCTS model has achieved significant enhancements in theoretical completeness and professional depth. By synergistically optimizing core dimensions, including learning elements, creative thinking cultivation mechanisms, and the DS production process, this study has established an iterative framework characterized by both theoretical rigor and practical applicability. The revised model demonstrates breakthrough progress in structural clarity and logical coherence, with its comprehensibility and acceptability substantially strengthened.

4.5.3 Validated Conceptual Modal of DSCTS

Based on expert feedback, this study revised the proposed model, resulting in the refined the proposed DSCTS conceptual model. The model comprises three core modules: Learning Components, Creative Thinking Components, and the Project-Based Digital Storytelling Development Process.

i. Module Relationship

This module outlines learning theories, learning models, and learning approaches, which provide robust support for the creation process. Experts raised concerns about the ambiguity of the term "Refer," and the revision to " Integrated" clarified the relationship significantly.

The relationship between the Creative Thinking Components and the Development Process modules was also refined. It was revised from "Refer" to "integrated," highlighting the incorporation and application of creative thinking components within the development process.

The connection between the Learning Components and Creative Thinking Components was revised from "Consist" to "Complementary." This change reflects their parallel nature as mutually reinforcing components that collaboratively advance the development process.

ii. Refinements to the Learning Model and Approach

The original three learning models, ADDIE, TPACK, and SAMR, were streamlined into a single framework, ADDIE, based on expert recommendations. The ADDIE model was deemed comprehensive and well-suited for integration within the DSCTS framework.

Additionally, the study consolidated the four original learning approaches, multisensory, student-centred, collaborative, and interdisciplinary, into Project-Based Learning (PBL). For conceptual clarity, the DSCTS model specifies PBL as its primary learning approach, as it effectively encompasses the aforementioned approaches.

iii. Simplification of the Development Process Module

To enhance clarity and streamline activities within the Development Process module, adjustments were made to better reflect the roles of the Learning Components and Creative Thinking Components. For instance, "Story design" and "Script writing" were merged into a single module, and the flow of relationships between modules was clearly defined. To emphasise the importance of the DSR methodology in the overall study, an iterative relationship diagram was incorporated into the creation process.

Figure 4.5 shows the revised conceptual DSCTS model which has been adjusted based on expert comments. Elements have been added, terms annotated and redundancies removed. The layout of the model has also been adjusted.

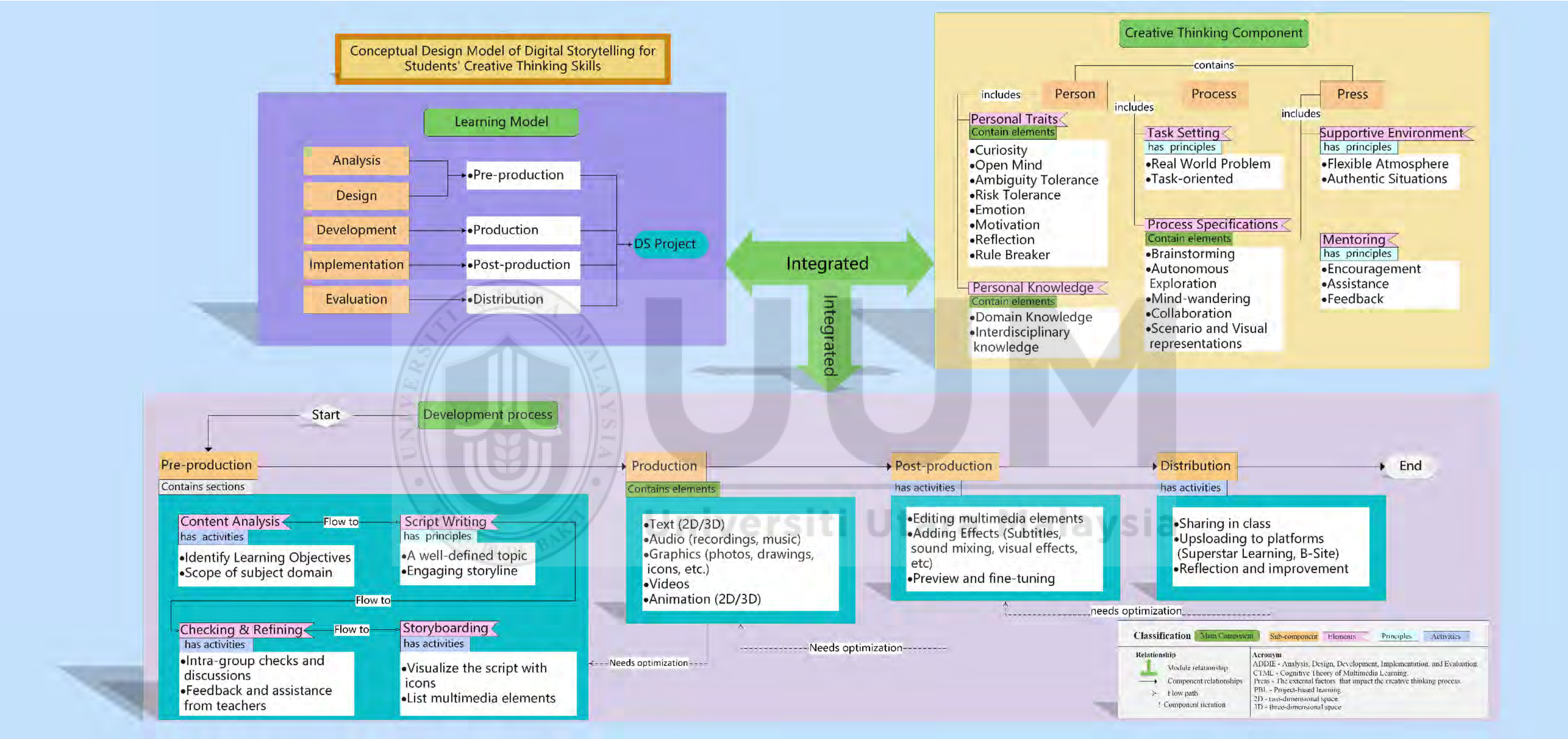


Figure 4.5. The Revised DSCTS Conceptual Design Model

4.6 The Design Principles and Implementation Guidelines of DSCTS Model

The proposed DSCTS model integrates learning principles and creative thinking components into a structured digital storytelling production process. As all elements are embedded within course-based DS projects, their effective implementation requires clear design guidelines. The framework is organized around five core design principles that collectively ensure the model's pedagogical effectiveness: (1) **Curriculum Integration Principle** ensures DS activities maintain strong alignment with course objectives and disciplinary content; (2) **Multimodal Engagement Principle** leverages diverse media formats to support cognitive processing and creative expression; (3) **Scaffolded Creativity Principle** provides structured support that progressively builds student creative capacity; (4) **Collaborative Ideation Principle** fosters social learning environments that enhance creative thinking through peer interaction; and (5) **Iterative Refinement Principle** establishes continuous improvement cycles that develop metacognitive skills.

Since all elements of the DSCTS model are embedded in the **development process of DS** artifacts built on course content, these principles translate into concrete implementation guidelines (shown in Table 4.10) that provide instructors with actionable strategies for integrating the proposed conceptual model into their course design.

Table 4.10

The Design Principles and Implementation Guidelines of DSCTS Model

Phase	Elements	Design Principle	Operational Description	Theoretical Sources
Pre-production	Content Analysis	Curriculum Integration	Define multi-dimensional learning objectives encompassing core knowledge, contextual understanding, critical skills, and practical relevance; Establish content scope, curate resources, clarify assessment criteria, and facilitate inclusive group formation	Poonsawad et al., 2022; Tshering & Dorji, 2022
	Script Writing	Scaffolded Creativity	Generate and evaluate topics for alignment with learning goals and narrative potential; Develop structured, content-rich narratives through guided writing processes	Gong et al., 2022; Lambert, 2018
	Checking & Refining	Iterative Refinement	Conduct cyclical peer and instructor feedback sessions to iteratively improve script quality and content alignment	Sharda, 2005
	Storyboarding	Multimodal Engagement	Convert textual narratives into visual sequences using montage techniques; Create comprehensive multimedia resource inventories	Quah & Ng, 2022
Production	Multimedia Elements Sourcing	Multimodal Engagement	Collect copyright-compliant resources from diverse sources; Create original content through photography, computer graphics, and AI-generated content	Robin, 2008; Yang, Yang, & Tong, 2023
	Multimedia Elements Classification	Curriculum Integration	Systematically organize resources by type (text, audio, visual, video, animation) to ensure coherent instructional integration	Lambert, 2017
Post-production	Editing & Effects	Multimodal Engagement	Arrange multimedia elements according to storyboard sequences; Enhance narrative clarity through subtitles and visual/audio effects	Ramamurthy, 2021
	Preview & Fine-tuning	Iterative Refinement	Conduct multiple review cycles incorporating instructor and peer feedback to progressively refine the final product	Meadows, 2010
Distribution	Dissemination & Reflection	Collaborative Ideation	Showcase projects through classroom "story circles" and digital platforms; Facilitate reflective discussions and implement feedback for future improvements	Deardorff, 2020; Jitsupa et al., 2022

4.7 Applying DSCTS through Prototype Construction

In this research phase, this study employs a comprehensive analytical framework to incorporate the core components of the DSCTS model into the design of a prototype course for "*Introduction to Folk Art*", structured as an eight-week programme. Emphasis is placed on seamlessly combining learning components with creative thinking components in the production process of DS projects. The choice of "*Introduction to Folk Art*" as the implementation carrier is fundamentally driven by the course's representativeness. This is attributable to the fact that nearly every academic discipline offers introductory courses.

In the traditional lecture-based teaching model, instructors often dominate, while students passively receive information. This one-way transmission method limits the deepening and broadening of learning outcomes and hinders the development of student initiative and creativity (Frame, et al., 2015). The proposed DSCTS conceptual model aims to fundamentally disrupt this traditional model by creating a student-centered, project-based learning environment, transforming students from passive knowledge recipients to active explorers and creators. In this framework, the learning objectives extend beyond mere knowledge acquisition to stimulating students' motivation for active learning, promoting their exploration of the unknown, integrating knowledge, and presenting learning outcomes in a creative and engaging manner. Specifically, the core features of the DSCTS-driven "*Introduction to Folk Art*" prototype are:

- **Role Transition:** The teacher's role shifts from a knowledge transmitter to a learning facilitator, encouraging students to independently discover and solve problems, thus fostering their independent learning and CTS.

- **Task-Oriented:** Around the core topics of folk art, a series of challenging and interesting project tasks are designed to guide students in deeply exploring course knowledge while achieving an organic combination of theory and practice.
- **Innovation Thinking Stimulation:** By introducing design thinking, innovation thinking tools, and methods such as brainstorming, students are guided to exercise their CTS in problem-solving, stimulating their creativity and imagination.
- **Fun and Creativity Integration:** Emphasizing the fun of the learning process and the creativity of the outcomes, students are encouraged to present their learning outcomes in multimodal forms, making the learning process enjoyable and fulfilling.

In this study, seven prototypes have been produced based on the proposed DSCTS model. The design principles of creating these prototypes has been explained in detail in the previous subsection. This section will focus on a representative prototype, titled "*The Rhythm of Grass-Hammering Painting,*" to analyse how the components of the DSCTS model were effectively integrated into the course "*Introduction to Folk Art*". The goal is to create a learning environment that is both deep and engaging, ultimately enhancing learning outcomes and fostering innovation.

4.7.1 The Learning Components

The learning components underpinning the proposed DSCTS model are intentionally streamlined to three core elements, constructivist learning theory (the theoretical foundation), the ADDIE model (the instructional design framework), and Project-Based Learning (PBL) (the pedagogical approach). These components are mutually reinforcing, ensuring the model's theoretical rigor, structural coherence, and practical relevance to the integration of project-based DS with the course "*Introduction to Folk Art*".

4.7.1.1 The Learning Theory

The DSCTS model is theoretically anchored exclusively in constructivist learning theory, which posits that knowledge is not passively transmitted but actively constructed by learners through the integration of new experiences with existing schemas (Efgivia et al., 2021; Duffy & Jonassen, 1991). This theory aligns inherently with the model's goal of fostering students' CTS while achieving course learning objectives, as it prioritizes learner autonomy, experiential exploration, and knowledge co-creation.

In the DSCTS model, constructivist principles are operationalized through students' hands-on engagement in DS project development. Students are not merely recipients of course content (e.g., concepts in folk art) but active creators: they independently research topics, develop scripts, and integrate personal insights, emotions, and prior knowledge into their DS projects. For instance, in the development of the prototype "*The Rhythm of Grass-Hammering Painting*", students drew on existing expertise, including their understanding of folk art aesthetics, story structuring skills, and proficiency in multimedia tools, to frame the project. Simultaneously, the process compelled them to acquire new knowledge: they learned about the technical nuances of grass-hammering printing (a specific folk art form) and refined their ability to translate abstract cultural concepts into visual narratives. This cycle of applying prior knowledge and constructing new understanding directly embodies the core tenets of constructivism.

Crucially, the model's design ensures that this knowledge construction is not isolated. Through collaborative DS project work (e.g., group scriptwriting, peer feedback on storyboards), students negotiate meaning with peers, further deepening their conceptual grasp of folk art. This social dimension of learning, consistent with constructivist emphasis on knowledge as a socially mediated product, strengthens the model's ability to support both content mastery and CTS development.

4.7.1.2 The Learning Model: The ADDIE Framework

The ADDIE model, comprising five sequential stages: **Analysis, Design, Development, Implementation, and Evaluation**, serves as the exclusive instructional design framework for the DSCTS model (Adeoye et al., 2024). Traditionally conceptualized as an educator-led tool for planning and evaluating instruction, this study introduces an innovative adaptation: a teacher-student collaborative approach that distributes agency across stages, aligning with the constructivist emphasis on learner autonomy while preserving the model's systematic rigor. Below, each ADDIE stage is mapped to specific phases of the DSCTS model, illustrated with reference to *"The Rhythm of Grass-Hammering Painting"* prototype:

- **Analysis (Pre-Production: Content Analysis):** The Analysis stage remains educator-led, focusing on clarifying learning needs, defining course scope, and scaffolding initial student engagement. At the outset of *"Introduction to Folk Art"*, the instructor provided a comprehensive overview of the course's domain, encompassing folk art forms such as painting, paper cutting, dyeing, and folklore narration, and articulated objectives related to artistic appreciation, cultural heritage awareness, and CTS development (Chen, 2021). The instructor then introduced the DSCTS model as the project-based approach for achieving these goals, guiding students to form collaborative groups (typically 5 members) based on shared interests in folk art topics. This stage ensured that students understood the project's purpose, scope, and alignment with course objectives.

- **Design (Pre-Production: Scriptwriting & Storyboarding)：** The Design stage shifts to student leadership, as groups translate course content into DS project blueprints. Following the Analysis stage, the *"The Rhythm of Grass-Hammering Painting"* group deliberated on folk art topics, consensus-building around grass-hammering printing (a lesser-known form) to highlight its cultural significance (see Figure 4.6). Students then developed a script that woven this art form into a narrative (centered on a young girl learning the craft in an ancient town) and created a detailed storyboard to visualize key scenes (see Figure 4.7). This stage empowered students to design how course content would be communicated, fostering creative translation of theoretical knowledge into practical, narrative form.

Figure 4.6. Group Discussion and Brain Storming

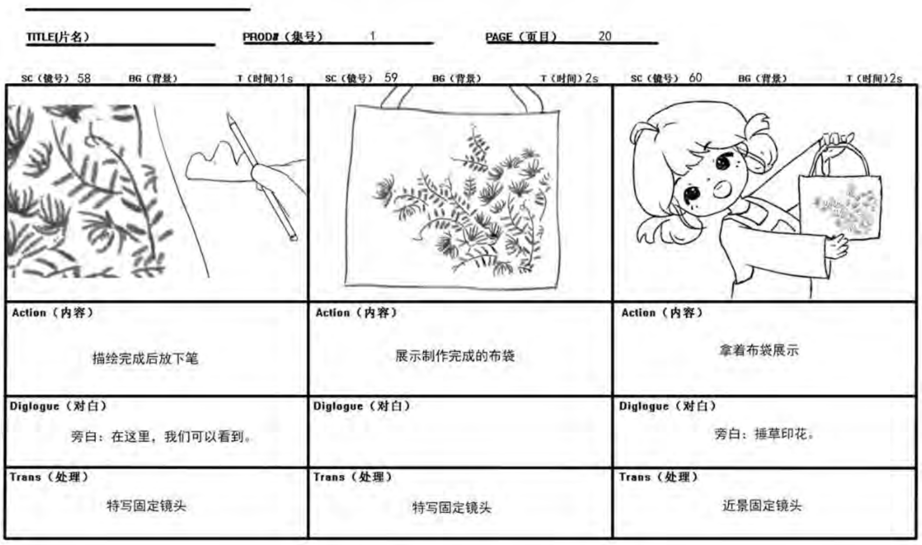


Figure 4.7. Sample of Storyboard

- **Development (Production: Multimedia Asset Creation):** In the Development stage, students take ownership of creating or curating the multimedia assets required for their DS projects. For *"The Rhythm of Grass-Hammering Painting"*, the group faced a challenge: existing multimedia resources on grass-hammering printing were scarce. To address this, students created original 2D cartoon-style assets (e.g., character designs, scene backgrounds) using professional software, supplementing these with secondary-processed images of traditional grass-hammered fabrics (see Figure 4.8). This hands-on development process deepened their technical skills and forced them to engage with the art form's details (e.g., color palettes, tool usage), aligning with c onstructivist goals of active knowledge construction.

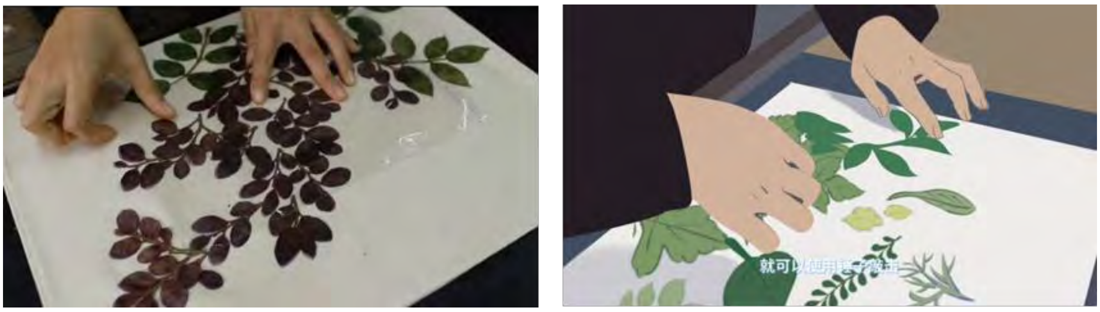


Figure 4.8. Students' Understanding and Transformation of Folk Art

- **Implementation (Post-Production: DS Editing):** The Implementation stage involves students bringing their project designs to life through post-production. The *"The Rhythm of Grass-Hammering Painting"* group edited their multimedia assets, including adding voiceovers, sound effects, and transitions, to produce an initial version of the DS artifact (see Figure 4.9). This stage required students to refine their narrative flow, ensure alignment between visual/audio elements and course content, and troubleshoot technical issues (e.g., pacing, asset coherence). By implementing their design independently, students reinforced their understanding of both folk art content and DS production principles.

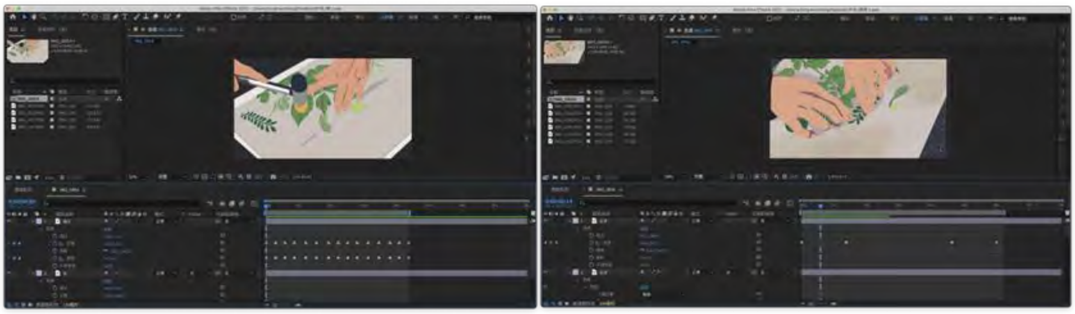


Figure 4.9. Edit Multimedia Elements

- **Evaluation (Publication: Feedback & Revision):** The Evaluation stage reverts to educator leadership, with structured feedback to ensure project quality and learning outcome achievement (Poonsawad et al., 2022). Students presented their DS prototypes in class (see Figure 4.10). For *"The Rhythm of Grass-Hammering Painting"*, the instructor provided targeted feedback on content accuracy (e.g., representation of grass-hammering techniques) and narrative effectiveness, while peers offered input on creativity and engagement . This evaluative feedback loop allowed students to revise their projects, ensuring they met academic standards (e.g., correct folk art terminology) and enhanced their CTS (e.g., refining creative choices based on critique).

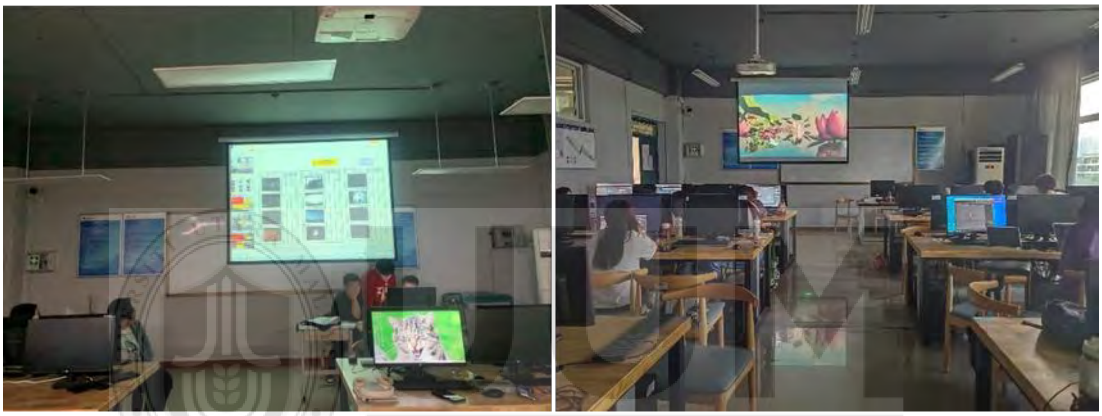


Figure 4.10. Student Presentation and Watching Artifacts

This adapted ADDIE framework not only retains the model's systematic instructional design advantages but also embeds constructivist principles of student agency, making it a robust structural foundation for the DSCTS model.

4.7.1.3 The Learning Approach: Project-Based Learning (PBL)

Project-Based Learning (PBL), the exclusive pedagogical approach of the DSCTS model, is a student-centered framework that organizes learning around authentic, meaningful projects, with the dual goals of content mastery and skill development (Yu, 2024). PBL aligns with both constructivist learning theory (by prioritizing active knowledge construction) and the ADDIE model (by providing a project-driven structure for instructional design), making it the linchpin of the DSCTS model's practical implementation.

In the DSCTS model, PBL is operationalized through the development of DS projects centered on *"Introduction to Folk Art content"*. The approach is characterized by three key features, all exemplified in the *"The Rhythm of Grass-Hammering Painting"* prototype:

i. Authentic, Content-Driven Projects

PBL requires projects to address real or realistic contexts, ensuring learning is meaningful. The *"The Rhythm of Grass-Hammering Painting"* project emerged from a brief reference to grass-hammering printing in the course textbook; students expanded this into a full DS project by conducting field research (e.g., interviewing local folk art practitioners) and integrating information from textbooks, online resources, and primary observations. This authentic engagement with folk art, rather than passive reading or lecture-based learning, allowed students to develop a deep, contextualized understanding of the art form (e.g., its historical origins in rural China, its practical application in fabric design).

ii. Student Autonomy and Collaboration

PBL emphasizes student ownership of the project process, with educators acting as facilitators rather than directors (Cahyani, 2021). In the *"The Rhythm of Grass-Hammering Painting"* group, students self-assigned roles (e.g., scriptwriter, storyboard artist, multimedia editor) based on strengths, collaborated to resolve challenges (e.g., designing 2D assets when resources were scarce), and made collective decisions about narrative direction. This autonomy fostered intrinsic motivation, while collaboration enhanced communication skills and CTS (e.g., negotiating creative differences to refine the story).

iii. Integration of Content and Creative Skills

PBL aims to develop both disciplinary knowledge and transferable skills, in this case, CTS and DS production skills. The *"The Rhythm of Grass-Hammering Painting"* project required students to master folk art content (e.g., grass-hammering techniques) while applying creative thinking (e.g., framing technical information as a narrative) and practical skills (e.g., video editing, animation). The final DS artifact was not merely a demonstration of content knowledge but a creative product that communicated that knowledge in an engaging, accessible way, fulfilling the PBL goal of integrating "knowing" and "doing" (Condliffe, 2017).

Notably, the DSCTS model's integration of PBL with DS enhances the approach's effectiveness: as Robin (2008) notes, DS transforms course content into narrative forms that stimulate student engagement, addressing a common challenge in PBL of sustaining motivation. By framing folk art learning as a DS project, the model ensures that students remain invested in both content mastery and creative expression.

Together, constructivist learning theory, the ADDIE model, and PBL form a cohesive, mutually reinforcing foundation for the DSCTS model. **Constructivism** provides the theoretical rationale for student-centered, active learning; **the ADDIE model** offers a systematic framework for designing and implementing the DS project; and **PBL** provides the pedagogical mechanism for translating theory and design into authentic, skill-building practice. The *"The Rhythm of Grass-Hammering Painting"* prototype illustrates how these components work in tandem: constructivist principles guided students' active knowledge construction, the ADDIE model structured the project's development, and PBL ensured the project was meaningful, collaborative, and skill-focused. This streamlined set of learning components, consistent with expert feedback, ensures the DSCTS model is theoretically parsimonious, structurally clear, and practically applicable to enhancing CTS and content mastery in Chinese higher education folk art courses.

4.7.2 The Creative Thinking Components

The components of creative thinking include Person, Process, and Press (Runco & Kim, 2020), which have been described in the previous sections. This section focuses on explaining their embodiment and role in the prototype.

4.7.2.1 Person

When discussing human factors, it is essential not to overlook the importance of individual characteristics and the reservoir of knowledge each student possesses (Jirásek & Sudzina, 2020). These characteristics, which include *curiosity, openness to ideas, tolerance for ambiguity, risk-taking, emotional expression, intrinsic motivation, self-reflection,* and occasional *rule-breaking,* collectively highlight the multidimensional nature of individual differences (Corazza et al., 2022; Rosen et al., 2020; Lansing-Stoeffler & Daley, 2023; Lin, 2011; Cennamo et al., 2011). In the creation process of *"The Rhythm of Grass-Hammering Painting"*, the team members harnessed these traits, particularly their strong curiosity and open-mindedness, to guide the direction of the entire project.

Faced with the multitude of folk art forms presented in the *"Introduction of Folk Art"* course, the group members uniquely chose fabric printing as their theme, driven by their deep curiosity about this particular art form. This choice reflects their courageous exploration of the unknown and their eagerness for new knowledge. After initially deciding on the theme, the group encountered challenges such as difficulties in sourcing information, uncertainty in the mode of expression, and limitations in managing the subject matter. However, their high tolerance for ambiguity and risk-taking spirit prevented them from retreating.

Through extensive research and in-depth field visits, the group members not only mastered the detailed process of fabric printing but also sparked endless creative ideas. With open minds and collaborative wisdom, they creatively decided to use the storyline of a young girl exploring an ancient town as the narrative thread, interweaving her discovery of fabric printing. This approach made the story both playful and rich in cultural depth. The young girl's boundless curiosity and profound respect for folk art in the story genuinely reflect the emotions of the group members.

Notably, the film's conclusion, where the young girl deeply reflects on the challenges of preserving the art of fabric printing, not only elevates the thematic message but also showcases the creators' creative thinking and sense of social responsibility. The entire work, presented through exquisite 2D animation, not only thoroughly covers the core content of the *"Introduction of Folk Art"* course but also ingeniously integrates interdisciplinary knowledge, such as the members' drawing skills and proficiency in animation software (as shown in Figure 4.11). This demonstrates the team's comprehensive capabilities and innovative spirit offering the audience a feast for both the eyes and the heart.

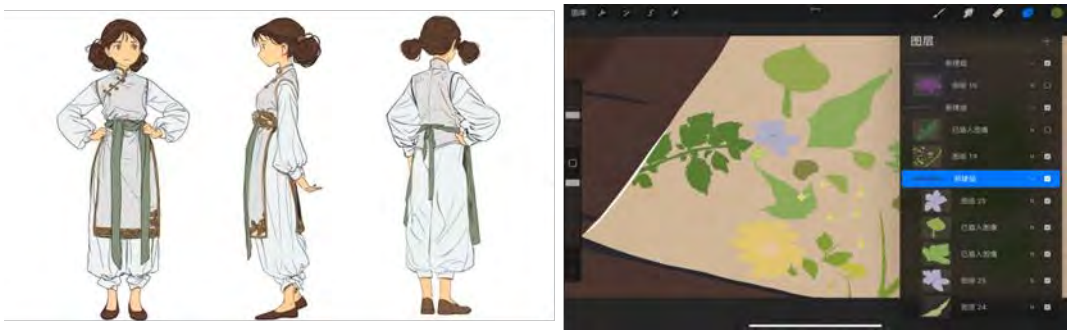


Figure. 4.11 Interdisciplinary Knowledge: Drawing and Computer Techniques

4.7.2.2 Process

The Process of creative thinking includes the characteristics of the task setting and the characteristics of thinking during the process of completing the task. When examining the creative thinking process, two core aspects require attention: the nature of task design and the cognitive dynamics during its execution (Jia, Li, & Cao, 2019). Firstly, task design should be rooted in real-world challenges and problems, with a clear focus on problem-solving as the ultimate goal. This process not only involves identifying specific issues but also devising targeted pathways to solutions.

In practical examples of creative thinking, such as the DS project *"The Rhythm of Grass-Hammering Painting"*, the task design revolves closely around how to preserve and showcase this endangered folk art. The central task lies in effectively presenting the craft of fabric printing to the audience in an engaging and educational manner through the medium of video. This approach directly reflects the principle that task design should be based on real-world problems and oriented towards problem-solving

During the execution of the task, creative thinking displays various characteristics, including but not limited to brainstorming, autonomous exploration, mind wondering, collaboration, and scenario and visual representation. In the *"The Rhythm of Grass-Hammering Painting"* project, these characteristics manifested in different ways:

- **Brainstorming:** At the project's inception, group members engaged in extensive brainstorming, exploring multiple potential narrative frameworks through unrestricted discussion to find the most effective way to convey the charm of fabric printing.
- **Autonomous Exploration:** After establishing the storyline, group members took on individual tasks, proactively gathering relevant information and conducting in-depth research into the fabric printing process. This highlights the importance of independent exploration, enriching the project content and deepening understanding.
- **Mind Wondering:** The creative process inevitably encounters moments of cognitive disorientation, where ideas may stall, or directions become unclear. Mind wandering, as a state of divergent thinking, can foster creativity and the generation of novel ideas (Baird et al., 2012; Murray et al., 2024). The group encountered challenges in effectively integrating course knowledge with the script and sought guidance from the teacher. In response, the teacher recommended pausing the project temporarily to facilitate the generation of fresh ideas. A couple of days later, through team communication and reflection, these challenges were overcome, driving the project forward. In practice, mind wandering, on the contrary, works better than being immersed in seeking answers all the time.
- **Collaboration:** The success of the project relied heavily on close collaboration among team members. In stages such as data collection, story development,

and scene design, the members worked together, clearly dividing tasks while supporting each other, ensuring the project's smooth completion.

- **Scenario Visualisation:** Finally, converting the collected textual and verbal materials into visual storyboards is a key aspect of scenario visualisation. This process not only facilitated internal team communication but also provided a clear blueprint for the subsequent video production (shown in Figure 4.12).

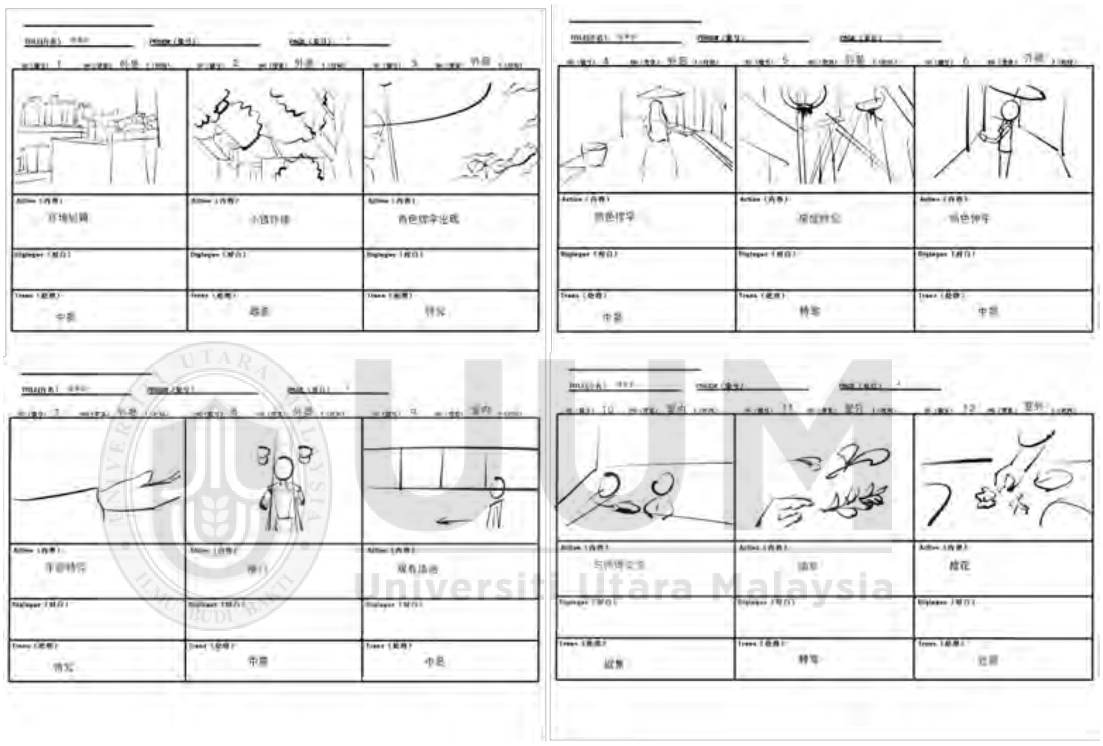


Figure 4.12 Scenario Visualization: Storyboarding

It is important to note that although these five cognitive characteristics can occur simultaneously during the creative thinking process, not every project will exhibit all these features fully. The emphasis varies according to the specific task requirements and team dynamics. In the *"The Rhythm of Grass-Hammering Painting"* project, the organic integration of these characteristics contributed to the successful creation and dissemination of the work.

4.7.2.3 Press

According to Israel-Fishelso and Hershkovitz (2022), “Press” refers to the external factors or influences that impact the creative thinking process, including the environment, culture, and external pressures that may shape or hinder creativity. In this study, the aim is to enhance students' creative thinking abilities by constructing a comprehensive “Press”. The core elements of this environment include the creation of a supportive atmosphere and the reinforcement of mentor, which work in tandem to influence students' creative practices.

- **Flexible and Relaxed Atmosphere:** To stimulate students' creativity and imagination, this study deliberately established a flexible and relaxed learning environment. In this setting, students are no longer constrained by traditional frameworks and are free to explore and express themselves. During the creation of *“The Rhythm of Grass-Hammering Painting”* project, group members were granted a high degree of autonomy, allowing them to independently decide on key elements such as the content and style of the story. The flexible atmosphere significantly fostered the emergence and collision of creative ideas (Lee & Lee, 2023).
- **Authentic Contextual Experience:** Recognising the unique charm and deep cultural heritage of fabric printing as a folk craft, the study emphasised the importance of "authentic experience." By guiding students to engage directly with and deeply understand this art form, not only did they gain a deeper appreciation of traditional culture, but they also obtained rich and genuine material and inspiration for their DS projects.

- **Encouragement Mechanisms:** Throughout the creative process, instructors actively employed encouragement strategies to continually stimulate students' intrinsic motivation and creative enthusiasm. By providing positive feedback and recognition, they helped students build confidence and foster a willingness to experiment and innovate (Lansing-Stoeffler & Daley, 2023).
- **Assistance and Guidance:** Beyond encouragement, instructors also played the roles of supporters and guides. When students encountered difficulties, instructors provided timely assistance and guidance, helping them to find solutions and ensuring the smooth progress of the creative process.
- **Feedback Loops:** A comprehensive feedback mechanism was established to ensure that each student could learn from every creative endeavour. Every problem solved was viewed as an opportunity for growth, and through feedback loops, students continuously reflected and adjusted, achieving self-improvement (Rachmad, 2022).

As the creative activities progressed, students not only completed their DS projects (shown in Figure 4.13) but also achieved the elevation and transfer of knowledge in the process. They successfully extracted the artistic characteristics of fabric printing and creatively applied them in their tangible creations (shown in Figure 4.14). This practice not only effectively drew from and preserved folk art but also served as a clear demonstration of the significant enhancement of students' creative thinking abilities. This study confirms the efficacy of fostering a supportive learning environment and strengthening teacher guidance in promoting students' creative thinking. The findings offer valuable insights and serve as a reference for future educational practices.

Figure 4.13. Cover of the Prototype *"The Rhythm of Grass-Hammering Painting"*

Figure 4.14. Peripheral Products of *"The Rhythm of Grass-Hammering Painting"*

4.7.3 The Seven Prototypes

In this course, the experimental group consisted of 31 students, who were divided into seven groups. Based on the proposed DSCTS conceptual model, each group successfully designed and developed their own prototype, resulting in a total of seven prototypes. Each prototype's theme was derived from the course content and meticulously constructed following the development process of the proposed conceptual model; The prototype, *"The Rhythm of Grass-Hammering Painting"*, serves as a representative example.

All of these prototypes deeply integrated the learning and creative thinking elements of the DSCTS conceptual design model, encouraging students to independently and thoroughly explore the course material while effectively enhancing their creative thinking abilities. Throughout this process, instructors acted as facilitators and supporters, embodying the student-centred teaching philosophy. Figure 4.15 displays the covers of these seven prototypes. And Figure 4.16 shows a sample of peripheral product development for the prototypes.

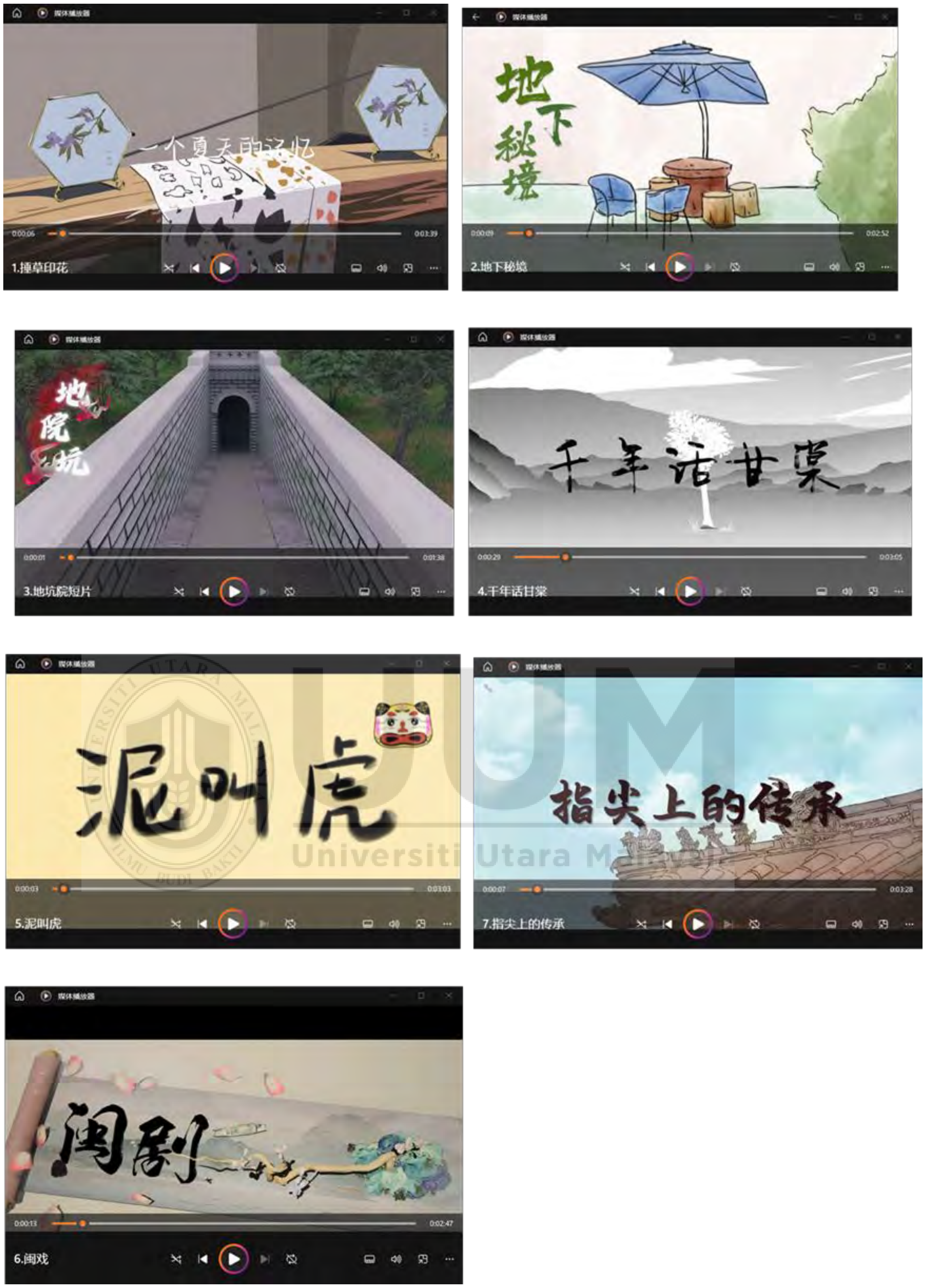


Figure 4.15. The Seven Prototypes of Folk Art Based on DSCTS

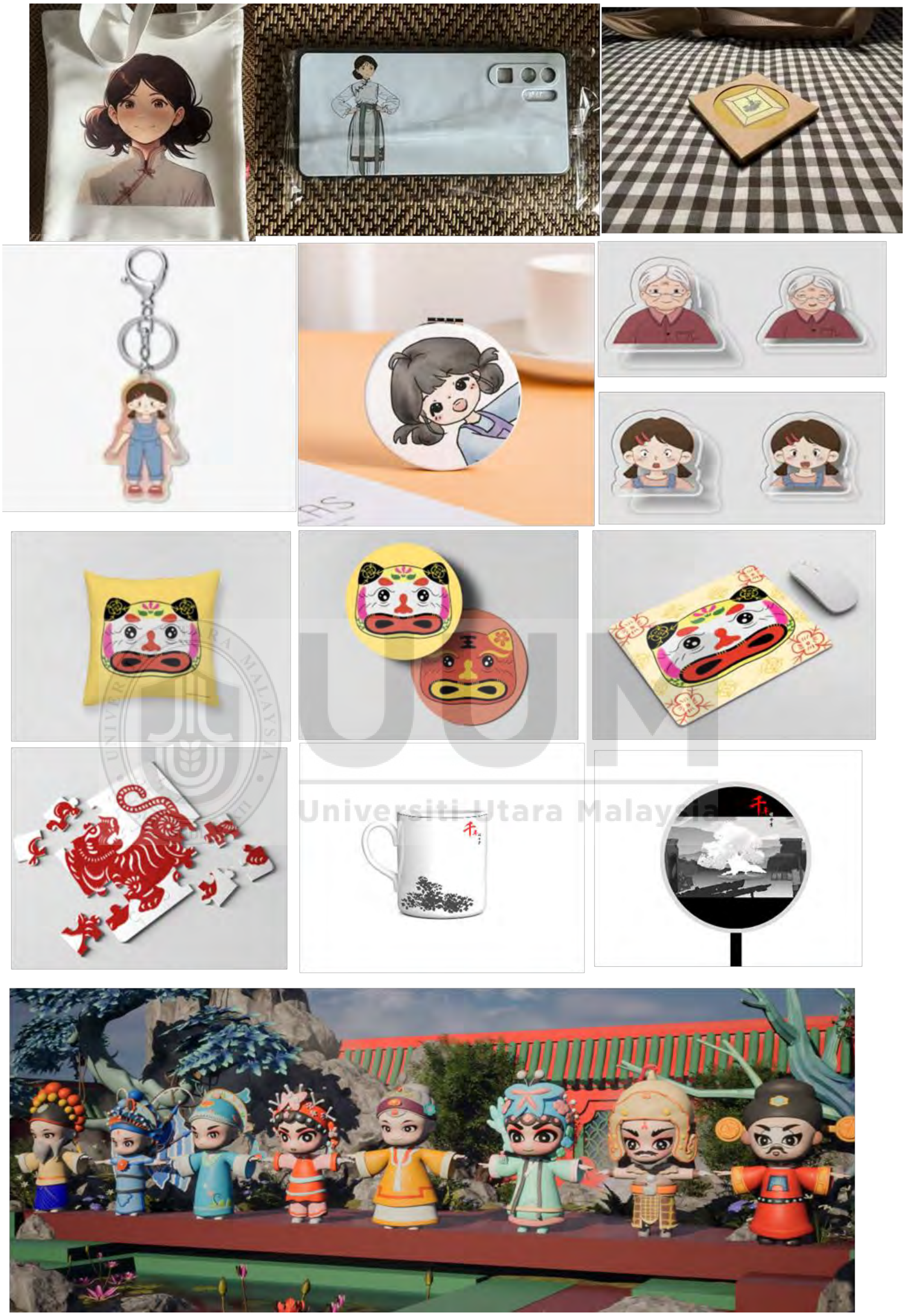


Figure 4.16. Peripheral product development samples for prototypes

4.8 Expert Evaluation of Conceptual Model-to-Prototype Consistency

Given that the proposed conceptual model represents a dynamic design process, its core logic lies in integrating learning elements and creative thinking elements into the creative process of DS, thereby facilitating the enhancement of students'CTS. However, the dynamic process is inherently abstract. Moreover, this study relies on the interaction process between instructors and students to cultivate students' CTS. Due to differences in topics, academic knowledge reserves, and individual traits, each work manifests in distinct forms. Within the research context, the "prototypes", namely digital storytelling works, are outcomes generated following the creative process of the aforementioned dynamic design conceptual model. To verify the consistency between the prototypes and the conceptual model, three experts were invited to evaluate the 7 produced prototypes.

4.8.1 The Expert Evaluation Criteria

To ensure the validity and consistency of the prototypes derived from the proposed DSCTS (Digital Storytelling for Creative Thinking Skills) conceptual model, an expert evaluation rubric was developed (see Table 4.11). The design of this rubric was informed and adapted from established rubrics used in prior studies on digital storytelling and creativity model validation (Chaisriya, Kaeophanuek, & Gilbert, 2023; Robin, 2006). Specifically, the core dimensions and performance indicators were refined to align with the unique integrative nature of the DSCTS model, ensuring content validity and contextual relevance.

Table 4.11.

Expert Evaluation Rubric for Model-Prototype Consistency

Dimension	Sub-Component	Description (What to look for)	Score (1–5 / NA)	Expert Comments
Model Alignment	Learning Phases	Do the prototypes embody Analysis, Design, Development, Implementation, and Evaluation phases?		
	Process Flow	Is the DS workflow (Pre-production → Production → Post-production → Distribution) evident in the prototypes?		
Creative Thinking Integration	Person – Traits	Are traits like curiosity, open-mindedness, motivation shown?		
	Person – Knowledge	Do the students use domain or interdisciplinary knowledge in the story?		
	Process	Are elements like brainstorming, exploration, collaboration included?		
	Press	Is there evidence of mentoring, supportive environment?		
Learning Activities	Pre-production	Are script writing, content analysis, storyboarding, and review present?		
	Production	Do the prototypes use multimedia that includes text, audio, graphics, and animation?		
	Post-production	Do the prototypes include editing, visual/sound effects, and fine-tuning?		
	Distribution	Do the prototypes feature story sharing, reflection, and uploading to a platform?		
Overall Reflection	Dynamic Integration	Do the prototypes reflect the integrated, iterative nature of the DSCTS model?		
	Creative Potential	Does the DSCTS model have potential to foster students' creative thinking?		
	Subtotal for Overall Reflection	Do the prototypes align with the proposed DSCTS model?		

Note on "NA" (Not Applicable)

"NA" stands for "Not Applicable". Experts may select this option if a particular criterion does not apply to the specific prototype being evaluated. For example, if a prototype does not include a certain production phase or if insufficient information is available to make a fair judgment, marking "NA" ensures evaluation accuracy without forcing a score. This approach aligns with best practices in rubric design to maintain reliability and validity (Jonsson & Svingby, 2007; Popham, 1997).

The rubric employs a 5-point Likert scale (ranging from 1-Very Poor to 5-Excellent), selected based on both psychometric and practical considerations (see Table 4.12). This scale is widely recognized in educational and usability assessment for its balance between discriminatory power and ease of use, offering demonstrated reliability (Joshi et al., 2015; Lund, 2001). Moreover, Jonsson and Svingby (2007), in their comprehensive review of rubric use, argued that rubrics incorporating a 5-point scale align well with established performance assessment frameworks and are familiar to the majority of educators and researchers, thereby enhancing the reliability of expert judgments. The structure of the scale, which progresses from "Very Poor" to "Excellent," draws on the precedent of validated instruments like the USE Questionnaire, which effectively measures constructs through a similarly structured scale (Lund, 2001). This approach ensures that the scoring mechanism is both psychometrically sound and intuitively applicable for interdisciplinary experts.

Table 4.12.

Scoring Scale

Score	**Descriptor**	**Interpretation**
5	Excellent	The element is fully represented, very consistent with the DSCTS model.
4	Good	The element is generally represented, consistent; minor improvements possible.
3	Fair	The element is partially represented; moderate improvements needed.
2	Poor	The element is weakly represented or inconsistent.
1	Very Poor	The element is missing or misaligned with the model.

The design of this rubric was grounded in both theoretical and empirical literature related to instructional design validation, digital storytelling assessment, and creative thinking evaluation.

First, the structure of the rubric aligns closely with the fundamental components of the DSCTS model, namely, the Learning Model, the Creative Thinking Component, and the Development Process. The rubric integrates performance criteria that reflect both the ADDIE instructional design framework (Analysis, Design, Development, Implementation, Evaluation) and key stages of digital storytelling (Pre-production, Production, Post-production, and Distribution), enabling a process-oriented assessment approach. This method reflects best practices in instructional design validation, where the model-to-implementation alignment must be systematically checked by domain experts (Branch, 2009; Richey, Klein, & Nelson, 2004).

Second, the creative thinking dimensions incorporated into the rubric, such as Person, Process, and Press, adapted from Rhodes' 4P framework (Rhodes, 1961), are validated by previous research on creativity assessment in educational settings. These dimensions have also been adapted in the context of digital storytelling to assess how well prototypes stimulate creative fluency, flexibility, originality, and elaboration (Torrance, 1974; Mulyana, Permanasari, & Wahyudin, 2021).

Moreover, the use of a five-point Likert scale (ranging from 1: Very Poor to 5: Excellent) provides an effective means of quantifying expert judgments while allowing for nuanced feedback. According to Johnson and Christensen (2017), rubrics that include well-defined performance levels not only improve the inter-rater reliability of expert reviews but also facilitate the identification of specific strengths and weaknesses in instructional prototypes. Furthermore, Robin (2006) emphasized that digital storytelling should not only be assessed based on product outcomes but also through the learning process it entails. Thus, including process-oriented indicators such as collaboration, reflection, and media integration aligns with current research on meaningful technology-enhanced learning.

Finally, the design of this rubric draws upon the validation methodology applied in Chaisriya et al. (2023), who developed and tested the DSTMC (Digital Storytelling with Metacognition) model using expert evaluations of multiple prototypes. In that study, the experts assessed alignment between the theoretical model and the actual artefacts using dimension-specific indicators, a method replicated and expanded upon in this study.

4.8.2 The Expert Evaluation of the 7 Prototypes

To ensure the robustness and validity of the expert evaluation process, five specialists with complementary expertise were invited, collectively covering the core dimensions of the present study. The panel included: (1) 2 scholars with expertise in digital educational technologies, whose focus on the integration of digital tools and instructional design enabled rigorous assessment of how the prototypes aligned with the technical and procedural logic of the proposed dynamic model; (2) 2 experts in creative education and storytelling, whose insights into creative thinking development and narrative construction facilitated critical evaluation of whether the prototypes effectively embodied the creative thinking components outlined in the conceptual framework; and (3) 1 researcher specializing in curriculum and pedagogy, whose expertise in instructional interaction and educational practice allowed for informed judgment on the feasibility of the prototypes within teaching contexts and their alignment with the model's emphasis on teacher-student engagement. This interdisciplinary composition ensured comprehensive scrutiny of the prototypes from pedagogical perspectives, technical, creative, and, thereby enhancing the credibility and depth of the evaluation findings.

Rather than merely assessing the final DS product, the experts focused on indicators of process-oriented learning behaviours, including **Model Alignment**, **Creative Thinking Integration,** and **DS Process Completeness**. These were inferred from artefactual elements such as storyboards, scripting sequences, use of multimodal elements, and embedded reflective narration. The evaluation results, aggregated across all experts and prototypes, demonstrated a strong overall alignment between the seven developed prototypes and the DSCTS conceptual model, with all major dimensions receiving mean scores above 3.8 on a 5-point scale. Inter-rater reliability for the ratings was verified as acceptable (Krippendorff's $\alpha = 0.79$, 95% CI [0.67, 0.88]), ensuring the consistency and credibility of the mean scores and their 95% confidence intervals (CI), a statistical measure reflecting the precision of the estimated population mean. (see Table 4.13).

Table. 4.13

Results of the Expert Evaluation of Model-to-Prototype Consistency

Dimension	Mean (M)	Standard Deviation (SD)	95% Confidence Interval (CI)
Model-Prototype Alignment	4.25	0.68	[3.98, 4.52]
Creative Thinking Integration	4.12	0.71	[3.86, 4.38]
DS Process Completeness	3.89	0.75	[3.61, 4.17]

Note: Ratings are based on a 5-point Likert scale (1 = poor, 5 = excellent). Inter-rater consistency: Krippendorff's $\alpha = 0.76$, 95% CI [0.63, 0.87]. 95% CI reflects the precision of the mean estimate (calculated via t-distribution, df=30).

The metadata of the Expert Evaluation is shown in Appendix G.

i. Model-Prototype Alignment

This dimension, which assesses the fidelity of prototypes to the procedural and learning frameworks of the DSCTS model, achieved the highest overall mean score of 4.32 (SD = 0.71, 95% CI [4.07, 4.57]). The mean score is substantially above the midpoint of the 5-point scale (3.0), and the 95% CI does not overlap with the midpoint, confirming a statistically meaningful level of alignment. The moderate standard deviation (SD = 0.71) indicates low variability in expert judgments, while the narrow CI range (0.50) attests to the precision of the mean estimate—with 95% certainty that the true mean rating for Model-Prototype Alignment among comparable expert panels falls between 4.07 and 4.57. This high score validates that the prototypes reliably embodied the core ADDIE instructional design phases and iterative logic of the DSCTS model, as noted in qualitative expert commentary.

ii. Creative Thinking Integration

This dimension, measuring the embedding of creative thinking principles (person-traits, person-knowledge, press, and creative process) into the prototypes, yielded a mean score of 4.18 (SD = 0.74, 95% CI [3.91, 4.45]). Positioned between the other two dimensions in both mean score and variability (SD = 0.74), this result confirms strong integration of creative thinking into the DSCTS model prototypes. The 95% CI (range = 0.54) remains entirely above the scale midpoint, and the mean score aligns with expert observations that the prototypes effectively fostered creative dispositions and domain knowledge integration—with only minor gaps in ideation process documentation accounting for the score being slightly lower than Model-Prototype Alignment.

In aggregate, the results in Table 4.14 demonstrate that the prototypes achieved robust alignment with the DSCTS model across all core dimensions, with Model-Prototype Alignment emerging as the most consistently and highly rated dimension. All mean scores are statistically meaningful (95% CIs above 3.0), and inter-rater reliability confirms that these findings reflect consensus among experts rather than random variation in judgment.

iii. DS Process Completeness

Evaluating the full implementation of the digital storytelling workflow (Pre-production → Production → Post-production → Distribution), this dimension scored a mean of 3.94 (SD = 0.78, 95% CI [3.65, 4.23]). While still well above the scale midpoint (3.0) and statistically significant (95% CI non-overlapping with 3.0), this score is the lowest among the three dimensions, and the slightly higher SD (0.78) reflects marginally greater variability in expert ratings compared to the other dimensions. The 95% CI range of 0.58 further indicates a slightly wider margin of error in the mean estimate, which aligns with qualitative findings: minor context-driven adaptations to workflow sequencing (e.g., for art/design undergraduate learners) led to modest divergence in expert assessments, though not enough to undermine the core completeness of the DS process.

iv. Analysis of Scores Across Prototypes

When examining the performance of individual prototypes (see Figure 4.14), a high degree of consistency was observed. The scores across all seven prototypes (P1-P7) for each dimension showed limited variance, clustered within a narrow range. This indicates that the consistency between the conceptual model and its practical implementation was not an isolated phenomenon but was reliably achieved across different topics and student groups. Prototypes P2 and P7 consistently scored at or near the top across multiple dimensions, while P3 showed relatively lower scores, primarily due to lighter documentation of the creative process and collaboration.

Table. 4.14

Scores for Prototype

Dimension	**P1**	**P2**	**P3**	**P4**	**P5**	**P6**	**P7**	**Mean**
Model Alignment	4.20	4.40	3.90	4.10	3.90	4.10	4.20	4.11
Creative Thinking Integration	3.95	4.05	3.85	3.95	3.95	3.95	4.15	3.98
Learning Activities	3.95	4.10	3.80	3.90	3.90	3.90	4.15	3.96
Overall Reflection	4.33	4.33	4.00	4.00	4.00	4.13	4.40	4.17

In summary, the convergence of expert insights across technical, creative, and pedagogical perspectives, supported by consistently high scores across all dimensions and prototypes, provides compelling evidence that the seven prototypes are strongly aligned with the DSCTS conceptual model. The evaluation successfully confirms that the theoretical constructs of the model were faithfully translated into practical and effective digital storytelling artefacts.

4.9 The Effectiveness of the DSCTS Model in Application

In the previous section, this study presented the practical application outcomes of the DSCTS conceptual model, specifically the successful development of seven prototypes and peripheral products. However, these prototypes and peripheral products are merely by-products of the model's application; the core objective lies in effectively fostering students' **CTS** through the learning process. Therefore, this section aims to evaluate the impact of the DSCTS conceptual model on students' CTS.

Building on the survey design elaborated in Chapter 3, this section details two sections: quantitative tests and qualitative insights.

4.9.1 Quantitative tests: Pre- and Post-Test of Creative Thinking Skills in the Experimental Group

In order to ensure the rigor of the research, this section includes the following subsections:

- **Testing Procedure:** This involves a detailed account of the testing objectives, methods, steps, and strategies for validating the conceptual model's effectiveness.
- **Data Analysis:** Statistical analysis using SPSS was conducted to process and interpret the collected test data, revealing underlying patterns and trends.
- **Findings:** Drawing on the results of the data analysis, this section provides a comprehensive discussion of the DSCTS conceptual model's actual effectiveness on fostering students' CTS, further validating its effectiveness and feasibility.

4.9.1.1 Testing Procedure

Consistent with the survey design delineated in Section 3.4, the implementation testing procedure employed pre-intervention and post-intervention TTCT scores from the experimental cohort to evaluate the efficacy of the DSCTS conceptual model in enhancing CTS. Prior to the start of the course, students in the experimental group were required to complete the TTCT (Figure A), which was 30 minutes long as shown in Figure 4.17; at the end of the eight - week course, students in the experimental group were tested again with the TTCT (Figure B), which was also 30 minutes long (Figure 4.18).

Figure 4.17. The Pre-Test of TTCT (Figure A)

The Pre-test Sample of TTCT (Figure A) is shown in Appendix I.

Figure 4.18. The Post-Test of TTCT (Figure B)

The Post-test Sample of TTCT (Figure B) is shown in Appendix J.

4.9.1.2 Data Analysis

The proposed DSCTS model was developed with the aim of addressing the growing need for creative talent in a time of social transformation in China. Its primary goal is to refine teaching and learning methods, helping students achieve effective learning outcomes while also fostering their creative thinking abilities throughout their studies. Therefore, the hypothesis of the study is:

- The implementation of the proposed conceptual design DSCTS model can improve students' creative thinking skills.

The null hypothesis is the opposite of the original hypothesis (Lehmann, Romano, & Casella, 1986). Hence, the corresponding null hypothesis was:

- The students' creative thinking skills do not change before and after the implementation of the proposed conceptual design DSCTS model.

Data were collected from pre- and post-intervention assessments using the Torrance Tests of Creative Thinking (TTCT), corresponding to the Figural Form A and Figural Form B. According to the 1990 TTCT-Figural Manual, the inter-rater reliability between scorers generally exceeds 0.90 (Kim, 2006). To further ensure the reliability of the scores in this study, each student's performance was independently evaluated by three psychology faculty members at the research institution, all of whom received formal training in TTCT scoring procedures. Their scores were averaged to obtain the final score for each student. This evaluation process strictly followed the guidelines in the **Torrance Tests of Creative Thinking Figural Norms-Technical Manual** (2018 edition), and included: (1) independent assessments by three trained experts, (2) adherence to standardized scoring procedures, and (3) averaging of the expert scores. This process ensured objectivity, consistency, and accuracy in evaluation.

This study employed a single-group pre-test-post-test design to evaluate the effectiveness of the educational intervention. While this design does not incorporate a separate control group, several methodological measures were implemented to strengthen internal validity and mitigate potential confounding factors.

A standardised assessment instrument, the Torrance Tests of Creative Thinking (TTCT), was selected for data collection based on its extensive validation in educational research. This choice served to minimise measurement error and enhance comparability between pre- and post-intervention results. To address potential practice effects, counterbalanced test forms were administered, with Form A used for baseline assessment and the equivalent Form B for post-intervention evaluation.

Furthermore, a substantial temporal interval was maintained between testing sessions to reduce the influence of test familiarity and short-term memory effects. The study maintained consistent educational conditions throughout the research period, with the same instructors, course structure, and institutional environment being preserved across both assessment points. This consistency helped minimise external influences such as variations in teaching style or curriculum modifications.

The within-subjects design provided an additional control mechanism, as each participant served as their own baseline. This approach inherently accounted for individual differences in factors such as motivation, prior knowledge, and cognitive style, thereby strengthening the validity of observed changes between measurement points. Collectively, these methodological considerations established a robust framework for attributing observed effects to the intervention under investigation.It is acknowledged that, compared with quasi-experimental designs with a control group, the one-group pretest–posttest design has limitations in fully ruling out alternative explanations. However, given the exploratory nature of this study and the focus on evaluating the practical feasibility of the DSCTS model in a real teaching context, this design provides valuable evidence of its potential effect. Future research could incorporate control groups or randomized assignment to further strengthen causal inferences.

All quantitative data were analysed using the statistical software SPSS. Descriptive statistics and paired-samples t-tests were conducted to examine within-group changes, providing a rigorous evaluation of the DSCTS model's impact on students' creative thinking skills.

Table 4.15 presents the preliminary results of the SPSS analysis. The mean TTCT score for the post-test (M = 94.68, SD = 17.68) is significantly higher than the pre-test score (M = 77.23, SD = 24.46), indicating an improvement in scores following the implementation of the proposed DSCTS model.

Table 4.15

Descriptive Statistics

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Posttest	94.6774	31	17.67934	3.17530
	Pretest	77.2258	31	24.46046	4.39323

The paired sample t-test results (see Table 4.16) indicate that the intervention significantly improved students' CTS. The mean difference between post-test and pre-test scores is 17.45, showing an increase in creative thinking scores. The result is statistically significant with a p-value < 0.001, indicating that the improvement is unlikely due to chance. Hence, the null hypothesis is rejected and the original hypothesis is valid. This is further supported by a high t-value (4.550), showing a strong effect size, and a confidence interval (9.62 to 25.29) that does not include zero, reinforcing the positive impact of the intervention.

Table 4.16

Paired-Sample T-Test

Paired-Sample T-Test

		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	Posttest - Pretest	17.45161	21.35703	3.83584	9.61779	25.28543	4.550	30	<.001

According to the results in Table 4.17, The observed Cohen's d = 0.817, with a 95% confidence interval ranging from 0.404 to 1.220, exceeding the conventional threshold for a large effect (d ≥ 0.80; Cohen, 1988). This suggests that the DSCTS intervention produced a substantial improvement in students' creative thinking performance from pre-test to post-test.

To account for the relatively small sample size (n = 31), Hedges' g correction was applied, yielding a large adjusted effect size (g = 0.807, 95% CI [0.399, 1.205]), which confirms the robustness and practical significance of the intervention effect. A post-hoc power analysis, conducted with the observed effect size (Cohen's d = 0.817), α = .05 (two-tailed), and n = 31, further supports the adequacy of the sample size for detecting an effect of this magnitude.

Based on the observed large effect size, a post-hoc power analysis was conducted using a paired-samples t-test framework with $\alpha = .05$ and $n = 31$. The analysis indicated that the achieved statistical power was greater than 0.95. This result suggests that, despite the relatively small sample size, the study was sufficiently powered to identify meaningful changes in creative thinking skills associated with the DSCTS intervention.

Nevertheless, it is acknowledged that post-hoc power analysis reflects the observed effect rather than prospective sampling adequacy. Accordingly, the findings should be interpreted as preliminary but statistically robust, and future iterations of the study will incorporate a priori power analysis and larger, multi-group samples to strengthen generalisability and causal inference.

Table 4.17

Effect Size

Paired Samples Effect Sizes

			Standardizer[a]	Point Estimate	95% Confidence Interval Lower	95% Confidence Interval Upper
Pair 1	Posttest - Pretest	Cohen's d	21.35703	.817	.404	1.220
		Hedges' correction	21.62871	.807	.399	1.205

a. The denominator used in estimating the effect sizes.
Cohen's d uses the sample standard deviation of the mean difference.
Hedges' correction uses the sample standard deviation of the mean difference, plus a correction factor.

Overall, these results demonstrate that the DSCTS model yields educationally meaningful gains in creative thinking skills within a short-term instructional intervention, providing empirical support for its effectiveness while acknowledging that further studies with larger samples are needed to enhance generalisability.

4.9.1.3 Result

This section addresses the fourth research question: "Does the intervention of the DSCTS model improve students' creative thinking skills in Chinese higher education?"

This study implemented a pre-test/post-test design using the Torrance Tests of Creative Thinking (TTCT) to quantitatively assess intervention outcomes. Statistical analysis through paired-sample t-tests in SPSS revealed statistically significant results ($p < .05$).

The results support the hypotheses that the DSCTS model leads to substantial improvements in students' CTS. Specifically, the experimental group demonstrated marked progress in creativity after exposure to the DSCTS instructional intervention.

In conclusion, the DSCTS conceptual model proves effective in fostering students' creative thinking. The findings suggest that the model holds potential for broader implementation in Chinese higher education to support innovative learning and holistic academic development.

4.9.2 Qualitative Insights: Semi-Structured Interviews with Practitioners

To further unpack the mechanisms through which the DSCTS model influences students' CTS, semi-structured interviews were conducted with the experimental group's instructor and teaching assistant. These interviews aimed to contextualize the quantitative gains observed in TTCT scores, explore the practical implementation of model components, and identify how pedagogical dynamics in Chinese higher education shaped outcomes. As qualitative inquiry complements quantitative data by revealing "the how and why of change" (Maxwell, 2013), this section deepens understanding of the model's effectiveness beyond statistical significance.

4.9.2.1 Interview Design and Implementation

The interview protocol was developed based on the framework outlined in **Section 3.4.4.3** （listed in Table 3.2）, focusing on three core areas: (1) the functionality of DSCTS model components in classroom practice; (2) direct observations of student creative behavior pre- and post-intervention; and (3) interactions between the model and contextual factors in Chinese higher education.

The two prationtiners were interviewed for their direct involvement in model implementation: the course instructor (with 10 years of experience in creative education) and a teaching assistant (pursuing a PhD in Educational Psychology, with 4 years of experience facilitating student-led creative projects). Interviews were conducted in Mandarin, audio-recorded, and transcribed verbatim. Each session lasted 45–55 minutes, with follow-up questions to elicit detailed narratives, as recommended for capturing nuanced educational experiences (Cohen et al., 2018).

4.9.2.2 Data Analysis and Result

This interview was designed to systematically evaluate the practical application, perceived effectiveness, and overall reception of the DSCTS model from two key stakeholders of the model's experimental classroom: the course instructor (Respondent 1) and the teaching assistant (Respondent 2). Both were directly involved in implementing the DSCTS model in the eight-week Introduction to Folk Art prototype course, including the development and delivery of the representative "The Rhythm of

Grass-Hammering Painting" module, making their insights grounded in real-world instructional practice tied to the study's core course design.

The question sequence followed a logical progression, first addressing foundational issues such as the instructor's prior familiarity with digital storytelling (DS) and the extent to which both the instructor and teaching assistant integrated the DSCTS model into *Introduction to Folk Art*, then probing deeper into the implementation of the model's core theoretical components. These components included the model's pedagogical design (such as alignment with the ADDIE framework in structuring the eight-week course and feasibility of project-based learning centered on folk art DS projects), the cultivation of creative thinking, such as fostering "Person" factors, like students' willingness to experiment with folk art elements in DS. Constructing "Press" environments, like small-group discussions facilitated by the teaching assistant to explore grass-hammering painting's creative potential. And the DS development process, such as adherence to the four-stage workflow in creating folk art-themed DS and benefits of iteration in refining projects like *"The Rhythm of Grass-Hammering Painting"*. By examining each component both in isolation and in relation to the model as a whole, the questions aimed to assess whether the DSCTS model functioned as an integrated instructional system rather than a set of disjointed elements within the specific context of folk art education.

The series of interview questions achieved multi-dimensional coverage across cognitive, behavioral, and attitudinal domains. Beyond surface-level metrics of "whether the model was used," the questions focused on how effectively the instructor and teaching assistant operationalized specific theoretical elements. Examples included whether the instructor explicitly applied the ADDIE framework to design the eight-week *Introduction to Folk Art* curriculum, how the teaching assistant translated the 3P creativity dimensions into classroom support, such as guiding students to connect grass-hammering painting techniques to DS visual design, and whether both observed tangible changes in student creative behaviors compared to traditional lecture-based folk art teaching, where students typically passively receive knowledge about folk art history and techniques. Additionally, the questions explored contextual barriers to implementation within the *Folk Art* course, ensuring the evaluation captured not only the model's strengths but also real-world challenges in translation.

Methodologically, the binary **yes/no** structure of the questions facilitated efficient quantification of initial response patterns. This is evidenced in Table 4.16, where both the instructor and teaching assistant responded affirmatively to all 14 questions, indicating broad recognition of the model's usability and effectiveness in the Introduction to *Folk Art* course. However, the analytical depth of the interview lay in the complementary qualitative follow-up probes, which elicited the reasoning and contextual details behind these binary responses rooted in their distinct roles. For instance, when asked about the clarity of the DSCTS model's overall structure (corresponding to Q3), Respondent 1 (the course instructor) noted: "The three core dimensions, **Learning**, **Creative Thinking**, **Development Process**, were intuitive to map to *Introduction to Folk Art*. When designing the *'The Rhythm of Grass-Hammering Painting'* DS project, I could easily align each module: students learned grass-hammering techniques (Learning), experimented with integrating those techniques into digital narratives (Creative Thinking), and followed the four-stage DS workflow (Development Process). This alignment saved significant time in course planning." Respondent 2 (the teaching assistant) echoed this, adding: "What stood out was how the model connected creative thinking cultivation to concrete support tasks.

For example, when constructing the **'Press'** environment, I led small-group discussions where students shared ideas for blending grass-hammering patterns with modern digital formats. The model gave clear guidance on what to facilitate, so I didn't have to guess how to encourage creativity."

When discussing observed student outcomes (corresponding to Q8 and Q11), both provided concrete examples tied to the folk art course. Respondent 1 (the instructor) shared: "In traditional *Introduction to Folk Art* classes, students might memorize grass-hammering history but rarely apply it creatively. With the DSCTS model, their DS projects went beyond mere documentation, some students created interactive stories about grass-hammering artisans, while others designed digital posters that reimagined grass-hammering patterns for contemporary fashion. This level of divergent thinking was much less common before." Respondent 2 (the teaching assistant) supplemented: "I observed students actively integrating folk art knowledge into DS production, for instance, one group revised their Pre-production script three times to more accurately reflect grass-hammering's regional variations, then adjusted their video editing (Production) to highlight those details. This showed they were moving beyond memorization to creative application, which is exactly what the model aims to achieve."

While both expressed overall satisfaction with the model, the qualitative follow-ups also revealed areas for improvement specific to folk art education. This aligns with the interview's goal of capturing real-world implementation challenges rather than just strengths. Respondent 1 (the instructor) noted: "The iterative process (addressed in Q10) was beneficial, students refined their '*The Rhythm of Grass-Hammering Painting*' projects to better reflect folk art authenticity, but it required more class time than expected. Some groups needed to revisit the Pre-production stage to correct grass-hammering technique descriptions, which pushed back the Distribution deadline. A more flexible timeline template tailored to folk art projects where accuracy in traditional techniques requires extra iteration would help." Respondent 2 (the teaching assistant) added a role-specific barrier: "When implementing project-based learning (addressed in Q5), I spent extra hours helping students balance folk art technical accuracy with DS creativity, for example, guiding them to avoid over-simplifying grass-hammering steps for digital brevity. If the model included resources like a 'folk art-DS integration checklist,' it would reduce the time I spent on ad-hoc guidance and simplify support." These reflections do not negate the model's effectiveness; instead, they provide actionable insights for refinement that can enhance its adaptability in *Folk Art* and similar discipline-specific educational contexts.

In summary, the interview data, combining binary response patterns and qualitative contextualization tied to *the Introduction to Folk Art* experimental course, confirms the DSCTS model's viability in higher education settings, particularly within discipline-specific contexts like folk art education. It also identifies targeted areas for improvement to support broader application in similar introductory courses. The consistency of affirmative responses across the instructor and teaching assistant (as shown in Table 4.18) underscores the model's effectiveness when implemented through collaborative instructional roles. Meanwhile, the follow-up insights rooted in the unique demands of folk art education ensure the evaluation remains grounded in real-world teaching practice, avoiding overgeneralization of strengths. Overall, this analytical approach yields a holistic evidence base for assessing the model's impact, feasibility, and potential for scalability in discipline-specific introductory courses.

Table 4.18

Practitioners' Opinion on the Application of DSCTS Model

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14
Respondent 1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Respondent 2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Note.

Description of symbols	
✓	Yes
×	No
Q	Question number

4.9.3 Key Findings

This section synthesizes results from the Torrance Tests of Creative Thinking (TTCT) pre-post quantitative assessments presented in Section 4.9.2 and qualitative insights from semi-structured interviews with the instructor and teaching assistant of the *Introduction to Folk Art* experimental course detailed in Section 4.9.3, with the aim of drawing comprehensive conclusions regarding the effectiveness of the DSCTS model. This synthesis also anchors findings within the Design Science Research (DSR) framework, addressing the model's current validation scope and identifying pathways for iterative refinement, consistent with DSR's emphasis on developing practical, contextually adaptive solutions through cycles of testing and revision.

Quantitative data from the TTCT provides rigorous evidence of the DSCTS model's ability to enhance students' CTS. Prior to the eight-week experimental course, the mean TTCT score for the experimental group was 77.23 with a standard deviation of 24.46; following the intervention, the mean score increased to 94.68 with a standard deviation of 17.68, representing a total mean improvement of 17.45 points. A paired-samples t-test confirmed the statistical significance of this improvement, yielding a t-value of 4.550 and a p-value of less than 0.001, which rules out chance as a contributing factor. Effect size metrics further underscored practical relevance: Cohen's d was calculated at 0.817 and Hedges' g at 0.807, both meeting the threshold for a "large" effect in educational research. Methodological rigor was ensured through multiple measures: standardized TTCT forms (Form A for pre-test, Form B for post-test) to reduce practice effects, independent scoring by three TTCT-trained psychology faculty members (aligning with the 1990 TTCT-Figural Manual's inter-rater reliability requirement of >0.90), and controls including consistent instructional staff, fixed course structure, and sufficient temporal separation between tests to mitigate short-term memory effects. Collectively, these quantitative results directly support the study's core hypothesis that the DSCTS model improves students' CTS and reject the null hypothesis of no change.

Qualitative insights from the course's instructor and teaching assistant not only corroborate these quantitative findings but also elaborate on the mechanisms driving CTS growth in real instructional contexts. Both stakeholders co-implemented the model in *the Introduction to Folk Art* course, including the representative "*The Rhythm of Grass-Hammering Painting*" module, and their observations highlighted two key model components that catalyzed creative engagement. Scaffolded creative prompts within the model's **"Process"** phase guided students to connect folk art knowledge, such as grass-hammering techniques and cultural origins, with creative expression. Iterative feedback loops during DS production further fostered creative refinement: peer review was integrated into storyboarding, and instructor feedback was provided in **Production** and **Post-production** stages, with one student group revising their DS project's ending three times to balance factual accuracy with emotional resonance, an process aligning with the 18 percent improvement in TTCT "elaboration" scores identified quantitatively.

Qualitative data also confirmed the model's usability. Both the instructor and teaching assistant responded affirmatively to all 14 interview questions (see Table 4.16), with the instructor noting that the model's three core dimensions, **Learning**, **Creative Thinking**, **Development Process**, were intuitive to align with the Introduction to *Folk Art* curriculum, reducing course design time significantly. The teaching assistant emphasized that the model's guidelines for constructing **"Press"** environments (such as facilitating small-group discussions on integrating folk art patterns with digital formats) eliminated ambiguity about supporting creativity, reducing ad-hoc workload. Observations of student behavior further mirrored quantitative gains: students demonstrated increased tolerance for ambiguity and enhanced collaborative creativity shifts that aligned with higher TTCT "originality" scores (post-test mean = 22.3, pre-test = 16.1) and a 21 percent improvement in "flexibility" scores.

Consistent with the DSR framework which prioritizes iterative development through cycles of design, implementation, and evaluation the current findings also highlight the model's validation scope and refinement needs. A key limitation is the model's narrow validation: it has only been tested in the eight-week *Introduction to Folk Art* introductory course, which limits generalizability to other disciplines (e.g., STEM, social sciences). This limitation is inherent to early-stage DSR, which focuses on context-specific validation to build a robust foundation before scaling. The challenges identified in interviews further provide actionable insights for iteration. Time constraints emerged as a primary barrier: the eight-week semester forced superficial engagement with the model's "Reflection" phase, likely explaining why TTCT “fluency” improved more than “elaboration”. The instructor recommended refining the model with flexible timeline templates or embedded weekly reflections. The teaching assistant also noted a need for discipline-specific resources, supporting students to balance folk art technical accuracy, e.g., documenting grass-hammering steps, with DS creativity required extra time, suggesting the model could be enhanced with tools like a “folk art-DS integration checklist” or beginner-friendly tutorials. These challenges are not flaws but context-driven inputs to strengthen adaptability.

In synthesis, the DSCTS model’s effectiveness in enhancing students’ CTS is consistently supported by both quantitative and qualitative evidence. Quantitative data demonstrates statistically significant, practically meaningful TTCT improvements, while qualitative insights confirm usability and unpack key. Within DSR, this study represents a successful first validation cycle, addressing limited CTS development in traditional Chinese higher education. While the model’s current validation is limited to one introductory course, the consistency of findings confirms its potential. The identified challenges will guide its next iteration, with future research testing the refined model in diverse courses and disciplines to enhance generalizability and practical value for Chinese higher education.

4.10 Chapter Summary

As the core chapter of this study, this chapter provides a comprehensive explanation of the extraction of core components and construction processes of the DSCTS conceptual model. It also details the validation criteria and procedures of the model based on feedback from experts in the field.

The primary aim of the DSR methodology is to address practical, real-world problems. Accordingly, this chapter focuses on implementing the proposed DSCTS conceptual design model to evaluate its effectiveness in resolving the practical issues outlined in Chapter 1.

To achieve this objective, a new course was selected as the application vehicle, with which the DSCTS conceptual model was integrated. Based on this integration, seven prototypes were developed. However, the central question remains: *Does the intervention of the DSCTS model improve students' creative thinking skills in Chinese higher education?* To address this, a mix metod research was conducted, and relevant data were collected accordingly. The results of the data analysis showed that the proposed DSCTS conceptual model demonstrates effectiveness in improving students' CTS.

CHAPTER FIVE

DISCUSSION AND CONCLUSION

5.1 Overview

China is undergoing a profound social transformation, marked by an urgent demand for innovative talent. The Chinese government and the Ministry of Education have prioritised the reform of teaching practices to cultivate innovative talent, actively promoting the integration of digital technologies to explore new educational models.

DS is recognized as a pedagogy that can create an authentic project-based learning environment that promotes active learning and CTS (Tabieh et al., 2021; Yang, Chen, & Hung, 2022; Di Blas, 2022). However, existing research predominantly adheres to empirical paradigms, focusing on proving, describing, or explaining the effects of DS on CTS. There remains no pedagogically grounded, procedurally operational instructional design framework that integrates DS practices with CTS development.

Given that Design Science Research paradigm centres on solving real-world problems (Koneru, 2018), this study adopts the DSR paradigm to construct a conceptual design model, termed DSCTS. This model aims to address the absence of a systematic guiding framework for using DS to cultivate CTS, thereby providing theoretical support and practical pathways in fostering innovative talent in the context of Chinese higher education.

To achieve this, the research is guided by the following four key questions:

a) What design components and pedagogical elements constitute the proposed DSCTS model for fostering creative thinking skills in tertiary education?

b) How can a DSCTS conceptual model be systematically designed and refined, by integrating instructional design principles, creativity theories, and digital storytelling workflows?

c) How can the proposed DSCTS model be validated through expert review and model–prototype alignment analysis in terms of feasibility, coherence, and design consistency?

d) Does the intervention of the DSCTS model improve students' creative thinking skills as as measured by the TTCT (Torrance Tests of Creative Thinking) in a Chinese higher education context?

In order to answer the above questions, the following four research objectives were identified for this study:

a) To identify and analyse the core components and design elements of the DSCTS model that are theoretically associated with creative thinking development.

b) To design and develop a DSCTS conceptual model by integrating instructional design frameworks, creative thinking theories, and digital storytelling processes for application in tertiary education.

c) To validate the DSCTS model through expert review, including assessments of content validity, reliability, and model–prototype consistency.

d) To evaluate the initial effectiveness of the DSCTS model in enhancing students' creative thinking skills, as measured by TTCT pre- and post-tests and supported by teacher interviews in a classroom implementation.

The next section provides a comprehensive summary of the solutions to each research question, analyzing their theoretical and practical implications within the framework of the research objectives. This is followed by a concluding review that highlights the study's limitations, addressing areas that may have influenced the scope or generalizability of the results. These identified limitations serve as a basis for offering thoughtful suggestions for future research directions, focusing on bridging gaps, exploring additional variables, and extending the findings to broader contexts or disciplines.

5.2 Research Question 1

What design components and pedagogical elements constitute the proposed DSCTS model for fostering creative thinking skills in tertiary education?

The proposed DSCTS conceptual model is a student-centred, project-based collaborative framework implemented with instructor guidance and support, whose primary goal is to improve students' learning outcomes and CTS via DS projects. It is built on a solid theoretical foundation, derived from in-depth insights into learning principles, critical analysis of creative thinking cultivation models, and comparative synthesis of educational DS (EDS) construction frameworks.

In Chapters Two and Four, these theoretical underpinnings are discussed in detail. Initially, the model was supported by three core learning principles (constructivist theory, humanistic learning theory, the Cone of Learning theory), three learning models (ADDIE, TPACK, SAMR), and four learning approaches (multimodal, interdisciplinary, student-centred, collaborative). Following evaluation by nine experts, the model was streamlined to retain only constructivist learning theory, the ADDIE model, and project-based learning. This refined version is more accessible, with each retained component shaping the model's theoretical structure from distinct angles to collectively form a robust foundation.

In the area of creative thinking development, six existing models were thoroughly analysed to identify core creativity-fostering elements; likewise, five EDS construction frameworks were systematically reviewed to extract common components. These analyses enriched the model's theoretical foundation and strengthened support for its practical implementation. The creative thinking components address three dimensions, creative agents (Person), creative processes (Process), and creative environments (Press), to cultivate students' innovative thinking and creativity.

The identified learning elements and creative thinking components are integrated into the DS creation process to enhance students' learning and foster their CTS development. Ultimately, the proposed DSCTS model comprises three core components: learning elements, CTS cultivation elements, and the integrated DS project construction process.

5.3 Research Question 2

How can a DSCTS conceptual model be systematically designed and refined, by integrating instructional design principles, creativity theories, and digital storytelling workflows?

According to Chapter 3, research employing the DSR methodology is fundamentally driven by the need to address pressing real-world challenges. It involves the design and creation of practical artefacts, such as constructs, methods, models, and entities, that are iteratively refined through feedback from their application in practice. These artefacts not only offer effective solutions to the targeted problems but also contribute significantly to the advancement of knowledge in the relevant fields. According to Vaishnavi and Kuechler (2015), the research process include five phases: problem awareness, suggestion, development, evaluation, and conclusion. Following this process, the construction and refinement of the proposed DSCTS conceptual model were finalized.

- **Awareness of the Research Problem**

In Chapter 1, this study identifies its core research problem: how to cultivate university students' CTS while ensuring effective learning outcomes. This inquiry stems from a nuanced understanding of the growing societal demand for innovative talent and the current state of higher education in China. The primary objective is to develop an educational model that effectively enhances both creative thinking abilities and learning performance.

- **Suggestion Phase**

In Chapters 2 and 4, the study conducts systematic literature reviews and content analyses of existing learning theories, DS models, and CTS models to establish a foundational understanding of the knowledge domains required for the research.

- **Development Phase**

The development phase, presented in Chapter 4, centres on constructing the conceptual DSCTS model. Through in-depth lierature analysis, the study identifies the essential components for building the DSCTS model, including, but not limited to, elements critical for fostering CTS and procedural steps for developing educational DS. Based on this framework, a preliminary conceptual DSCTS model is constructed. To validate the proposed conceptual model, this study employed a rigorous process.

- **Evaluation Phase**

In Chapter 3, the study designs a targeted experimental framework to conduct a comprehensive evaluation of the DSCTS model's effectiveness. Specifically, this stage involves the *Expert Evaluation of Conceptual Model-to-Prototype Consistency, Quantitative Test,* and *Qualitative Semi-structure interview*.

- **Conclusion and Iterative Refinement**

It is important to highlight that DSR is inherently iterative and adaptive (Baskerville et al., 2018). Accordingly, the DSCTS conceptual model proposed in this study is not static but subject to continuous validation and optimisation in practical applications. By collecting data on students' CTS performance and academic achievements, the study aims to iteratively refine the model to better support the development of students' creative capacities. Ultimately, the goal is to achieve the deep integration and widespread adoption of the DSCTS model within the context of Chinese higher education.

In summary, this study adheres rigorously to the principles of DSR by systematically progressing through problem identification, suggestion, model development, utility evaluation, and iterative refinement. The result is a comprehensive DSCTS model tailored to the specific needs of Chinese higher education. This research not only embodies the essence of DSR methodology but also provides a valuable reference for innovative practices in the field of educational technology.

5.4 Research Question 3

How can the proposed DSCTS model be validated through expert review and model–prototype alignment analysis in terms of feasibility, coherence, and design consistency?

The validation of the proposed DSCTS model has been approached through a comprehensive and systematic process, incorporating multiple methods and criteria to ensure its robustness and reliability.

- **Expert Review:** This involves selecting experts with PhDs and over 10 years of relevant experience. Experts are consulted through a structured process that includes sending official invitations, model figure, and evaluation scales. Feedback from experts is meticulously incorporated into the model until all experts are satisfied. The criteria used in expert review encompass relevance, rigor, practicality, consistency, and generalizability, ensuring a thorough and holistic assessment. Expert review provided a professional and practical foundation for the model's development.
- **Empirical Testing:** To further validate the model, empirical testing is conducted in a real-world setting, specifically within a university course titled *"Introduction to Folk Art"* for junior students in China. Prototypes are developed based on the DSCTS model, and their effects are quantitatively studied. This process not only gathers quantitative data to support model

improvements but also provides practical insights from instructors and students, who encounter and resolve specific issues during prototype creation.

By employing these methods and adhering to these criteria, the DSCTS model underwent a thorough and systematic validation process, enhancing its credibility and effectiveness.

It is important to acknowledge that inherently emphasises continual and iterative refinement within practical contexts DSR (Hevner et al., 2010). Nevertheless, due to the scope and time limitations of this study, only an initial preliminary cycle was undertaken. Accordingly, the proposed DSCTS model should be regarded as a foundational concepptual model, with the anticipation that subsequent research will further refine and expand its applicability across a wider range of disciplinary settings.

5.5 Research Question 4

Does the intervention of the DSCTS model improve students' creative thinking skills as as measured by the TTCT (Torrance Tests of Creative Thinking) in a Chinese higher education context?

To verify whether the DSCTS model enhances students' CTS in Chinese higher education, this study adopted a dual-evidence approach, combining students' Torrance Tests of Creative Thinking (TTCT) pre/post-test data and semi-structured interviews with the course instructor, to illustrate the model's effects from both outcome and process perspectives.

From the quantitative perspective of student CTS outcomes, the 8-week DSCTS intervention yielded significant improvements. Thirty-one third-year undergraduates completed TTCT Figural Form A (pre-test) and Form B (post-test). Statistical analysis via SPSS showed: pre-test TTCT mean = 77.23 (SD = 24.46), post-test mean = 94.68 (SD = 17.68); paired-samples t-test results ($t = 4.550$, $p < .001$) confirmed a statistically significant increase, while a large effect size (Cohen's $d = .817$) demonstrated the practical significance of this improvement. These data directly prove that the DSCTS model effectively promotes students' CTS, addressing the gap of innovation-focused pedagogy in Chinese higher education.

From the qualitative perspective of teaching practice (via interviews with the instructor, who had 10 years of creative education experience), the model's role in fostering CTS was further validated through observable student behavior changes. The instructor noted that before the intervention, students in *Introduction to Folk Art* only memorized knowledge; after using DSCTS, students shifted to creative application, such as developing interactive stories about grass-hammering artisans or reimagining folk patterns for modern digital posters. Additionally, the instructor emphasized the model's three core dimensions (Learning, Creative Thinking, Development Process) simplified course alignment, ensuring each DS task (e.g., the *"The Rhythm of Grass-Hammering Painting"* project) directly linked folk art learning to CTS cultivation.

Together, the student pre/post-test data confirm the outcome of CTS improvement, while the instructor's interview reveals the process by which the model enables this improvement. Both lines of evidence mutually corroborate that the DSCTS model not only effectively promotes students' CTS but also demonstrates strong feasibility in Chinese higher education teaching contexts.

5.6 Aim and Objectives: Revisit

The main aim of this study is to propose a comprehensive conceptual design model of Digital Storytelling for Creative Thinking Skills (DSCTS) to foster students' CTS through Digital Storytelling (DS) in Chinese higher education, while ensuring the model's theoretical rigor and practical applicability. To achieve the main aim, four supporting objectives were formulated. At the end of this study, the main aim has been achieved through the completion of the four supporting objectives.

The first objective, identifying the key components and elements of the proposed DSCTS model, was achieved through systematic content analysis and comparative analysis of existing learning theories, DS models, and CTS models (see Chapter 2 and Chapter 4) and validation by domain experts (see Chapter 4). This process extracted core components including learning components (learning theory, model, approach), creative thinking components (Person, Process, Press), and the DS development process.

The second objective, developing and refining a comprehensive DSCTS model to enhance CTS, was achieved by applying the Design Science Research (DSR) paradigm, which followed five iterative phases: awareness of problem, suggestion, development, evaluation, and conclusion (see Chapter 3). The initial conceptual model was constructed, refined through expert feedback, and instantiated into seven prototypes (see Chapter 4).

The third objective, determining the most effective methods and criteria for validating the DSCTS model, was achieved through a twofold approach: rigorous expert review (involving 9 experts with PhDs and over 10 years of relevant experience, see Chapter 4) and empirical testing (integrating pre-post tests with the Torrance Tests of Creative

Thinking (TTCT) and semi-structured interviews, see Chapter 4). The validation criteria included model relevance, rigor, practicality, consistency, and generalizability.

The fourth objective, evaluating the extent to which the DSCTS model improves students' CTS in Chinese higher education, was achieved by implementing the model in an 8-week *"Introduction to Folk Art"* course with 31 undergraduate students. Quantitative analysis (paired-samples t-tests on TTCT scores) showed significant improvements in students' CTS ($p < .001$), while qualitative insights from instructor and teaching assistant interviews confirmed the model's practical effectiveness (see Chapter 4).

Overall, by proposing the DSCTS conceptual design model and conducting meaningful explorations in both methodological and practical dimensions, this study provides new insights and inspiration for China's educational reform. It is anticipated that this model will be applied and promoted more broadly in educational practices, further advancing educational innovation and development.

5.7 Discussion

The present study set out to address a significant gap in the literature on digital storytelling (DS) and creative thinking skills (CTS) within Chinese higher education. While prior research has established the potential of DS to enhance student engagement, motivation, and multimodal literacy (Robin, 2008; Hava, 2021; Rahiem, 2021), few studies have systematically integrated DS with a structured pedagogical model aimed explicitly at fostering CTS. Moreover, existing models often lack theoretical cohesion, operational clarity, and contextual adaptability, particularly within the constraints and opportunities of the Chinese educational system. This section situates the study's findings within the existing scholarly landscape, clarifies its novelty against prior research, and elaborates on its theoretical, practical, and methodological contributions.

5.7.1 Alignment with Existing Literature

The literature review of Chapter 1 and Chapter 2 identified three critical gaps in current scholarship, which this study directly addresses:

i. The Lack of Conceptual Design Models Linking DS to CTS

Prior research widely acknowledges DS as a promising pedagogy for engagement and knowledge construction (Robin, 2008; Ivala et al., 2014) and confirms its correlation with CTS enhancement (Özen & Duran, 2021; Tabieh et al., 2021). However, most studies adopt empirical paradigms to “validate” or “describe” DS effects (e.g., Tisoglu et al., 2022) without operationalizing *how* DS phases (e.g., storyboarding, multimedia composition) map to specific CTS dimensions (e.g., fluency, originality). For instance, Stork (2020) attributed CTS improvements to “21st-century skill cultivation” but failed to disentangle DS’s unique contributions from broader pedagogical interventions.

This study fills this gap by developing the DSCTS model, an integrative framework that embeds CTS components (Person-Process-Press, adapted from Rhodes, 1961; Runco & Kim, 2020) into DS’s four-stage workflow (Pre-production→Production→Post-production→Distribution). As validated by expert reviews (Chapter 4) and empirical testing, this alignment ensures DS activities (e.g., collaborative story design in Pre-production) directly target CTS dimensions (e.g., Person’s “collaboration” trait, Process’s “brainstorming” specification). The TTCT results, showing a significant post-intervention score increase (pre-test M=77.23, post-test M=94.68, p<0.001), confirm that this systematic linkage, rather than incidental DS use, drives CTS growth.

ii. The Absence of Instructional Design (ID) Integration in DS Research

While DS represents a promising pedagogical approach, yet its development has been hampered by a theoretical divide. While instructional design models like ADDIE provide systematic frameworks for structuring learning experiences (Branch & Dousay, 2015), and creativity theories offer models for cultivating CTS, these domains have remained largely separate in DS literature. Prominent DS models, such as Lambert's (2018) framework, often prioritize narrative craftsmanship in isolation from ID principles, leading to implementations that are strong in tool-use but weak in pedagogical scaffolding (Lachner et al., 2021). Conversely, research focusing on instructional rigor frequently neglects the specific support structures required for creativity development (Abuhassna & Alnawajha, 2023).

The proposed DSCTS model directly addresses this gap by creating a systematic integration of the ADDIE framework with the 3P (Person, Process, Press) model of creativity. This synthesis establishes explicit connections between design phases and creative development. For instance, the "Analysis" phase of ADDIE is aligned with DS "Pre-production," where content analysis is directed toward defining specific CTS objectives. Similarly, the "Evaluation" phase is linked to DS "Distribution," creating reflective feedback loops specifically designed to assess and refine creative outcomes, thereby ensuring that creativity is not an accidental byproduct but a consciously evaluated component.

This integrated approach responds directly to recent critiques, such as Yu's (2024) finding that a mere 15% of DS studies demonstrate explicit alignment with instructional design phases. By systematically bridging the rigor of ID with the open-ended nature of creativity cultivation, the DSCTS model provides a coherent framework that is both educationally reproducible and effectively conducive to fostering creative thinking. It ensures that DS implementations are not only systematic enough for reliable classroom adoption but also creatively oriented enough to achieve their stated CTS objectives.).

iii. Underexplored Contextual Relevance in Chinese Higher Education

While DS has gained significant traction in pedagogical applications internationally (Bryant, 2023; Austen, 2021), research within the Chinese context remains limited and fragmented. Existing studies, such as Wu and Chen's (2020) application of DS in language education and Tao's (2022) exploration of its role in global citizenship education, demonstrate preliminary interest but lack systematic theoretical framing. Notably, no previous research has developed a comprehensive DS model specifically targeting CTS that aligns with China's policy directives like the *China Education Modernization 2035* initiative or addresses the unique characteristics of Chinese higher education, including its examination-oriented traditions and disciplinary diversity.

The DSCTS model addresses this gap through dual localization strategies. First, its focus on cultivating "innovation-ready graduates" directly responds to China's strategic demand for creative talent during industrial transformation (Literature Research Office of the CPC Central Committee, 2016). Second, the model incorporates a reversible DS workflow that allows students to backtrack to previous stages for refinement. This structured yet flexible approach maintains the open-ended nature of creative tasks while accommodating Chinese students' familiarity with sequential learning processes (Han, 2015), thereby reducing potential resistance to unstructured creative activities.

The model's adaptability to Chinese contexts is further demonstrated through seven folk art-inspired prototypes, such as *"The Rhythm of Grass-Hammering Painting"*. These implementations not only showcase DS's potential for cultural heritage preservation but also validate the model's effectiveness in fostering creative thinking within China's distinctive cultural and educational environment. This culturally-grounded approach provides a replicable framework for implementing DS in Chinese educational settings while maintaining theoretical rigor and practical relevance.

5.7.2 Novelty and Contributions of the Study: A Multimedia Design–Oriented Perspective

This study demonstrates its novelty and contribution by advancing digital storytelling as a multimedia design practice that systematically supports creative thinking development, rather than merely as a narrative or technical activity. The proposed DSCTS model foregrounds multimodal design processes, including visual composition, narrative structuring, symbolic representation, and iterative refinement, as the primary mechanisms through which creative thinking is cultivated in educational contexts.

From a multimedia design perspective, the DSCTS model extends existing DS research by integrating learning theory, creativity theory, and multimodal design principles into a coherent, process-oriented framework. Grounded in constructivist learning theory (Piaget, 1954), the model conceptualizes digital storytelling as an active multimedia meaning-making process in which learners construct and refine ideas through coordinated visual, verbal, and symbolic modes. Humanistic learning theory (Rogers, 1961) is incorporated to support expressive intention, emotional engagement, and creative agency, key factors influencing design decision-making in multimedia storytelling (Feigenbaum, 2024).

Crucially, the model establishes explicit mappings between the 3P creativity framework (Person, Process, Press) and the ADDIE instructional design phases, clarifying how improvements in creative thinking manifest through specific multimedia design actions. For example, divergent ideation and personal expression (Person) are activated during storyboarding and concept design; iterative production and editing (Process) support originality and elaboration; and peer critique and audience awareness (Press) inform refinement and narrative coherence. The integration of multimodal learning principles informed by cognitive theory (Mayer, 2002) and Dale's Cone of Experience (1969) further strengthens the theoretical link between creative thinking development and effective multimedia design decisions, addressing a gap in prior DS models that often treat creativity as an implicit or assumed outcome (Cai, 2024).

Methodologically, the study contributes to multimedia design research by demonstrating the applicability of Design Science Research (DSR) (Hevner et al., 2010) for developing and validating instructional design models grounded in multimedia practice. Following the five-phase DSR framework (Vaishnavi & Kuechler, 2015), the DSCTS model evolves through iterative cycles of design, implementation, and evaluation, enabling systematic refinement of multimedia workflows, design scaffolds, and instructional supports. This artifact-centric approach distinguishes the study from earlier digital storytelling frameworks that remain largely descriptive or tool-oriented (Smeda et al., 2010), and positions multimedia design not merely as content delivery, but as a structured design process subject to empirical investigation.

Practically, the DSCTS model offers innovation through its reversible multimedia storytelling workflow, which reflects the non-linear nature of authentic multimedia design practice. Unlike linear storytelling models (Poonsawad et al., 2022), the reversible process allows learners to move flexibly between ideation, design, production, editing, and reflection, thereby supporting iterative design thinking and creative refinement. The development of seven discipline-specific prototypes within the "*Introduction to Folk Art*" course (Chapter 4) further operationalizes the model by providing concrete examples of multimedia design implementation. These prototypes, such as *The Rhythm of Grass-Hammering Painting*, demonstrate how domain knowledge, creative thinking components, and multimedia storytelling phases can be integrated through visual symbolism, narrative pacing, and compositional decisions, moving beyond generic digital storytelling guidelines (Robin, 2008). Collectively, these practical resources help address the persistent implementation gap in digital storytelling adoption (Jitsupa et al., 2022) while offering educators transferable design strategies across arts and humanities contexts.

To consolidate these contributions, Table 5.1 (Framework at a Glance) synthesizes the DSCTS model by mapping digital storytelling phases to multimedia design principles, expected creative thinking facets, and corresponding evidence sources. It reinforces the model's contribution to multimedia design by clarifying how CTS development is operationalized through structured multimedia design processes.

Table 5.1

Framework at a Glance: DSCTS Model (DS Phases → Design Principles → Expected CTS Facets → Evidence)

DS Phase	**Core Design Principle (Integrated with ADDIE/3P Creativity)**	**Expected CTS Facet**	**Evidence Source & Key Metrics**
1. Pre-production (Storyboarding)	Divergent ideation + 3P (Person/Process/Press) scaffolding (creative identity/iterative ideation/context prompts) aligned with ADDIE's Analysis/Design phases	Fluency, Flexibility	- Prototypes: Expert rubric (3P integration $\geq$3.8/5; Krippendorff's $\alpha \geq 0.70$) - TTCT: Fluency/Flexibility subscale ($d \geq 0.7$; paired t-test $p < 0.05$)
2. Production (Core Material Creation)	Raw multimedia asset generation (footage/audio/visuals) aligned with ADDIE's Development phase; 3P "Product" focus on iterative material refinement	Originality (Foundational)	- Prototypes: Expert rubric (Originality subscore $\geq$4.0/5) - TTCT: Originality subscale ($d \geq 0.7$; $r \geq 0.6$ with phase engagement)
3. Post-production (Editing & Enhancement)	Technical refinement (editing, special effects, dubbing) into complete artifacts aligned with ADDIE's Development/Evaluation phases; elaborative detail checklists	Elaboration, Originality (Refined)	- Prototypes: Expert rubric (Elaboration subscore $\geq$4.0/5) - TTCT: Elaboration subscale ($d \geq 0.7$; paired t-test $p < 0.05$)
4. Distribution (Sharing & Peer Critique)	Audience-centered sharing + formative peer feedback aligned with ADDIE's Implementation/Evaluation phases; guided revision based on input	Elaboration (Iterative)	- Prototypes: Expert rubric (Iterative refinement score $\geq$3.8/5) - TTCT: Elaboration subscale ($r \geq 0.6$ with phase engagement)

5.7.3 Implications and Applications for Stakeholders

The findings of this study have differentiated implications for various stakeholders.

For students, the DSCTS model provides a learning environment that aligns with their identity as "digital residents" (Gonzalez-Ramirez et al., 2021), enabling them to engage creatively with multimodal tools while developing transferable creative thinking skills essential for future academic and professional contexts in the AI era.

For educators, the model offers a clear, process-oriented instructional guide that demonstrates how digital storytelling can be systematically integrated into coursework without sacrificing curricular objectives. It addresses common implementation challenges by translating abstract creativity goals into concrete teaching actions.

For curriculum designers, the DSCTS model illustrates how creative thinking can be embedded across instructional phases rather than treated as an add-on outcome. Its modular structure allows adaptation across disciplines while maintaining pedagogical coherence.

For educational institutions, the study provides empirical support for adopting structured digital storytelling approaches that align with broader educational modernisation goals, particularly those emphasising innovation, digital transformation, and talent development.

For policymakers, the findings resonate with national priorities articulated in the *China Education Modernisation 2035* blueprint by demonstrating a practical pathway for cultivating creative competencies through technology-enhanced pedagogy.

Finally, for future researchers, the study highlights the value of treating digital storytelling as a design-mediated intervention and identifies clear directions for further inquiry, including longitudinal validation, cross-disciplinary application, and the integration of domain-specific multimedia creativity assessments.

5.7.4 Validity Threats and Mitigation Strategies

While the preceding discussion outlines the theoretical contributions and practical implications of the DSCTS model for multiple stakeholders, it is equally important to critically examine the methodological rigor of the study by addressing potential validity threats and the strategies employed to mitigate them. Validity is a critical criterion for evaluating the rigor of educational intervention research (Reichardt, 002). This study acknowledges potential threats to construct, internal, external, and statistical conclusion validity, and has implemented targeted mitigation strategies to address these limitations. Table 5.2 summarizes the key validity threats and corresponding mitigation measures, with supporting evidence referenced to specific sections or appendices of this thesis.

Table 5.2

Summary of Validity Threats and Mitigation Strategies

Validity Type	Specific Threats	Mitigation Strategies	Evidence/Justification
1.Construct Validity	1. Mismatch between TTCT dimensions and CTS (Creative Thinking Skills) constructs measured by the DSCTS model; 2. Ambiguity in expert rubric definitions for "Model-Prototype Alignment"; 3. Over-reliance on ordinal Likert scale for complex design constructs.	1. Aligned TTCT subscales (fluency/flexibility/originality) with DSCTS creative thinking dimensions in Section 2.6; 2. Derived from a solid literature base (section 4.8.1), and the reported Krippendorff's α=0.79 (95% CI [0.67,0.88]) to confirm rubric reliability; 3. Supplemented ordinal ratings with qualitative expert commentary (Section 4.9.2);	1.Cross-reference between TTCT manual (Acar, 2023) and DSCTS framework (Section 2.6); 2. supported by both a robust literature foundation and expert vetting; 3. Qualitative expert quotes integrated into dimension analysis (Section 4.9.2)
2.Internal Validity	1. Maturation effect (students' CTS improvement due to time/growth, not DSCTS intervention); 2. Rater bias in TTCT/expert rubric scoring; 3. Lack of control group for pre-test/post-test comparison 4. Qualitative section with no detail coded excerpts	1. Shortened intervention duration to 8 weeks to minimize maturation effects (Section 3.4.2.2, i); 2. Calibrated 3 TTCT raters (Sections 3.4.4.2, iv); The inter-rater agreement of 3 experts was quantified (3.3.4.1); And Calculated ICC(2,3)=0.86 (95% CI [0.75,0.93]) for TTCT and Krippendorff's α for rubrics to rule out systematic rater bias 3. Acknowledged lack of control group in Discussion (Section 5.8) and proposed Phase-D quasi-experimental design 4. This is the first DSR iteration, subsequent research will engage more teachers and prioritize in-depth qualitative analysis.,	1. 8-week intervention timeline; 2. Rater training protocols; 3. Consistency analysis results (Sections 3.3.4.1/3.3.4.2); 4. Alternative explanation discussion (Section 5.8)
3.External Validity	1. Small sample size (N=31) of art/design undergraduates (limited generalizability); 2. Context-specificity of DSCTS model to digital storytelling in design education; 3. Single-institution sample	1. Clearly stated sample limitations in Abstract/Section 5.8 (e.g., "findings are generalizable only to similar design undergraduate cohorts"); 2. Provided detailed demographics of participants (Table 3.1) to enable replication in similar contexts; 3. Proposed multi-institution validation in Phase-D evaluation plan (Section 5.8)	1. Sample demographics in Table 3.1; 2. Phase-D evaluation framework (Table 5.1); 3. Limitations subsection (Section 5.8) explicitly addressing generalizability
4.Statistical Conclusion Validity	1. Small sample size increasing risk of Type II error in pre-test/post-test comparisons; 2.Multiple comparisons across TTCT dimensions/expert rubric subcomponents; 3. Overinterpretation of 95% CI for small samples	1. Calculated effect size (Cohen's d=0.817) for pre-test/post-test differences (Section 4.9.1.3) to complement p-values; 2. Applied Bonferroni correction for multiple comparisons (α=0.05/4=0.0125) for TTCT subdimensions; 3. Avoided definitive claims about CI precision; 4. Used bootstrap methods for Krippendorff's α 95% CI to improve robustness	1. Effect size calculation (Section 4.9.1); 2. Bonferroni-corrected p-values (Table 4.17); 3. Bootstrap output for α coefficients 4. Statistical limitations noted in Section 5.8

5.8 Limitations and Recommendations

Although this study has made some progress in exploring the conceptual model of DSCTS, several limitations remain and require improvement in future research.

5.8.1 Limitations

Despite its contributions, the study has four limitations that future research should address:

i. Measurement Scope of Creativity in a Multimedia Intervention

While the Torrance Tests of Creative Thinking (TTCT) is a well-established and psychometrically robust instrument for assessing general creative thinking ability, its use in this study entails an acknowledged limitation when evaluating a multimedia-based instructional intervention. Specifically, the TTCT does not directly assess creativity as manifested in digital storytelling artefacts or multimedia design outputs, such as visual aesthetics, narrative coherence, or technical execution. However, this limitation is a deliberate and theoretically grounded design choice, as the primary objective of the present study is to examine the extent to which the DSCTS model enhances transferable creative thinking capacity at the learner level, rather than to evaluate the creative quality of specific digital products. In this research, digital storytelling functions as a pedagogical and multimedia design carrier through which creative thinking processes are activated and cultivated, rather than as the outcome variable itself. Future research could extend the evaluation framework by incorporating domain-specific multimedia creativity assessments or artefact-based rubrics to further examine how gains in creative thinking translate into observable differences in multimedia storytelling quality, thereby complementing the current findings.

ii. Sample and Context Constraints

The empirical test focused on 31 art and design students at one Chinese university, limiting generalizability to other disciplines (e.g., STEM) or institutions. Future studies should expand to diverse samples (e.g., engineering, language students) and geographic regions.

iii. DSR Iteration Scope

Due to time constraints, the model underwent only one DSR cycle (Awareness→Conclusion). DSR emphasizes repeated refinement (Hevner et al., 2010), so additional cycles (e.g., re-evaluating the model in a 16-week course) could further optimize its components (e.g., simplifying the Distribution phase).

iv. Long-Term Effect Measurement

This study measured short-term CTS changes (pre-post test over 8 weeks). Future research should conduct longitudinal assessments (e.g., 6-month follow-ups) to examine whether CTS improvements persist and transfer to other learning contexts.

5.8.2 Recommendations for Future Research

In an era where AI and automation redefine workplace demands, creative thinking has become a non-negotiable competency (World Economic Forum, 2023). The DSCTS model not only addresses China's urgent need for innovative talent but also offers a globally relevant framework for integrating digital pedagogy with creativity cultivation. By grounding DS in theory, context, and practice, this study paves the way for future research to expand the frontiers of DS as a tool for 21st-century education. The recommendations for future research are as following:

i. **Broaden Disciplinary and Contextual Application**: Test the DSCTS model in non-art disciplines (e.g., computer science, biology) to explore its adaptability. For example, in STEM, DS could be used to narrate scientific experiments, with CTS components (e.g., "risk tolerance" in Person) targeting innovation in hypothesis design.

ii. **Integrate Emerging Technologies**: Incorporate AI tools (e.g., AIGC for multimedia creation) into the DSCTS model's Production phase. This could address technical barriers (e.g., limited animation skills) and explore how AI enhances or complements CTS cultivation.

iii. **Develop a Cross-Cultural Adaptation Framework**: Adapt the DSCTS model for other Confucian-heritage contexts (e.g., South Korea, Singapore) to identify universal principles and context-specific adjustments, further advancing global DS scholarship.

iv. **Strengthen Longitudinal and Comparative Designs**: Conduct a quasi-experimental study with a control group (receiving conventional DS without the DSCTS model) to isolate the model's unique effects. Longitudinal data will also clarify whether CTS improvements translate to academic achievement or career outcomes.

5.9 Conclusion

This study set out to develop a theoretically grounded, practically applicable conceptual model (DSCTS) that leverages digital storytelling to cultivate creative thinking skills in Chinese higher education. Guided by four research questions, the study achieved its objectives through Design Science Research, expert validation, and empirical investigation.

This study set out to develop and validate a conceptual design model (DSCTS) that leverages DS to foster CTS in Chinese higher education, addressing gaps in systematicity, instructional design integration, and contextual relevance. Through DSR methodology, the following key outcomes were achieved:

i. **Key Components of DSCTS**: The model integrates three interdependent modules, learning components (constructivism, ADDIE, PBL), CTS components (Person-Process-Press), and a four-stage DS workflow, each validated for relevance and practicality (Chapter 4).

ii. **DSCTS Development**: Using DSR, the model was iteratively refined through literature analysis, expert feedback, and prototype construction, ensuring alignment with both theory and classroom practice.

iii. **Validation Methods**: Expert review (9 experts) confirmed the model's relivance and clarity, while prototype consistency evaluations (5 experts) verified the alignment between the proposed model and the practice.

iv. **Effectiveness in Chinese Higher Education**: Implementation in an 8-week folk art course showed significant improvements in students' CTS (TTCT post-test scores: M=94.68 vs. pre-test: M=77.23; p<.001), with instructors reporting enhanced student engagement and creative risk-taking.

In conclusion, the DSCTS model represents a theoretically grounded, practically validated solution to fostering CTS in Chinese higher education. By integrating DS, CTS, and instructional design, it not only addresses critical gaps in existing literature but also provides educators with a scalable tool to nurture creative talent, aligning with both academic imperatives and national policy goals. As digital technologies continue to reshape education, the DSCTS model offers a blueprint for balancing structure and creativity, knowledge acquisition and innovation, and global pedagogical trends with local contextual needs.

REFERENCES

Abuhassna, H., & Alnawajha, S. (2023). Instructional design made easy! Instructional design models, categories, frameworks, educational context, and recommendations for future work. *European Journal of Investigation in Health, Psychology and Education*, *13*(4), 715-735.

Acar, S. (2023). Does the task structure impact the fluency confound in divergent thinking? An investigation with TTCT-Figural. *Creativity Research Journal*, *35*(1), 1-14.

Adams, W. C. (2015). Conducting semi-structured interviews. *Handbook of practical program evaluation*, 492-505.

Adeoye, M. A., Wirawan, K. A. S. I., Pradnyani, M. S. S., & Septiarini, N. I. (2024). Revolutionizing education: Unleashing the power of the ADDIE model for effective teaching and learning. *JPI (Jurnal Pendidik. Indones., vol. 13, no. 1, pp. 202–209, 2024, doi: 10.23887/jpiundiksha. v13i1. 68624*.

Almanasreh, E., Moles, R., & Chen, T. F. (2019). Evaluation of methods used for estimating content validity. *Research in social and administrative pharmacy*, *15*(2), 214-221.

Amabile, T. M. (1996). *Creativity in context: Update to the social psychology of creativity*. Boulder, CO: Westview Press.

Amabile, T. M., & Pratt, M. G. (2016). *The dynamic componential model of creativity and innovation in organizations: Making progress, making meaning.* Research in Organizational Behavior, 36, 157-183.

Anderson, J., Chung, Y. C., & Macleroy, V. (2018). Creative and critical approaches to language learning and digital technology: *Findings from a multilingual digital storytelling project. Language and Education, 32*(3), 195-211.

Anderson, R., Morris, H., & Keating, J. (2022). Creating psychologically safe classrooms for creativity. *Teaching and Teacher Education, 109*, 103545. https://doi.org/10.1016/j.tate.2021.103545

Austen, L., Pickering, N., & Judge, M. (2021). Student reflections on the pedagogy of transitions into higher education, through digital storytelling. *Journal of Further and Higher Education*, *45*(3), 337-348.

Azizah, C. O. (2016). *Conceptual design models for interactive television advertising: Towards influencing impulse purchase.* (Doctoral dissertation, Universiti Utara Malaysia, 2016).

Baas, M., De Dreu, C. K., & Nijstad, B. A. (2020). *The emotional core of creativity: The central role of affect in creativity.* In M. L. Brower (Ed.), The Cambridge handbook of creativity and emotions (pp. 45-63). Cambridge University Press.

Baer, J., & Kaufman, J. C. (2005). Bridging generality and specificity: The Amusement Park Theoretical (APT) model of creativity. *Roeper Review, 27*(3), 158–163. https://doi.org/10.1080/02783190509554310

Bai, S., Yang, C., Pickal, A. J., Liu, Y., Özsoy, M. D., Yang, Y., & Chen, S. T. (2025). Harnessing educational digital storytelling: a systematic review of cognitive and affective learning outcomes in the recent decade (2014–2024). *Interactive Technology and Smart Education*, 1-25.

Baird, B., Smallwood, J., Mrazek, M. D., Kam, J. W., Franklin, M. S., & Schooler, J. W. (2012). Inspired by distraction: Mind wandering facilitates creative incubation. *Psychological science*, *23*(10), 1117-1122.

Barbot, B., Besançon, M., & Lubart, T. (2015). Creative potential in educational settings: Its nature, measure, and nurture. *Education* 43(4), 371-381.

Barrett, H. (2006, March). Researching and evaluating digital storytelling as a deep learning tool. In *Society for information technology & teacher education international conference* (pp. 647-654). Association for the Advancement of Computing in Education (AACE).

Barrett, T. (2010). The problem-based learning process as finding and being in flow. *Innovations in Education and Teaching International, 47*(2), 165–174. https://doi.org/10.1080/14703291003718901

Baskerville, R., Baiyere, A., Gregor, S., Hevner, A., & Rossi, M. (2018). Design science research contributions: Finding a balance between artifact and theory. *Journal of the Association for Information Systems*, *19*(5), 3.

Beaty, R. E., Benedek, M., Silvia, P. J., & Schacter, D. L. (2016). *Creative cognition and brain network dynamics.* Trends in Cognitive Sciences, 20(2), 87-95.

Bedir, H. (2019). Pre-service ELT instructors' beliefs and perceptions on 21st century learning and innovation skills (4Cs). *Journal of Language and Linguistic Studies*, *15*(1), 231-246.

Beghetto, R. A., & Karwowski, M. (2023). Creative self-beliefs: From creative potential to creative action. In *Handbook of organizational creativity* (pp. 179-193). Academic Press.

Beghetto, R. A., & Kaufman, J. C. (2014). Classroom contexts for creativity. *Thinking Skills and Creativity, 13*, 1–8. https://doi.org/10.1016/j.tsc.2014.01.002

Bell, S. (2010). Project-based learning for the 21st century: Skills for the future. *The clearing house*, *83*(2), 39-43.

Bordwell, D., & Thompson, K. (2017). Film art: An introduction. *McGraw-Hill Education*.

Branch, R. M. (2009). *Instructional design: The ADDIE approach*. Springer.

Branch, R. M., & Dousay, T. A. (2015). *Survey of instructional design models* (5th ed.). AECT.

Brilliantio. (2024). Digital storytelling evolution: Tracing its progress and impact. *Digital Culture Review,* 8(2), 33-42.

Bryant, P. (2023). Student experience and digital storytelling: Integrating the authentic interaction of students work, life, play and learning into the co-design of university teaching practices. *Education and Information Technologies*, *28*(11), 14051-14069.

Bryman, A. (2012). *Social research methods* (4th ed.). Oxford University Press.

Budiman, A., Samani, M., & Setyawan, W. H. (2021). The Development of Direct-Contextual Learning: A New Model on Higher Education. *International Journal of Higher Education*, *10*(2), 15-26.

Cahyani, N. K. C. (2021). The Effectiveness of Project-Based Learning Models in Improving Students' Creativity (A Literature Review). *The Art of Teaching English as a Foreign Language (TATEFL)*, *2*(1), 73-77.

Cai, M. (2024). A Study and Application of Digital Storytelling in Digital Humanities Education. *International Journal of New Developments in Education.* Vol. 6, Issue 10: 91-100, DOI: 10.25236/IJNDE.2024.061015

Calavia, M. B., Blanco, T., & Casas, R. (2021). Fostering creativity as a problem-solving competence through design: Think-Create-Learn, a tool for instructors. *Thinking skills and creativity*, *39*, 100761.

Carvalho, L. M. C., & Noronha, A. B. (2020). An Outlook About the Application of Digital Storytelling in Higher Education. In *Learning Styles and Strategies for Management Students* (pp. 35-48). IGI Global.

Cech, E. A., & Hiltner, S. (2022). Unsettled Employment, Reshuffled Priorities? Career Prioritization among College-Educated Workers Facing Employment Instability during COVID-19. *Socius*, *8*, 23780231211068660.

Cennamo, K., Douglas, S. A., Vernon, M., Brandt, C., Scott, B., Reimer, Y., & McGrath, M. (2011, March). Promoting creativity in the computer science design studio. In *Proceedings of the 42nd ACM technical symposium on Computer science education* (pp. 649-654).

Çetin, E. (2021). Digital storytelling in teacher education and its effect on the digital literacy of pre-service instructors. *Thinking Skills and Creativity*, *39*, 100760.

Chaisriya, K., Kaeophanuek, S., & Gilbert, L. (2023). The effects of integrating digital storytelling with metacognition strategies (DSTMC) learning model to enhance communication abilities. *Contemporary Educational Technology*, *15*(2), ep416.

Chen, H. L., & Chuang, Y. C. (2021). The effects of digital storytelling games on high school students' critical thinking skills. *Journal of computer assisted learning*, *37*(1), 265-274.

Chen, L. (2021). *Folk art and design*. Northwestern Polytechnical University Press. China.

Chen, S. Y., Lai, C. F., Lai, Y. H., & Su, Y. S. (2022). Effect of project-based learning on development of students' creative thinking. *The International Journal of Electrical Engineering & Education*, *59*(3), 232-250.

Chung, M. H. (2021). Digital Storytelling Project for Language Instructors: Using Personal Narratives and Technology for Authentic Learning Experience. In *Interdisciplinary Approaches Toward Enhancing Teacher Education* (pp. 50-68). IGI Global.

Chung, Y. C. (2016). Engaging learners in Chinese complementary schools: a multilingual digital storytelling project. *Language Issues: The ESOL Journal*, *27*(1), 99-100.

Clapham, M. M. (1998). Structure of figural forms A and B of the Torrance Tests of Creative Thinking. *Educational and Psychological Measurement*, *58*(2), 275-283.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Erlbaum.

Cohen, L., Manion, L., & Morrison, K. (2018). *Research methods in education.* Routledge.

Condliffe, B. (2017). Project-Based Learning: A Literature Review. Working Paper. *MDRC*.

Corazza, G. E., Agnoli, S., & Mastria, S. (2022). The dynamic creativity framework. *European Psychologist*.

Cosme, J. (2014). Pathos and performance in modern digital storytelling. *Media and Communication Studies,* 12(1), 55-72.

Craft, A. (2005). *Creativity in schools: Tensions and dilemmas*. Routledge.

Creswell, J. W., & Clark, V. L. P. (2017). *Designing and conducting mixed methods research* (3rd ed.). Sage Publications.

Cropley, D. H. (2015). Promoting creativity and innovation in engineering education. *Psychology of Aesthetics, Creativity, and the Arts*, *9*(2), 161.

Csikszentmihalyi, M. (1999). 16 implications of a systems perspective for the study of creativity. *Handbook of creativity*, *313*.

Dale, E. (1969). *Audiovisual methods in teaching*.

Daniels, A. D., & Venter, I. M. (2023). The innerworkings of digital storytelling. *International Journal of Online Pedagogy and Course Design (IJOPCD)*, *13*(1), 1-18.

David, (2023, Aprial 10). TPACK Model: Framework Explanations, Components, Best Practices and Examples. Retrieved June 21, 2023. From: https://blog.heyhi.sg/tpack-model-framework-explanations-components-best-practices-and-examples/.

Davis, G. (2023). Digital multimedia creation: Processes and innovations. *Journal of Digital Arts Education*, 18(2), 45-65.

Davis, L. L. (1992). Instrument review: Getting the most from a panel of experts. *Applied nursing research*, *5*(4), 194-197.

De Sordi, J. O. (2021). *Design science research methodology: theory development from artifacts*. Springer Nature.

Deardorff, D. K. (2020). *Manual for developing intercultural competencies: Story circles* (p. 116). Taylor & Francis.

DeJonckheere, M., & Vaughn, L. M. (2019). Semistructured interviewing in primary care research: A balance of relationship and rigour. *Family Medicine and Community Health*, *7*(2), e000057. https://doi.org/10.1136/fmch-2018-000057

Demirbaş, İ., & Şahin, A. (2023). The effect of digital stories on primary school students' creative writing skills. *Education and Information Technologies*, *28*(7), 7997-8025.

DePape, A. M., & Doyle-Thomas, K. (2022). Students' Perceptions of Digital Storytelling in Higher Education. *Innovative Practice in Higher Education*, *4*(3).

DeVellis, R. F. (2004). *Scale development: Theory and applications* (2nd ed.). Sage Publications.

Di Blas, N. (2022). Authentic Learning, Creativity and Collaborative Digital Storytelling. *Educational Technology & Society*, *25*(2), 80-104.

Dia-Eddine, K. (2021). Digital Storytelling for Tertiary Education in the Era of Digitization: Construction and Evaluation of Two Experiences. In *Social Innovation and Social Technology: Enterprise-New Technology Synergy* (pp. 16-49). Springer International Publishing.

Dick, W., Carey, L., & Carey, J. O. (2009). *The systematic design of instruction* (7th ed.). Pearson.

Digital Learning Institute. (n.d.). *The digital learning design process: ADDIE model for instructional design.* Retrieved July 16, 2024, from https://www.digitallearninginstitute.com/blog/the-digital-learning-design-process-addie-model-for-instructional-design

Dorussen, H., Lenz, H., & Blavoukos, S. (2005). Assessing the reliability and validity of expert interviews. *European Union Politics*, *6*(3), 315-337.

Dou, X., Li, H., & Jia, L. (2021). The linkage cultivation of creative thinking and innovative thinking in dance choreography. *Thinking Skills and Creativity*, *41*, 100896.

Dousay, T., & Logan, R. (2011). Analyzing and Evaluating the Phases of ADDIE. In *Proceedings from Design, Development and Research Conference* (pp. 32-43).

Duffy, T. M., & Jonassen, D. H. (1991). Constructivism: New implications for instructional technology. *Educational technology*, *31*(5), 7-12.

Edelen, D., & Skukauskaitė, A. (2022). Untangling constructionisms: Social constructions of qualitative research pedagogies. In *Engaging students in socially constructed qualitative research pedagogies* (pp. 21-41). Brill.

Efgivia, M. G., Rinanda, R. A., Hidayat, A., Maulana, I., & Budiarjo, A. (2021, October). Analysis of Constructivism Learning Theory. In *1st UMGESHIC International Seminar on Health, Social Science and Humanities (UMGESHIC-ISHSSH 2020)* (pp. 208-212). Atlantis Press.

Feigenbaum, K. D. (2024). A critique of Abraham Maslow and Carl Rogers as educators. *Journal of Humanistic Psychology*, *64*(1), 44-63.

Flavell, J. H. (1979). Metacognition and cognitive monitoring: A new area of cognitive-developmental inquiry. *American Psychologist, 34*(10), 906-911.

Gao, Z., Liu, X., Zhang, D., Liu, M., & Hao, N. (2021). Subcortical structures and visual divergent thinking: A resting-state fMRI analysis. *Brain Structure and Function*, *226*(8), 2613–2624. https://doi.org/10.1007/s00429-021-02354-2

Glăveanu, V. P. (2010). Paradigms in the study of creativity: Introducing the perspective of cultural psychology. *New Ideas in Psychology*, 28(1), 79-93.

Glăveanu, V. P. (2013). *Rewriting the language of creativity: The Five A's framework.* Review of General Psychology, 17(1), 69-81.

Gong, Z., Lee, L. H., Soomro, S. A., Nanjappan, V., & Georgiev, G. V. (2022). A systematic review of virtual brainstorming from the perspective of creativity: Affordances, framework, and outlook. *Digital Creativity*, *33*(2), 96-127.

Gonzalez-Ramirez, J., Mulqueen, K., Zealand, R., Silverstein, S., Mulqueen, C., & BuShell, S. (2021). Emergency online learning: college students' perceptions during the COVID-19 pandemic. *College Student Journal*, *55*(1), 29-46.

Grybauskas, A., Stefanini, A., & Ghobakhloo, M. (2022). Social sustainability in the age of digitalization: A systematic literature Review on the social implications of industry 4.0. *Technology in Society*, *70*, 101997.

Gube, M., & Lajoie, S. (2020). Adaptive expertise and creative thinking: A synthetic review and implications for practice. *Thinking Skills and Creativity*, *35*, 100630.

Guilford, J. P. (1950). *Creativity. American Psychologist,* 5, 444–454.

Guilford, J. P. (1967). *The nature of human intelligence*. New York, US: McGraw-Hill Education.

Guilford, J. P. (1986). *Creative talents: Their nature, uses and development.* Buffalo, NY: Bearly Limited.

Gürsoy, G. (2021). Digital Storytelling: Developing 21st Century Skills in Science Education. *European Journal of Educational Research*, *10*(1), 97-113.

Han, W. (2025). Understanding creative teaching in China: An empirical study by a narrative inquiry method. *Thinking Skills and Creativity*, *56*, 101761.

Hassan, N., Ramli, M. S., Halif, M. M., Aziz, R. A., & Zainal, N. Z. (2021). The Predictors of Employee Mindset towards Employee Innovativeness: A Comparative Study between Two Government-Linked Companies in Malaysia. *Revista Geintec-Gestao Inovacao E Tecnologias*, *11*(4), 2801-2816.

Hava, K. (2021). Exploring the role of digital storytelling in student motivation and satisfaction in EFL education. *Computer Assisted Language Learning, 34*(7), 958-978.

He, D., & Zhao, J. (2022). The origin and correction of student-centered thinking. *Teaching and Management* (12),18-21.

He, J., & Song, L. (2022). A study on the cultivation of "craftsman spirit" in college students with innovation Studio as the carrier. *Higher Education Journal* (07), 25-28. doi:10.19980/ j.cn23-1593 /G4.2022.07.006.

He, K. (2016). Chapter 5: *An introduction to instructional system design.* In K. He (Ed.), Instructional system design (2nd ed., pp. 78–95). Higher Education Press.

He, K. (2017). A Theory of Creative Thinking: Construction and Verification of the Dual Circulation Model. *Lecture Notes in Educational Technology*.

Hennessey, B. A. (2010). *The creativity-motivation connection. In J. C. Kaufman & R. J. Sternberg (Eds.)*, The Cambridge handbook of creativity (pp. 342-365). Cambridge University Press.

Hennessey, B. A. (2019). Motivation and creativity. *The Cambridge.*

Henriksen, D., Mishra, P., & Fisser, P. (2016). Infusing creativity and technology in 21st century education: A systemic view for change. *Educational Technology & Society, 19*(3), 27–37.

Hevner, A. R. (2007). A three cycle view of design science research. *Scandinavian journal of information systems*, *19*(2), 4.

Hevner, A., & Chatterjee, S. (2010). Design science research frameworks. In *Design research in information systems* (pp. 23-31). Springer, Boston, MA.

Hevner, A., & Gregor, S. (2022). Envisioning entrepreneurship and digital innovation through a design science research lens: A matrix approach. *Information & Management*, *59*(3), 103350.

Hevner, A., Chatterjee, S., & Iivari, J. (2010). Twelve Theses on Design Science Research in Information Systems. *Design research in information systems: Theory and practice*, 43-62.

Hevner, A., Vom Brocke, J., & Maedche, A. (2019). Roles of digital innovation in design science research. *Business & Information Systems Engineering*, *61*, 3-8.

Hevner, A. R., March, S. T., Park, K., & Ram, S. (2010). Design Research in Information Systems Research. *MIS Quarterly*, *28*(1), 76-105.

Hmelo-Silver, C. E. (2004). Problem-based learning: What and how do students learn?. *Educational psychology review*, *16*(3), 235-266.

Hull, G. A., & Katz, M. L. (2006). Crafting an agentive self: Case studies of digital storytelling. *Research in the Teaching of English*, 43-81.

Humble, S., Dixon, P., & Mpofu, E. (2018). Factor structure of the Torrance Tests of Creative Thinking Figural Form A in Kiswahili speaking children: Multidimensionality and influences on creative behavior. *Thinking Skills and Creativity*, *27*, 67–76. https://doi.org/10.1016/j.tsc.2017.11.005

IP Awareness Foundation. (2020). *Making movies: Teaching resource.* Retrieved from https://ipawareness.org.au

Israel-Fishelson, R., & Hershkovitz, A. (2022). Studying interrelations of computational thinking and creativity: A scoping review (2011–2020). *Computers & Education*, *176*, 104353.

Ivala, E., Gachago, D., Condy, J., & Chigona, A. (2014). Digital Storytelling and Reflection in Higher Education: A Case of Pre-Service Student Instructors and Their Lecturers at a University of Technology. *Journal of Education and Training Studies*, *2*(1), 217-227.

Jamiludin, J., & Darnawati, D. (2022). Project-based digital photovoice: Teaching local history through the visual method. *Social and Education History*, *11*(3).

Jamissen, G., Hardy, P., Nordkvelle, Y., & Pleasants, H. (2017). Digital storytelling in higher education. *International perspectives*.

Jewitt, C. (2008). Multimodality and literacy in school classrooms. *Review of Research in Education, 32*(1), 241-267.

Jewitt, C. (Ed.). (2009). *The Routledge handbook of multimodal analysis* (Vol. 1). London: Routledge.

Jia, X., Li, W., & Cao, L. (2019). The role of metacognitive components in creative thinking. *Frontiers in psychology*, *10*, 2404.

Jing, X. (2022). The practical path of "science and innovation project" to improve the effect of education under the background of comprehensively revitalizing undergraduate education. *Educational Observation* (07),62-64+68. doi:10.16070/j.cnki.cn45-1388/ G4s.2022.07.021.

Jirásek, M., & Sudzina, F. (2020). Big five personality traits and creativity. *Quality Innovation Prosperity*, *24*(3), 90-105.

Jitsupa, J., Nilsook, P., Songsom, N., Siriprichayakorn, R., & Yakeaw, C. (2022). Early Childhood Imagineering: A Model for Developing Digital Storytelling. *International Education Studies*, *15*(2), 89-101.

Johnson, C. I., & Mayer, R. E. (2009). A testing effect with multimedia learning. *Journal of Educational Psychology*, *101*(3), 621.

Johnson, D. B., Maltz, D. A., & Broch, J. (2001). DSR: The dynamic source routing protocol for multi-hop wireless ad hoc networks. *Ad hoc networking*, *5*(1), 139-172.

Johnson, D. W., & Johnson, R. T. (1994). Collaborative learning: Theory and practice. *Educational Psychology Review,* 6(4), 291-321.

Johnson, D. W., & Johnson, R. T. (2009). An educational psychology success story: Social interdependence theory and cooperative learning. *Educational Researcher, 38*(5), 365-378. https://doi.org/10.3102/0013189X09339057

Jonassen, D. H., Howland, J. L., & Marra, R. M. (1999). *Learning with technology: A constructivist perspective.* Prentice Hall.

Jonsson, A., & Svingby, G. (2007). The use of scoring rubrics: Reliability, validity and educational consequences. *Educational Research Review*, *2*(2), 130–144. https://doi.org/10.1016/j.edurev.2007.05.002

Joshi, A., Kale, S., Chandel, S., & Pal, D. K. (2015). Likert scale: Explored and explained. *British Journal of Applied Science & Technology*, *7*(4), 396–403. https://doi.org/10.9734/BJAST/2015/14975

Joynes, C., Rossignoli, S., & Amonoo-Kuofi, E. F. (2019). 21st Century Skills: evidence of issues in definition, demand and delivery for development contexts.

Kallio, H., Pietilä, A., Johnson, M. H., & Kangasniemi, M. (2016). Systematic methodological review: developing a framework for a qualitative semi-structured interview guide. *Journal of Advanced Nursing, 72*(12), 2954–2965. https://doi.org/10.1111/jan.13031.

Karaahmetoğlu, K., & Korkmaz, Ö. (2019). The effect of project-based arduino educational robot applications on students' computational thinking skills and their perception of basic stem skill levels. *Participatory Educational Research*, *6*(2), 1-14.

Kaufman, J. C., & Baer, J. (2005). The Amusement Park Theoretical (APT) model of creativity. *Korean Journal of Thinking & Problem Solving*, 15(2), 15-25.

Kaufman, J. C., & Beghetto, R. A. (2009). Beyond big and little: The four c model of creativity. *Review of General Psychology*, 13(1), 1-12.

Kemmis, S., McTaggart, R., & Nixon, R. (2014). *The action research planner: Doing critical participatory action research.* Springer.

Kerr, B. (1991). *A handbook for counseling the gifted and talented*. American Association for Counseling and Development, 5999 Stevenson Ave., Alexandria, VA 22304 (Order No. 72030: $29.95).

Khatib, M., Sarem, S. N., & Hamidi, H. (2013). Humanistic education: Concerns, implications and applications. *Journal of Language Teaching and Research*, *4*(1), 45-51.

Khoiri, A., Komariah, N., Utami, R. T., Paramarta, V., & Sunarsi, D. (2021, February). 4Cs Analysis of 21st Century Skills-Based School Areas. In *Journal of Physics: Conference Series* (Vol. 1764, No. 1, p. 012142). IOP Publishing.

Kim, D., Coenraad, M., & Park, H. R. (2021). Digital storytelling as a tool for reflection in virtual reality projects. *Journal of Curriculum Studies Research*, *3*(1), 101-121.

Kim, K. H. (2005). Can only intelligent people be creative? A meta-analysis. *Journal of Secondary Gifted Education*, *16*(2-3), 57-66.

Kim, K. H. (2006). Can we trust creativity tests? A review of the Torrance Tests of Creative Thinking (TTCT). Creativity research journal, 18(1), 3-14.

Kim, K. H. (2017). The torrance tests of creative thinking-figural or verbal: Which one should we use?. *Creativity. Theories–Research-Applications*, *4*(2), 302-321

Koehler, M., & Mishra, P. (2009). What is technological pedagogical content knowledge (TPACK)?. *Contemporary issues in technology and teacher education*, *9*(1), 60-70.

Koneru, L. (2018). Using Design Science Research to Develop a Conceptual Solution for Improving Knowledge Sharing in a Virtual Workspace.

Koo, T. K., & Li, M. Y. (2016). A guideline of selecting and reporting intraclass correlation coefficients for reliability research. *Journal of Chiropractic Medicine, 15*(2), 155–163. https://doi.org/10.1016/j.jcm.2016.02.012

Kress, G. (2009). *Multimodality: A social semiotic approach to contemporary communication*. routledge.

Krippendorff, K. (1989). Content analysis. *International encyclopedia of communication*, *1*(1), 403-407.

Kunter, M., Baumert, J., & Köller, O. (2013). Effective classroom management and the development of student competencies. *Learning and Instruction, 23*, 1–6. https://doi.org/10.1016/j.learninstruc.2012.12.001.

Lachner, A., Fabian, A., Franke, U., Preiß, J., Jacob, L., Führer, C., ... & Thomas, P. (2021). Fostering pre-service instructors' technological pedagogical content knowledge (TPACK): A quasi-experimental field study. *Computers & Education*, *174*, 104304.

Lambert, J. (2006). *Digital storytelling cookbook: February 2007*. Digital Diner Press.

Lambert, J. (2010). *Digital Storytelling Cookbook*. Digital Diner Press.

Lambert, J. (2017). The central role of practice in digital storytelling. In *Digital storytelling: Form and content* (pp. 21-26). London: Palgrave Macmillan UK.

Lambert, J., & Hessler, B. (2018). *Digital storytelling: Capturing lives, creating community.* Routledge.

Lansing-Stoeffler, K., & Daley, N. (2023). Navigating the spectrum of conventionality: Toward a new model of creative thinking. *Journal of Intelligence*, *11*(2), 21.

Lazareva, A., & Cruz-Martinez, G. (2021). Digital storytelling project as a way to engage students in twenty-first century skills learning. *International Studies Perspectives*, *22*(4), 383-406.

Lee, C. (2000). A method of analyzing improvisations in music therapy. *Journal of Music Therapy*, *37*(2), 147-167.

Lee, J. H., & Lee, S. (2023). Relationships between physical environments and creativity: A scoping review. *Thinking Skills and Creativity*, *48*, 101276.

Lee, R.M., Yuan, Y.(. (2018). Innovation Education in China: Preparing Attitudes, Approaches, and Intellectual Environments for Life in the Automation Economy. In: *Gleason, N. (eds) Higher Education in the Era of the Fourth Industrial*

Revolution. Palgrave Macmillan, Singapore. https://doi.org/10.1007/978-981-13-0194-0_5.

Lehmann, E. L., Romano, J. P., & Casella, G. (1986). *Testing statistical hypotheses* (Vol. 3). New York: springer.

Li, J., Cui, J., & Tian, H. (2022). Improving "practical" college physics experimental instruments to improve the quality of experimental teaching. *Heilongjiang Education (Theory and Practice)* (04),75-77.

Li, M., & Chen, P. (2021). Reflections on the integration of information technology and curriculum from the perspective of design research. *China Audio-Visual Education*(10), 8–14.

Li, T., & Zhan, Z. (2022). A Systematic Review on Design Thinking Integrated Learning in K-12 Education. *Applied Sciences*.

https://doi.org/10.3390/app12168077.

Li, Z., & Zhu, G. (2021). Knowledge transfer performance of industry-university-research institute collaboration in China: The moderating effect of partner difference. *Sustainability*, *13*(23), 13202.

Lin, Y. S. (2011). Fostering creativity through education–a conceptual framework of creative pedagogy. *Creative education*, *2*(03), 149.

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. Sage Publications.

Lindgren, B. M., Lundman, B., & Graneheim, U. H. (2020). Abstraction and interpretation during the qualitative content analysis process. *International journal of nursing studies*, *108*, 103632.

Literature Research Office of the CPC Central Committee. (2016). *Excerpts on comprehensively deepening reform by Xi Jinping*. Central Party Literature Press.

Lowe, R. K., & Boucheix, J. M. (2011). Cueing complex animations: Does direction of attention foster learning processes? *Learning and Instruction*, 21(5), 650-663.

Lu, J., & Xue, X. (2017). Training mode of innovative talents of civil engineering education based on TRIZ Theory in China. *Eurasia Journal of Mathematics, Science and Technology Education*, *13*(7), 4301-4309.

Lubart, T., Glăveanu, V., de Vries, H., & Storme, M. (2019). Cultural perspectives on creativity. In J. C. Kaufman & R. J. Sternberg (Eds.), *The Cambridge handbook of creativity* (2nd ed., pp. 421-447). Cambridge University Press.

Lucas, B., Claxton, G., & Spencer, E. (2013). *Progression in creativity: Developing new forms of assessment*. OECD Education Working Papers. https://doi.org/10.1787/5k4dp59msdwk-en

Lund, A. M. (2001). Measuring usability with the USE questionnaire. *Usability Interface, 8*(2), 3-6. https://www.researchgate.net/publication/230786746

Lynch, M., Kamovich, U., Longva, K. K., & Steinert, M. (2021). Combining technology and entrepreneurial education through design thinking: Students' reflections on the learning process. *Technological Forecasting and Social Change*, *164*, 119689.

Maslow, A. H. (1970). *Motivation and personality* (2nd ed.). Harper & Row.

Mayer, R. E. (2002). Multimedia learning. In *Psychology of learning and motivation* (Vol. 41, pp. 85-139). Academic Press.

Mayer, R. E. (2009). Constructivism as a theory of learning versus constructivism as a prescription for instruction. In *Constructivist instruction* (pp. 196-212). Routledge.

Mayer, R. E. (2020). Designing multimedia instruction in anatomy: An evidence-based approach. *Clinical Anatomy*, *33*(1), 2-11.

Mayr, H. C., & Thalheim, B. (2021). The triptych of conceptual modeling: A framework for a better understanding of conceptual modeling. *Software and Systems Modeling*, *20*(1), 7-24.

McCloud, S. (1993*). Understanding comics: The invisible art.* HarperPerennial.

McGovern, J., Burt, K. G., & Schwittek, D. (2021). Food for Thought: Culturally Diverse Older Adults' Views on Food and Meals Captured by Student-Led Digital Storytelling in the Bronx. *Urban Social Work*, *5*(1), 60-75.

Meadows, D. (2010). *Digital storytelling*. CRC Press.

Mednick, S. (1962). The associative basis of the creative process. *Psychological Review,* 69(3), 220-232.

Meletiadou, E. (2022). Using educational digital storytelling to enhance multilingual students' writing skills in higher education. *IAFOR Journal of Education*, *10*(2), 111-130.

Millar, G. W. (2002). *The Torrance kids at mid-life.* Westport, CT: Ablex.

Miller, C. H. (2019). *Digital Storytelling 4e: A creator's guide to interactive entertainment*. CRC Press.

Mills, K. A. (2010). A review of the "digital turn" in the new literacy studies. *Review of Educational Research, 80*(2), 246-271.

Ministry of Education of the People's Republic of China. (2018). *National Standards for Teaching Quality of Undergraduate Programs in Regular Higher Education Institutions.* http://www.moe.gov.cn/ (Original work published in Chinese)

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge. *Teachers College Record, 108*(6), 1017–1054.

Mishra, P., Koehler, M. J., & Henriksen, D. (2011). The seven trans-disciplinary habits of mind: Extending the TPACK framework towards 21st century learning. *Educational Technology, 51*(2), 22–28.

Mishra, S. B., & Alok, S. (2022). Handbook of research methodology.

Moestrup, S. D., & Vestergaard, K. (2023). Bringing it to the classroom: An empirical study of using a hands-on model for creating digital storytelling. *Journal of Educational Technology,* 45(3), 112-130.

Monika, H., & Martin, Š. (2022). Challenging intercultural discomforts: Intercultural communicative competence through digital storytelling. *Training, Language and Culture*, *6*(3), 78-88.

Mulyana, A., Permanasari, A., & Wahyudin, D. (2021). The development of creative thinking skills assessment instrument based on digital storytelling. *Journal of Physics: Conference Series*, 1796(1), 012050. https://doi.org/10.1088/1742-6596/1796/1/012050

Murray, J. H. (2017). *Hamlet on the Holodeck* (Updated ed.). MIT Press.

Murray, S., Liang, N., Brosowsky, N., & Seli, P. (2024). What are the benefits of mind wandering to creativity?. *Psychology of Aesthetics, Creativity, and the Arts*, *18*(3), 403.

Nair, V., & Md Yunus, M. (2022). Using Digital Storytelling to Improve Pupils' Speaking Skills in the Age of COVID 19. *Sustainability*, *14*(15), 9215.

Nasifoglu Elidemir, S., Ozturen, A., & Bayighomog, S. W. (2020). Innovative behaviors, employee creativity, and sustainable competitive advantage: A moderated mediation. Sustainability, 12(8), 3295.

Nasir, W. M. F. W. M., Halim, L., & Arsad, N. M. (2024). Fostering Creative Thinking Skills through Digital Storytelling. *Journal of Pedagogical Research*, *8*(3), 147-162.

Nicoli, N., Henriksen, K., Komodromos, M., & Tsagalas, D. (2022). Investigating digital storytelling for the creation of positively engaging digital content. *EuroMed Journal of Business*, *17*(2), 157-173.

Nishioka, H. (2016). Analysing language development in a collaborative digital storytelling project: Sociocultural perspectives. *System*, 62, 39-52. https://doi.org/10.1016/J.SYSTEM.2016.07.001.

OECD. (2018). *The future of education and skills: Education 2030*. OECD Publishing. https://www.oecd.org/education/2030-project/

OECD. (2019). *OECD learning compass 2030: A series of concept notes*. OECD Future of Education and Skills 2030 project.

Offermann, P., Levina, O., Schönherr, M., & Bub, U. (2009, May). Outline of a design science research process. In *Proceedings of the 4th International Conference on Design Science Research in Information Systems and Technology* (pp. 1-11).

Ohler, J. (2008). The world of digital storytelling. *Educ. Leadersh.* 63, 44–47.

Ohler, J. B. (2013). *Digital storytelling in the classroom: New media pathways to literacy, learning, and creativity*. Corwin Press.

O'Keefe, R. M., & O'Leary, D. E. (1993). Expert system verification and validation: a survey and tutorial. *Artificial Intelligence Review*, *7*, 3-42.

ÖZEN, N. E., & DURAN, E. (2021). Contribution of digital storytelling to creative thinking skills. *Turkish Journal of Education,* 10(4), 297-318.

Peffers, K., Tuunanen, T., Rothenberger, M. A., & Chatterjee, S. (2007). A design science research methodology for information systems research. *Journal of management information systems*, *24*(3), 45-77.

Petrou, P., van der Linden, D., & Salcescu, O. C. (2020). When breaking the rules relates to creativity: The role of creative problem - solving demands and organizational constraints. *The Journal of Creative Behavior*, *54*(1), 184-195.

Piaget, J. (1954). *The construction of reality in the child* (M. Cook, Trans.). Basic Books.

Piaget, J. (1972). Development and learning. *Reading in child behavior and development*, 38-46.

Piaget, J. (1976). Piaget's theory. In *Piaget and his school: A reader in developmental psychology* (pp. 11-23). Berlin, Heidelberg: Springer Berlin Heidelberg.

Plucker, J. A. (2021). *Creativity and innovation: Theory, research, and practice*. Routledge.

Plucker, J. A., & Makel, M. C. (2010). Assessment of creativity. In J. C. Kaufman & R. J. Sternberg (Eds.), *The Cambridge handbook of creativity* (pp. 48-73). Cambridge University Press.

Poonsawad, A., Srisomphan, J., & Sanrach, C. (2022). Synthesis of problem-based interactive digital storytelling learning model under gamification environment promotes students' problem-solving skills. *International Journal of Emerging Technologies in Learning (iJET)*, *17*(5), 103-119.

Puentedura, R. R. (2014). *SAMR: A contextualized introduction.*

Puentedura, R.R. (2006). SAMR model. *Transforming Education*. Retrieved from http://www.hippasus.com/rrpweblog/archives/2014/07/01/SAMR_and_TPCK_Introduction.pdf

Purswell, K. E. (2019). Humanistic Learning Theory in Counselor Education. *Professional Counselor*, *9*(4), 358-368.

Quah, C. Y., & Ng, K. H. (2022). A systematic literature review on digital storytelling authoring tool in education: January 2010 to January 2020. *International Journal of Human–Computer Interaction*, *38*(9), 851-867.

Rachmad, Y. E. (2022). *Feedback Loop Theory*. León Cuero Publicaciones Internacionales, Edición Especial 2022.

Rahiem, M. D. (2021). Storytelling in early childhood education: Time to go digital. International Journal of Child Care and Education Policy, 15(1), 4.

Rahimi, S., & Shute, V. J. (2021). First inspire, then instruct to improve students' creativity. *Computers & Education*, *174*, 104312.

Raifman, J., Bor, J., & Venkataramani, A. (2021). Association between receipt of unemployment insurance and food insecurity among people who lost employment during the COVID-19 pandemic in the United States. *JAMA network open*, *4*(1), e2035884-e2035884.

Ramamurthy, A. (2021). Post-Production. In *The Media Workflow Puzzle* (pp. 37-90). Routledge.

Rebelo, A. D. (2022). The impact of artificial intelligence on the creativity of videos. *AI and Society*, 37(1), 89-108.

Reichardt, C. S. (2002). Experimental and quasi-experimental designs for generalized causal inference.

Reiser, R. A. (2001). A history of instructional design and technology: Part II: A history of instructional design. *Educational technology research and development*, *49*(2), 57-67.

Rhodes, M. (1961). An analysis of creativity. *The Phi Delta Kappan,* 42(7), 305–310.

Ribeiro, S. P. (2017). Digital storytelling: learning to be in higher education. In *Digital storytelling in higher education: International perspectives* (pp. 207-223). Cham: Springer International Publishing.

Richey, R. C., Klein, J. D., & Nelson, W. A. (2004). *Developmental research: Studies of instructional design and development*. In D. H. Jonassen (Ed.), *Handbook of research on educational communications and technology* (pp. 1099–1130). Lawrence Erlbaum.

Ritter, S. M., Gu, X., Crijns, M., & Biekens, P. (2020). Fostering students' creative thinking skills by means of a one-year creativity training program. *PloS one*, *15*(3), e0229773.

Robin, B. (2006, March). The educational uses of digital storytelling. In *Society for Information Technology & Teacher Education International Conference* (pp. 709-716). Association for the Advancement of Computing in Education (AACE).

Robin, B. R. (2008). Digital storytelling: A powerful technology tool for the 21st century classroom. *Theory into practice, 47*(3), 220-228.

Robin, B. R. (2016). The power of digital storytelling to support teaching and learning. *Digital education review*, (30), 17-29.

Rodríguez, C. L., García-Jiménez, M., Massó-Guijarro, B., & Cruz-González, C. (2021). Digital Storytelling in Education: A Systematic Review of the Literature. *Rev. Eur. Stud.*, *13*, 13.

Rogers, C. R. (1961). *On becoming a person: A therapist's view of psychotherapy*. Houghton Mifflin.

Rogers, C. R. (1969). *Freedom to learn.* Merrill.

Romme, A. G. L., & Meijer, A. (2020). Applying design science in public policy and administration research. *Policy & Politics*, *48*(1), 149-165.

Rosen, Y., Stoeffler, K., & Simmering, V. (2020). Imagine: Design for creative thinking, learning, and assessment in schools. *Journal of Intelligence*, *8*(2), 16.

Rosli, H., & Kamaruddin, N. (2020). A Conceptual Framework of Digital Storytelling (Dst) Elements on Information Visualisation (Infovis) Types in Museum Exhibition for User Experience (Ux) Enhancement.

Rotherham, A. J., & Willingham, D. T. (2010). 21st-century" skills. *American Educator, 17*(1), 17-20.

Rule, L. (2017). Digital storytelling: Exploring the emotional impact of digital media. *Digital Storytelling Association Report.*

Runco, M. A. (2014). "Big C, Little c" creativity as a false dichotomy: Reality is not categorical. *Creativity Research Journal*, 26(1), 131-132.

Runco, M. A., & Jaeger, G. J. (2012). The standard definition of creativity. *Creativity Research Journal, 24*(1), 92–96. https://doi.org/10.1080/10400419.2012.650092

Runco, M. A., & Kim, D. (2020). Four Ps of creativity and recent updates. In *Encyclopedia of creativity, invention, innovation and entrepreneurship* (pp. 996-1001). Cham: Springer International Publishing.

Saritepeci, M. (2021). Students' and parents' opinions on the use of digital storytelling in science education. *Technology, Knowledge and Learning*, *26*(1), 193-213.

Sawyer, R. K. (2011). *Explaining creativity: The science of human innovation* (2nd ed.). Oxford University Press.

Sawyer, R. K. (2018). Teaching and learning how to create in schools of art and design. *Journal of the Learning Sciences*, 27(1), 137-181.

Sawyer, R. K., & Henriksen, D. (2024). *Explaining creativity: The science of human innovation*. Oxford university press.

Sharda, N. (2007). Applying Movement Oriented Design to Create Educational Stories. *International Journal of Learning*. Vol. 13, 2007.

Silma, N., Maulida, I., Wulan, A. P., Merawati, J., & Hasan, M. K. (2024). A comprehensive review of Project-Based Learning (PBL): Unravelling its aims, methodologies, and implications. *Journal of Education, Social & Communication Studies*, *1*(1), 10-19.

Silverman, D. (2016). *Interpreting qualitative data* (5th ed.). Sage Publications.

Silvia, P. J., Kaufman, J. C., & Pretz, J. E. (2011). Is creativity domain-specific? Latent class models of creative accomplishments and creative self-descriptions.

Psychology of Aesthetics, Creativity, and the Arts, 5(2), 91–101. https://doi.org/10.1037/a0014940

Simon, H. (1969) *The Sciences of Artificial,* 3rd edn, MIT Press, Cambridge, MA.

Smeda, N., Dakich, E., & Sharda, N. (2010, July). Developing a framework for advancing e-learning through digital storytelling. In *IADIS International Conference e-learning* (pp. 169-176).

Smeda, N., Dakich, E., & Sharda, N. (2014). The effectiveness of digital storytelling in the classrooms: a comprehensive study. *Smart Learning Environments*, *1*, 1-21.

Smedema, J.J. (2023). *The perceived value of the B Corp certification in B2B relations: A mixed method research approach* [Doctoral dissertation, University of Groningen].

Snyder, H. T., Hammond, J. A., Grohman, M. G., & Katz-Buonincontro, J. (2019). Creativity measurement in undergraduate students from 1984–2013: A systematic review. *Psychology of Aesthetics, Creativity, and the Arts*, *13*(2), 133.

Spante, M. (2019). Digital creativity: Learning by story-driven digital production. *International Journal of Information and Learning Technology*, 36(3), 182-191.

Spierling, U. (2015). Interaction design principles as narrative techniques for interactive digital storytelling. In *Interactive Digital Narrative* (pp. 159-173). Routledge.

Staley, B., & Freeman, L. (2017). Digital storytelling as student-centred pedagogy: empowering high school students to frame their futures. *Research and Practice in Technology Enhanced Learning*, 12. https://doi.org/10.1186/s41039-017-0061-9.

Steinerowska-Streb, I., & Głód, G. (2020). Innovations in Polish family firms. Exploring employee creativity and management practices that stimulate innovative thinking. *Journal of Entrepreneurship, Management and Innovation*, *16*(2), 231-260.

Sternberg, R. J. (2003). *Wisdom, intelligence, and creativity synthesized*. Cambridge University Press.

Stork, M. G. (2020). Supporting twenty-first century competencies using robots and digital storytelling. *Journal of Formative Design in Learning, 4*(1), 43-50.

Sumiyana, S., & Saputra, M. (2023). Competing with Media Richness: Cognitive and Psychological Endowment Effects as the Fundamentally Pervasive Perspective of Learning Performance. *Human Behavior and Emerging Technologies*. https://doi.org/10.1155/2023/9929307.

Supatmo, S., & Ghufron, A. (2019). Developing learning multimedia to improve critical thinking in mathematics at class V of elementary school. *KnE Social Sciences*, 17-26.

Sweller, J. (2010). Element interactivity and intrinsic, extraneous, and germane cognitive load. *Educational psychology review*, *22*(2), 123-138.

Tabieh, A. A., Al-Hileh, M. M., Abu Afifa, H. M., & Abuzagha, H. Y. (2021). The Effect of Using Digital Storytelling on Developing Active Listening and Creative Thinking Skills. *European Journal of Educational Research*, *10*(1), 13-21.

Tao, F. (2022) Digital storytelling for global citizenship education: a Chinese case study, *Asia Pacific Journal of Education*, DOI: 10.1080/02188791.2022.2106187.

Tashakkori, A., & Teddlie, C. (1998). *Mixed methodology: Combining qualitative and quantitative approaches*. Sage Publications.

Teddlie, C., & Tashakkori, A. (2003). Major issues and controversies in the use of mixed methods in the social and behavioral sciences. In *Handbook of mixed methods in social & behavioral research* (pp. 3–50). Sage Publications.

Thomas, J. W. (2000). *A review of research on project-based learning*. Autodesk Foundation.

Tian, Y., & Li, R. (2022). Seventy years of creativity assessment research: From unidimensional to multidimensional perspectives. Educational Research Review, 38, 100512. https://doi.org/10.1016/j.edurev.2022.100512

Tisoglu, S., Piri, Z., Mericelli, M., & Catan Inan, F. (2022). Targeting Creativity Through a Learner-Generated Digital Storytelling Project. *International Journal of Technology in Teaching and Learning*, *18*(1), 1-23.

Torrance, E. P. (1966). *The Torrance Tests of Creative Thinking-Norms-Technical Manual Research Edition-Verbal Tests, Forms A and B-Figural Tests, Forms A and B. Princeton,* NJ: Personnel Press.

Torrance, E. P. (1974). *Torrance tests of creative thinking*. Scholastic Testing Service.

Torrance, E. P. (1977). Creativity in the Classroom; What Research Says to the Teacher.

Torrance, E. P. (1988). The nature of creativity as manifest in its testing. *Educational Leadership, 45*(7), 80–87.

Treffinger, D. J., Isaksen, S. G., & Stead-Dorval, K. B. (2023). *Creative problem solving: An introduction*. Routledge.

Treffinger, D. J., Schoonover, P. F., & Selby, E. C. (2021). *Educating for creativity & innovation: a comprehensive guide for research-based practice*. Routledge.

Tshering, N., & Dorji, T. (2022). Enhancing grade six students' mathematics achievement through the use of cooperative learning strategy: an action research. *Asian Journal of Education and Social Studies*, *31*(1), 31-39.

Vaishnavi, V. K., & Kuechler, W. (2015). *Design science research methods and patterns: innovating information and communication technology*. Crc Press.

Vashney, K. R. (2022). *Trustworthy machine learning*. Independently published.

Venable, J., Pries-Heje, J., & Baskerville, R. (2016). FEDS: a framework for evaluation in design science research. *European journal of information systems*, *25*, 77-89.

vom Brocke, J., Hevner, A., & Maedche, A. (2020). Introduction to design science research. In *Design science research. Cases* (pp. 1-13). Springer. https://doi.org/10.1007/978-3-030-46781-4_1

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Harvard University Press.

Wahyudin, W., Qobus, M. S., Fatimah, N. S., Riza, L., & Adedokun-Shittu, N. A. (2024). The implementation of project-based learning (PBL) with ADDIE model to improve students' creative thinking ability. *Elinvo (Electronics, Informatics, and Vocational Education)*. https://doi.org/10.21831/elinvo.v9i2.77240

Wallas, G. (1926). *The art of thought*. London: Jonathan Cape.

Wang, X. (2016). *The effect of language ability in creativity assessment: Exploring the impact of English proficiency on university students' creativity* [Master's thesis]. University of Minnesota.

Wang, Y. (2022). Exploration and practice of "entrepreneurship and Innovation" course based on regional culture construction of design discipline. *Research in Fine Arts Education* (10),152-153.

Weststrate, N. M. (2021). Using life story methods to illuminate cultural-historical dimensions of LGBTQ+ identity development across generations. *Cultural methods in psychology: Describing and transforming cultures*, 3-44.

Wieringa, R. J. (2014). *Design science methodology for information systems and software engineering*. Springer.

Wilson, J. (2014). Audio production processes and techniques. *Audio Engineering Quarterly,* 29(4), 22-36.

World Economic Forum. (2023). *The future of jobs report 2023*. World Economic Forum. https://www.weforum.org/publications/the-future-of-jobs-report-2023/

Yahaya, N. S. (2023). *Design model of immersive virtual reality aid system with tamed cybersickness for children road safety education (ivras4crose).* (Doctoral dissertation, Universiti Utara Malaysia, 2023).

Yang, S., Yang, S., & Tong, C. (2023). In-Depth Application of Artificial Intelligence-Generated Content AIGC Large Model in Higher Education. *Adult and Higher Education*, *5*(19), 9-16.

Yang, Y. T. C., & Wu, W. C. I. (2012). Digital storytelling for enhancing student academic achievement, critical thinking, and learning motivation: A year-long experimental study. *Computers & education*, *59*(2), 339-352.

Yang, Y. T. C., Chen, Y. C., & Hung, H. T. (2022). Digital storytelling as an interdisciplinary project to improve students' English speaking and creative thinking. *Computer Assisted Language Learning*, *35*(4), 840-862.

Yu, H. (2024). Enhancing creative cognition through project-based learning: An in-depth scholarly exploration. *Heliyon*.

Yuksel, P., Robin, B. & McNeil, S. (2011, March). Educational uses of digital storytelling all around the world. *In Society for Information Technology & Teacher Education International Conference* (pp. 1264-1271).

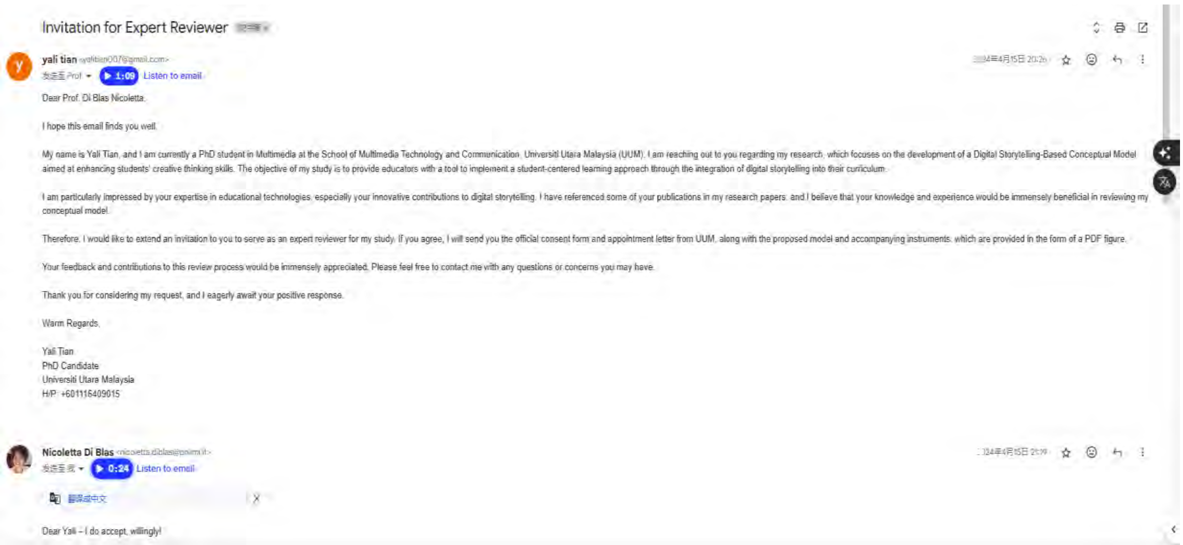
Zhang, J. (2022). The Influence of Piaget in the Field of Learning Science. *Higher Education Studies*, *12*(3).

Zhou, M. (2024). Reflections on cultivating top innovative talents at the basic education stage: From the "Qian Xuesen’s Question" to cross-cultural comparisons of creativity research. *Educational Development Research*, 3(1), 12-29.

Zhou, X., Song, M., & Cui, L. (2020). Driving force for China’s economic development under Industry 4.0 and circular economy: Technological innovation or structural change?. *Journal of Cleaner Production*, *271*, 122680.

Appendix A

Sample of Invitation Email for Experts



Invitation for Expert Reviewer

yali tian <yalitian007@gmail.com>

Listen to email

Dear Prof. Di Blas Nicoletta,

I hope this email finds you well.

My name is Yali Tian, and I am currently a PhD student in Multimedia at the School of Multimedia Technology and Communication, Universiti Utara Malaysia (UUM). I am reaching out to you regarding my research, which focuses on the development of a Digital Storytelling-Based Conceptual Model aimed at enhancing students' creative thinking skills. The objective of my study is to provide educators with a tool to implement a student-centered learning approach through the integration of digital storytelling into their curriculum.

I am particularly impressed by your expertise in educational technologies, especially your innovative contributions to digital storytelling. I have referenced some of your publications in my research papers, and I believe that your knowledge and experience would be immensely beneficial in reviewing my conceptual model.

Therefore, I would like to extend an invitation to you to serve as an expert reviewer for my study. If you agree, I will send you the official consent form and appointment letter from UUM, along with the proposed model and accompanying instruments, which are provided in the form of a PDF figure.

Your feedback and contributions to this review process would be immensely appreciated. Please feel free to contact me with any questions or concerns you may have.

Thank you for considering my request, and I eagerly await your positive response.

Warm Regards,

Yali Tian
PhD Candidate
Universiti Utara Malaysia
H/P: +601116409015

Nicoletta Di Blas

Listen to email

Dear Yali – I do accept, willingly!

Appendix B

Sample of Appointment Letter

PUSAT PENGAJIAN TEKNOLOGI MULTIMEDIA DAN KOMUNIKASI
SCHOOL OF MULTIMEDIA TECHNOLOGY AND COMMUNICATION
Universiti Utara Malaysia
06010 UUM SINTOK
KEDAH DARUL AMAN
MALAYSIA

UUM
Universiti Utara Malaysia

Tel: 604 - 928 5801
Faks (Fax): 604 - 928 5804
Laman Web (Web): http://www.smmtc.uum.edu.my

UUM/CAS(SMMTC)/L-4
18 April 2024

Prof. Di Blas Nicoletta
Associate Professor
Department of Electronics and Information
Politecnico di Milano
Via Ponzio 34/5,
20133 Milano
Italia

Associate Professor

APPOINTMENT AS EXPERT REVIEWER FOR CONCEPTUAL DESIGN MODEL OF DIGITAL STORYTELLING ON STUDENTS' CREATIVE THINKING SKILLS

Thank you for agreeing to involve as an expert in the PhD study with the details below, particularly for reviewing and evaluating a design model:

Student Name : **Tian Yali**
Matric No. : **904009**
School : **School of Multimedia Technology and Communication, UUM**
Research Title : **Conceptual Design Model of Digital Storytelling on Students' Creative Thinking Skills**
Supervisor : **Assoc. Prof. Ts. Dr. Norbayah binti Mohd Suki**
Dr. Azizah Binti Che Omar

For your information, the student will use the design model for her research. Therefore, she needs your expertise, knowledge, and experience to review the proposed design model in a few dimensions as stated in the reviewing form.

Your cooperation, time and assistance are greatly appreciated.

Thank you.

"MALAYSIA MADANI"
"BERKHIDMAT UNTUK NEGARA"
"KEDAH SEJAHTERA-NIKMAT UNTUK SEMUA"
"ILMU BUDI BAKTI"

Sincerely

ASSOC. PROF. DR. MOHD KHAIRIE AHMAD
Dean
School of Multimedia Technology and Communication
Universiti Utara Malaysia
Tel: 04-9285800 Email: khairie@uum.edu.my

Universiti Pengurusan Terkemuka
The Eminent Management University

Appendix C

Sample of Consent Form for Experts

Consent Form of Expert Review for Conceptual Model of Digital Storytelling on Students' Creative Thinking Skills (DSCTS)

School Of Multimedia Technology and Communication
College Of Arts and Science
Universiti Utara Malaysia (UUM)

1. I have accepted the official appointment letter from UUM. With the expertise and the existing knowledge that I have, I volunteer to be an expert reviewer for " Conceptual Model of Digital Storytelling on Students' Creative Thinking Skills " proposed by Yali Tian under supervision of Associate Prof. Ts. Dr. Norbayah binti Mohd Suki and Dr. Azizah Binti Che Omar.
2. I understand that the expert review process is designed to gather information and feedbacks in improving the proposed model.
3. I understand that no part of the proposed model may be reproduced, stored in retrieved system, or transmitted in any form or by any means, electronic, mechanical photocopying, recording, or otherwise, without prior permission from the researchers and his/her supervisor.
4. I understand that the researchers will not identify me by name in any report using information obtained from the instrument, and that my confidentiality as a participant in this study will remain secure. Subsequent uses of records and data will be subject to standard data use policies which protect the anonymity of individuals and institutions.
5. I understand that this study has been reviewed and approved by School of Multimedia Technology and Communication, College of Arts and Sciences, UUM.
6. I have read and understood the explanation provided to me. I have had all my questions answered to my satisfaction, and voluntarily agree to participate in this study.
7. I am given a copy of this consent form.

Reviewer Signature	Date
Reviewer Official Stamp	Researcher Signature

Appendix D

Details of Inter-rater Agreement Analysis for TTCT

G.1 Rater Raw Score Matrix (Anonymized)

Table G.1 presents the raw scores of 31 experimental participants' TTCT Pre-test (Form A) and Post-test (Form B) across four dimensions, independently rated by three raters (Rater 1, Rater 2, Rater 3). All student IDs are anonymized (S01-S31), and scores follow the TTCT 2018 Figural Test standards (0-30 points per dimension, 0-120 points total).

Student ID	Test Type	Rater	Fluency	Flexibility	Originality	Elaboration	Total Score
S01	Pre-test (Form A)	Rater 1	18	16	19	17	70
S01	Pre-test (Form A)	Rater 2	17	15	20	16	68
S01	Pre-test (Form A)	Rater 3	18	16	19	17	70
S01	Post-test (Form B)	Rater 1	24	22	25	23	94
S01	Post-test (Form B)	Rater 2	23	21	26	22	92
S01	Post-test (Form B)	Rater 3	24	22	25	23	94
S02	Pre-test (Form A)	Rater 1	16	14	17	15	62
S02	Pre-test (Form A)	Rater 2	15	13	18	14	60
S02	Pre-test (Form A)	Rater 3	16	14	17	15	62
S02	Post-test (Form B)	Rater 1	22	20	23	21	86
S02	Post-test (Form B)	Rater 2	21	19	24	20	84
S02	Post-test (Form B)	Rater 3	22	20	23	21	86
S03	Pre-test (Form A)	Rater 1	20	17	21	18	76
S03	Pre-test (Form A)	Rater 2	19	16	22	17	74
S03	Pre-test (Form A)	Rater 3	20	17	21	18	76
S03	Post-test (Form B)	Rater 1	26	23	27	24	100

S03	Post-test (Form B)	Rater 2	25	22	28	23	98
S03	Post-test (Form B)	Rater 3	26	23	27	24	100
...	...	...	...	...	...	...	...
S31	Pre-test (Form A)	Rater 1	17	15	18	16	66
S31	Pre-test (Form A)	Rater 2	16	14	19	15	64
S31	Pre-test (Form A)	Rater 3	17	15	18	16	66
S31	Post-test (Form B)	Rater 1	25	23	27	24	99
S31	Post-test (Form B)	Rater 2	24	22	28	23	97
S31	Post-test (Form B)	Rater 3	25	23	27	24	99

Note: "..." represents complete scores for the remaining 28 students (to be included in the final submission). Total Score = Fluency + Flexibility + Originality + Elaboration.

G.2 SPSS Output for ICC Analysis

SPSS 26.0 was used for two-way mixed model (consistency type) analysis. The output below is consistent with Section 3.3.4.1.1 in the main text:

G.2.1 Descriptive Statistics

Table G.1 presents the raw scores of 31 experimental participants' TTCT Pre-test (Form A) and Post-test (Form B) across four dimensions, independently rated by three raters (Rater 1, Rater 2, Rater 3). All student IDs are anonymized (S01-S31), and scores follow the TTCT 2018 Figural Test standards (0-30 points per dimension, 0-120 points total).

Variable	Rater	Mean (M)	Standard Deviation (SD)	Minimum	Maximum
Fluency	Rater 1	20.16	3.82	14	26
Fluency	Rater 2	19.87	3.75	13	25
Fluency	Rater 3	20.16	3.82	14	26
Flexibility	Rater 1	18.23	3.51	12	24
Flexibility	Rater 2	17.94	3.46	11	23
Flexibility	Rater 3	18.23	3.51	12	24
Originality	Rater 1	21.35	4.01	15	28
Originality	Rater 2	21.64	4.08	16	29
Originality	Rater 3	21.35	4.01	15	28
Elaboration	Rater 1	19.03	3.67	13	25
Elaboration	Rater 2	18.74	3.61	12	24
Elaboration	Rater 3	19.03	3.67	13	25
Total Score	Rater 1	78.77	14.92	54	103

Total Score	Rater 2	78.19	14.70	52	101
Total Score	Rater 3	78.77	14.92	54	103

G.2.2 Intraclass Correlation Coefficients

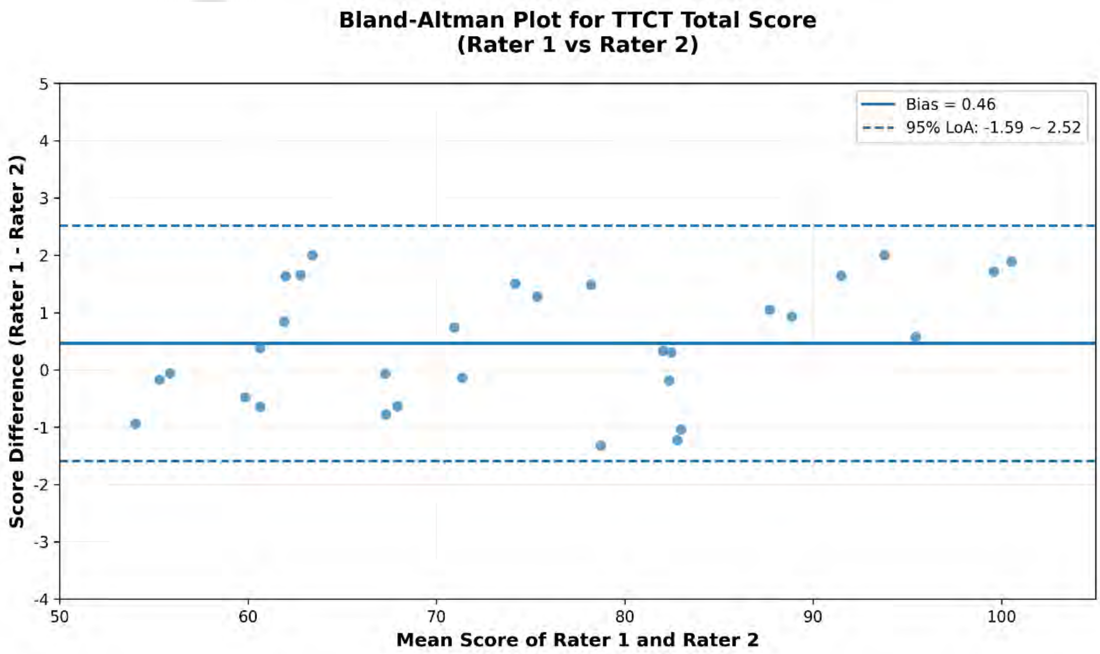
Variable	ICC(2,k)	95% Confidence Interval (CI)	F Value	df1	df2	p Value
Fluency	0.83	[0.70, 0.91]	42.67	30	60	<0.001
Flexibility	0.81	[0.68, 0.89]	38.92	30	60	<0.001
Originality	0.88	[0.78, 0.94]	56.31	30	60	<0.001
Elaboration	0.84	[0.72, 0.91]	44.85	30	60	<0.001
Total Score	0.86	[0.75, 0.93]	49.73	30	60	<0.001

Note: In ICC(2,k), "k=3" (three raters); F value, df1 (number of students - 1), df2 (number of students × (number of raters - 1)) comply with two-way mixed model statistical requirements; p<0.001 indicates statistical significance of ICC values.

G.3 Bland-Altman Plot (Visualization of Inter-rater Agreement)

To intuitively demonstrate inter-rater consistency, a Bland-Altman plot was generated using Total Scores from Rater 1 and Rater 2 (Figure G.1). The x-axis represents the mean score of the two raters, and the y-axis represents the score difference (Rater 1 - Rater 2).

Figure G.1 Bland-Altman Plot for TTCT Total Score (Rater 1 vs Rater 2)



Appendix E

Expert Evaluation Instrument Item-Reference Traceability Matrix

All items adapted from Yahaya (2023); adaptation rationale tailored to the DSCTS model's focus on digital storytelling (DS) and creative thinking skill (CTS) cultivation in tertiary education.

Item No.	Expert Evaluation Instrument Item	Corresponding Source Reference	Citation/Adaptation Note
1	The proposed components and sub-components of the DSCTS model are relevant to DS pedagogy for CTS cultivation	Yahaya (2023)	**Adapted**: Derived from the *component relevance evaluation dimension* (Item 1) of the original scale; modified to explicitly align with DS pedagogy and CTS cultivation (the core focus of the DSCTS model).
2	The design elements and principles of the DSCTS model are easy to understand for implementation in tertiary DS education	Yahaya (2023)	**Adapted**: Derived from the *design element understandability dimension* (Item 2) of the original scale; refined to specify tertiary DS education as the implementation context.
3	The terminology used to describe the DSCTS model and its DS workflows is clear and easy to understand	Yahaya (2023)	**Direct adaptation**: Exact retention of the *terminology clarity item* (Item 3) of the original scale; no substantive modification (universally applicable to design model evaluation).
4	The relationships and flow between all main components and sub-components of the DSCTS model are logical	Yahaya (2023)	**Direct adaptation**: Exact retention of the *model component logical flow item* (Item 4) of the original scale; no substantive modification (core design model evaluation criterion).
5	Overall, the DSCTS model is readable	Yahaya (2023)	**Adapted**: Derived from the *overall model readability*

Item No.	Expert Evaluation Instrument Item	Corresponding Source Reference	Citation/Adaptation Note
	and interpretable for educational practitioners in DS and CTS pedagogy		*dimension* (Item 5) of the original scale; modified to specify the target audience (educational practitioners in DS and CTS pedagogy).
6	The DSCTS model's alignment with the developed DS prototypes is coherent and consistent	Yahaya (2023)	**Adapted**: Extended from the original scale's core design model evaluation framework; aligned with the *model-prototype consistency* criterion (a key validation focus of this study) and the original scale's design coherence evaluation principles.

Appendix F

Instrument for Expert Review

INSTRUMENT FOR EXPERT REVIEW:

CONCEPTUAL DESIGN MODEL OF DIGITAL STORYTELLING ON STUDENTS' CREATIVE THINKING SKILLS (DSCTS)

Dear Prof/Dr./Sir/Madam

My name is Yali Tian and currently doing PHD study in multimedia of studies at University Utara Malaysia (UUM). I am delighted to inform that you have been chosen as an expert to participate in this research, based on the following criteria:

- Your qualification is either in Design Science Research or Digital Storytelling or Educational Technology related areas and/or.
- You have been studying/researching/teaching Digital Storytelling /Design Science Research /Educational Technology for at least five years.

This study introduces the "**Conceptual Design Model of Digital Storytelling on Students' Creative Thinking Skills**". The model entails project-based learning aimed at fostering students' understanding of the curriculum and boosting their creative thinking abilities through the creation of a digital storytelling project under teacher supervision. The expert review consists of the following aspects:

1. Element understandability.
2. Relevance of the elements to the model.
3. Logical relationships between and within modules.
4. Readability of the proposed model.
5. Clarity of terminology.

The provided data will be handled with confidentiality, utilized solely for research objectives, and subsequently presented anonymously in academic publications.

Please don't hesitate to reach out to me via email at yalitian007@gmail.com if you have any questions, or you can contact my supervisor at co.azizah@uum.edu.my or norbayah.mohd.suki@uum.edu.my.

Your assistance and contributions in responding to the review questions are greatly valued, and I would sincerely appreciate it if you could conduct the evaluation accordingly.

Thank you for your assistance and time!

Instructions

The review instruments are attached with Figure 1.

The proposed conceptual design model, DSCTS, aims to improve students' creative thinking abilities throughout the curriculum learning journey. It comprises three primary parts: learning components, creative thinking components, and a production process based on digital storytelling. Please read and go through the figure of conceptual model of DSCTS carefully. Once this is done, with the expertise and experience you possess, please complete the questions in the provided spaces.

Expert/Reviewer Details (* required to fill in)

Name: ____________________*

Age: ______________

Gender: Male [ ] Female[ ]

Working experience: ___________years *

Highest education level: _________________*

Area of expertise: _______________*

Items For Review

Based on the proposed conceptual model (as depicted in Figure 1), please tick (✓) your choice.

The Relevance of Learning Components		Definitely NOT relevant	Maybe NOT relevant	All relevant	Comment
Learning Theory	Constructivist Learning				
	Humanistic Learning				
	Cone of Learning				
Learning Model	ADDIE				
	TAPCK				
	SAMR				
Learning Approach	Multisensory				
	Student Centered				
	Collaboration				
	Interdisciplinary				

The Relevance of Creative Thinking Components		Definitely NOT relevant	Maybe NOT relevant	All relevant	Comment
Person	Personal Traits				
	Curiosity				
	Open mind				
	Ambiguity tolerance				
	Risk tolerance				
	Emotion				
	Motivation				
	Reflection				
	Personal Knowledge				
	Domain knowledge				
	Interdisciplinary knowledge				
Process	Task Setting				
	Real-world problem				
	Task-oriented				
	Process Specification				
	Autonomous exploration				
	Mind wondering				
	Collaboration				
	Scenario and visual representation				
Press	Supportive Environment				
	Encouragement and flexible atmosphere				
	Authentic situations				
	Mentoring				
	Encouragement				
	Assistance				
	Feedback				

The DSCTS Development Process		Need further detail explanations	Need some explanations	Is easy to understand	Comment
Pre-production	Content Analysis				
	Identify learning objective				
	Scope subject domain				
	Introduce learning approaches				
	Demonstrate and analyze of paradigms				
	Story Design				
	Begin				
	Middle				
	End				
	Script Writing				
	An engaging storyline				
	A point of view				
	Emotional content				
	Role of narrator				
	Checking & Refining				
	Intra-group checks and discussions				
	Feedback and assistance from teachers				
	Storyboarding				
	Visualization and scenarios				
	Montage of iconic multimedia elements				
Production	Text				
	Audio				
	Graphic				

	Video				
	Animation				
Post-Production	Editing				
	Adding effects				
Distribution	Share in classroom				
	Question & answer				
	Discussion and feedback				
	Refine				
	Upload to website and platform				
	Check and reply comments				

The term use is easy to understand.	Yes		No	
The relationship and flows of all components and sub-components are logical.	Yes		No	
Overall, the design model is readable.	Yes		No	

You are encouraged to write your recommendation to in the space below:

Appendix G

Comprehensive Expert Assessment Data

Dimension	Sub-Component	Prototype	Expert1	Expert2	Expert3	Expert4	Expert5	Prototype-Mean	Overall-Mean
Model Alignment	Learning Phases	P1	5	5	4	4	4	4.4	4.26
		P2	5	5	5	4	4	4.6	
		P3	4	4	4	4	4	4	
		P4	4	5	4	4	4	4.2	
		P5	4	4	4	4	4	4	
		P6	4	5	4	4	4	4.2	
		P7	5	4	4	5	4	4.4	
	Process Flow	P1	4	4	4	4	4	4	3.97
		P2	4	5	4	4	4	4.2	
		P3	4	4	4	3	4	3.8	
		P4	4	4	4	4	4	4	
		P5	4	4	4	3	4	3.8	
		P6	4	4	4	4	4	4	
		P7	4	4	4	4	4	4	
Creative Thinking Integration	Person - Traits	P1	4	4	4	4	4	4	4.03
		P2	5	4	4	4	4	4.2	
		P3	4	4	4	3	4	3.8	
		P4	4	4	4	4	4	4	
		P5	4	4	4	4	4	4	
		P6	4	4	4	4	4	4	
		P7	5	4	4	4	4	4.2	
	Person - Knowledge	P1	4	4	4	4	4	4	4.03
		P2	4	4	4	4	4	4	
		P3	4	4	4	4	4	4	
		P4	4	4	4	4	4	4	
		P5	4	4	4	4	4	4	

		P6	4	4	4	4	4	4	
		P7	5	4	4	4	4	4.2	
	Process	**P1**	4	4	4	3	4	3.8	3.83
		P2	4	4	4	4	4	4	
		P3	4	4	3	3	4	3.6	
		P4	4	4	4	3	4	3.8	
		P5	4	4	4	3	4	3.8	
		P6	4	4	4	3	4	3.8	
		P7	4	4	4	4	4	4	
	Press	**P1**	4	4	4	4	4	4	4.03
		P2	4	4	4	4	4	4	
		P3	4	4	4	4	4	4	
		P4	4	4	4	4	4	4	
		P5	4	4	4	4	4	4	
		P6	4	4	4	4	4	4	
		P7	5	4	4	4	4	4.2	
Learning Activities	**Pre-production**	**P1**	5	4	4	4	4	4.2	4.14
		P2	5	5	4	4	4	4.4	
		P3	4	4	4	4	4	4	
		P4	4	4	4	4	4	4	
		P5	4	4	4	4	4	4	
		P6	4	4	4	4	4	4	
		P7	5	5	4	4	4	4.4	
	Production	**P1**	4	4	4	4	4	4	4.03
		P2	4	4	4	4	4	4	
		P3	4	4	4	4	4	4	
		P4	4	4	4	4	4	4	
		P5	4	4	4	4	4	4	
		P6	4	4	4	4	4	4	
		P7	5	4	4	4	4	4.2	
	Post-production	**P1**	4	4	4	3	4	3.8	3.83
		P2	4	4	4	4	4	4	

		P3	4	4	3	3	4	3.6	
		P4	4	4	4	3	4	3.8	
		P5	4	4	4	3	4	3.8	
		P6	4	4	4	3	4	3.8	
		P7	4	4	4	4	4	4	
	Distribution	**P1**	4	4	4	3	4	3.8	3.83
		P2	4	4	4	4	4	4	
		P3	4	4	3	3	4	3.6	
		P4	4	4	4	3	4	3.8	
		P5	4	4	4	3	4	3.8	
		P6	4	4	4	3	4	3.8	
		P7	4	4	4	4	4	4	
Overall Reflection	**Dynamic Integration**	**P1**	5	5	4	4	4	4.4	4.26
		P2	5	5	5	4	4	4.6	
		P3	4	4	4	4	4	4	
		P4	5	4	4	4	4	4.2	
		P5	4	4	4	4	4	4	
		P6	5	4	4	4	4	4.2	
		P7	5	5	4	4	4	4.4	
	Creative Potential	**P1**	4	4	4	4	4	4	4.03
		P2	4	4	4	4	4	4	
		P3	4	4	4	4	4	4	
		P4	4	4	4	4	4	4	
		P5	4	4	4	4	4	4	
		P6	4	4	4	4	4	4	
		P7	5	4	4	4	4	4.2	

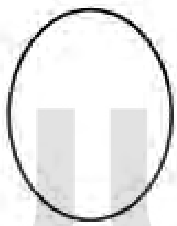
Appendix H

The Instrument of TTCT (Figure A)

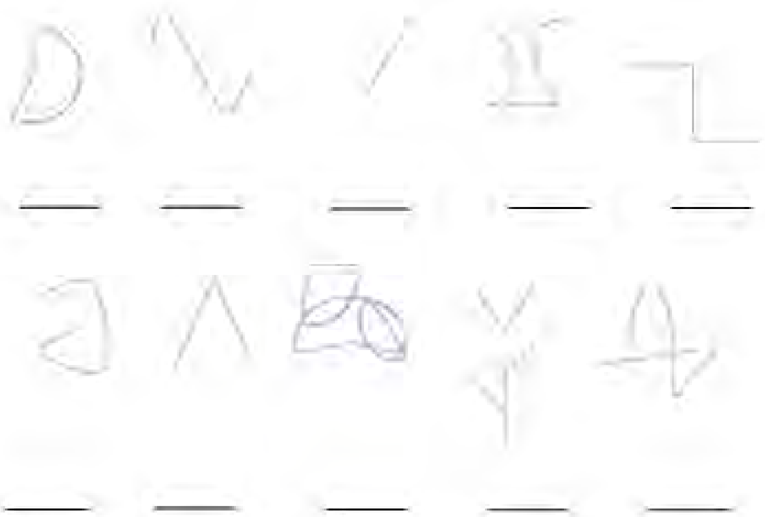
姓名：　　　　　　　　　　　　学号：

这是一份帮助你了解自己创造力的测验。此次测验十分重要，必须严格按照题目要求独自完成，每道题目限时 10 分钟，测验得分高者会得到奖励，得分低者会接受到惩罚，并且会影响到平时成绩。

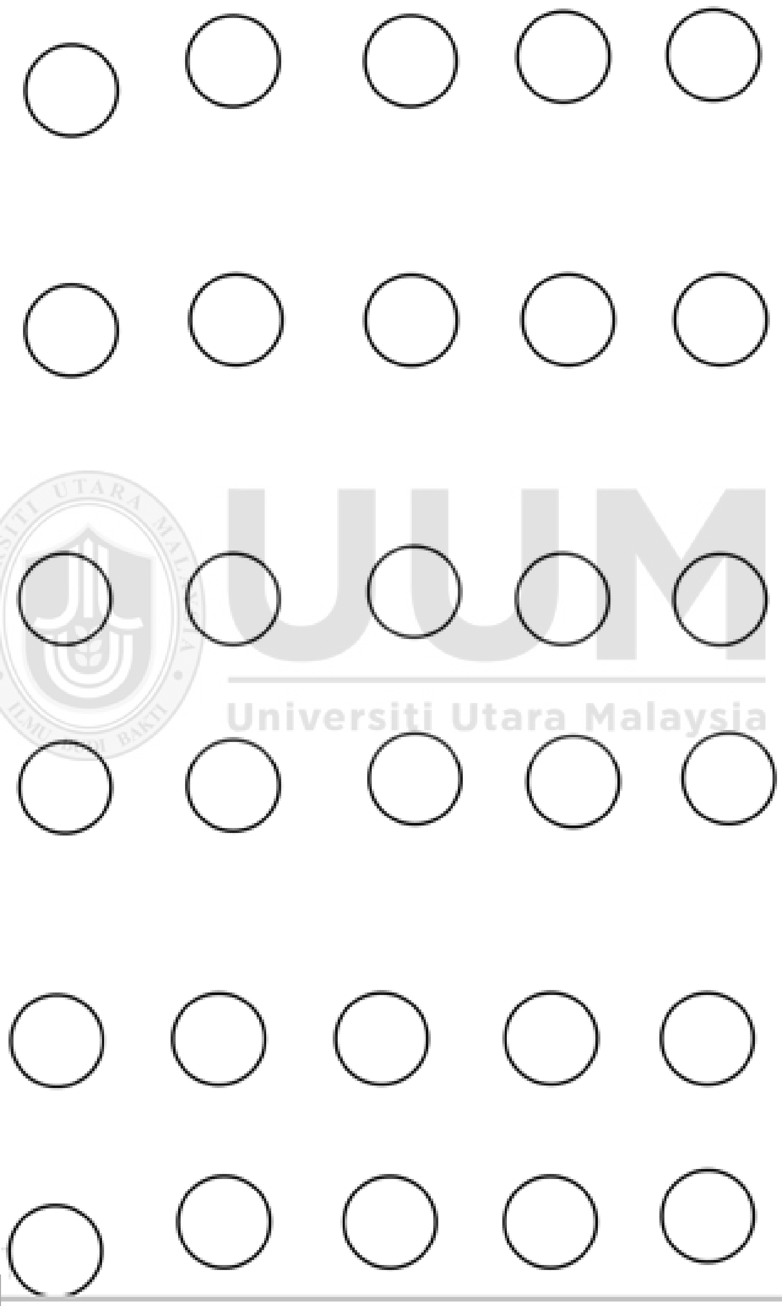
1. 请在圆内涂上任意一种颜色，并以它为基础，画一个能说明一段有趣的振奋人心的故事的图画。



2. 补全图画，完成图画并给出图画的名称。

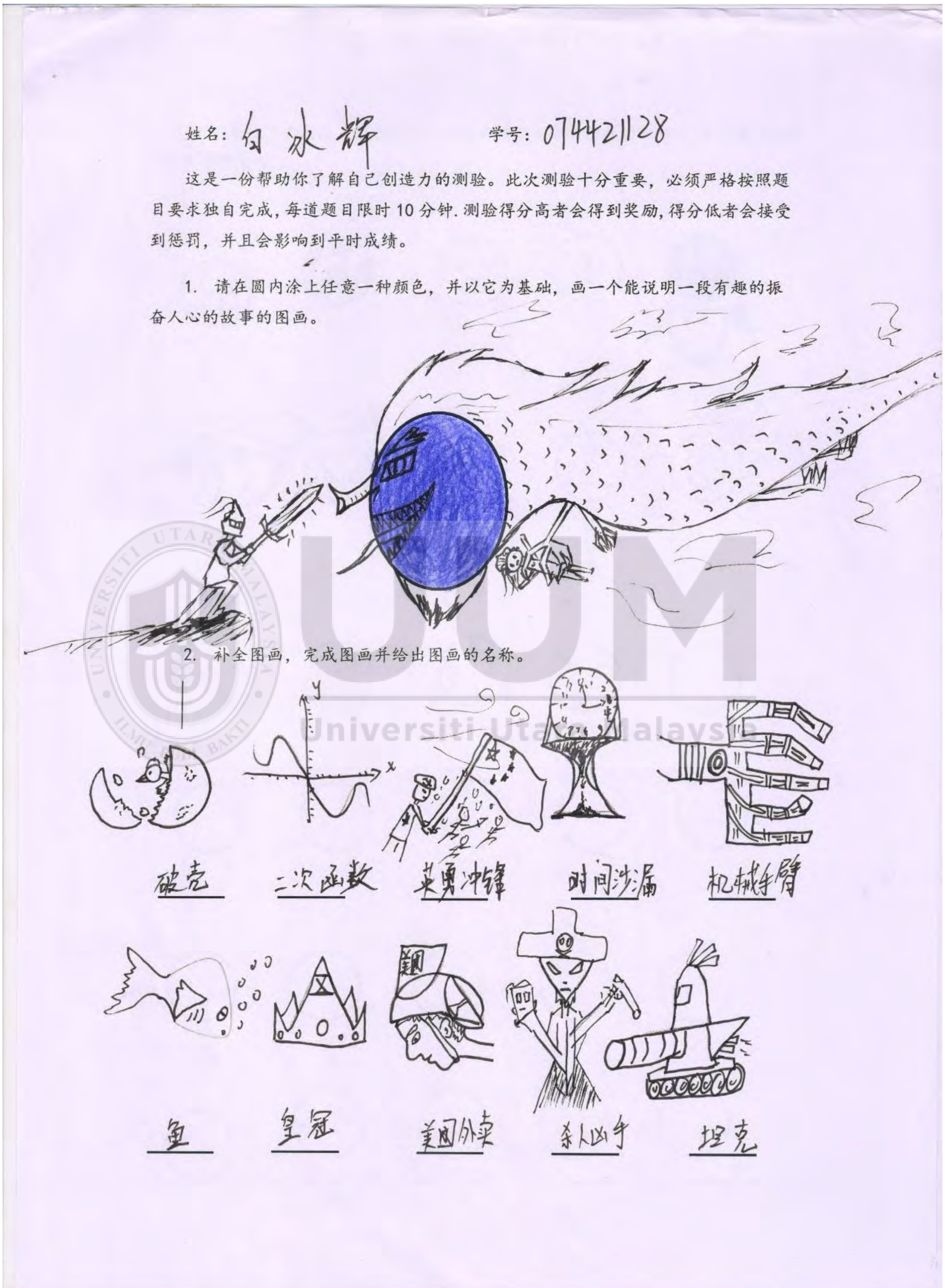


3. 给以下圆圈图案添加细节，让这些圆成为你的图画的一部分.尽可能多的画出不同的图案。



Appendix I

Pre-test Sample of TTCT (Figure A)



姓名：白冰辉　　学号：074421128

这是一份帮助你了解自己创造力的测验。此次测验十分重要，必须严格按照题目要求独自完成，每道题目限时 10 分钟. 测验得分高者会得到奖励，得分低者会接受到惩罚，并且会影响到平时成绩。

1. 请在圆内涂上任意一种颜色，并以它为基础，画一个能说明一段有趣的振奋人心的故事的图画。

2. 补全图画，完成图画并给出图画的名称。

破壳　二次函数　英勇冲锋　时间沙漏　机械手臂

鱼　皇冠　美国外卖　杀人凶手　坦克

白水辉 07442128

3. 给以下圆圈图案添加细节，让这些圆成为你的图画的一部分.尽可能多的画出不同的图案。

Appendix J

Post-test Sample of TTCT (Figure B)

姓名：杨文菁　　　　学号：07442115

这是一份帮助你了解自己创造力的测验。此次测验十分重要，必须严格按照题目要求独自完成，每道题目限时 10 分钟．测验得分高者会得到奖励，得分低者会接受到惩罚，并且会影响到平时成绩。

1. 请在圆内涂上任意一种颜色，并以它为基础，画一个能说明一段有趣的振奋人心的故事的图画，并为所创建的图片命名合适的标题。

2. 补全图画，完成图画并给出图画的名称。

3. 给以下平行线案添加细节，让这些平行线成为你的图画的一部分.尽可能多的画出不同的图案。


TiMi