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A Conceptual Framework for Integrating Human-Centred AI in 2D Animation Education: The 2DTAP Model

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ABSTRACT

The 2D animation course at higher education institutions demands students to acquire both technical and creative skills within a limited time frame. However, pre-production phases such as idea generation, scriptwriting, and visual development often consume up to 40% of the semester, thus reducing time available for mastering complex animation production techniques. This study introduces the 2D Animation Proposal Development Model (2DTAP), a pedagogical innovation that integrates Artificial Intelligence (AI) with a Human-Centred Artificial Intelligence (HCAI) framework. The model is designed to accelerate and simplify the pre-production process without compromising students' creativity and autonomy. By emphasizing principles such as augmentation, human-centric design, transparency, and student control over AI tools, 2DTAP enables students to produce higher-quality, consistent, and industry-relevant project proposals. This paper critically discusses how 2DTAP strengthens project-based learning in animation through ethical, interactive, and adaptive strategies that foster creativity and reflective thinking. The findings of this study are expected to contribute toward the development of a more responsive animation curriculum aligned with the challenges of future digital creative education.

Keywords: *2D Animation, Human-Centred AI, 2DTAP, Pre-Production, ChatGPT, Creative Education*

1 A NEW APPROACH TO TEACHING 2D ANIMATION WITH AI TOOLS

In the rapidly evolving digital education landscape, 2D animation programs in higher education face the challenge of balancing students' technical proficiency with their creative development. As highlighted by Ramlie et al. (2023), the evolution from Education 1.0 to 4.0 has progressively integrated technology into pedagogical practices, emphasizing interactive, media-rich learning environments that demand adaptive teaching models. A standard one-semester curriculum typically allocates up to 40% of its duration to pre-production activities such as idea generation, scriptwriting, and visual planning. This allocation often limits the time available for students to develop core production and post-production skills, which are essential for producing high-quality animations. In practice, such pre-production tasks are typically managed by specialized departments within professional studios. The complexity of these processes can increase students' cognitive load, reduce motivation, and ultimately affect learning outcomes.

Research has shown that integrating AI technologies such as ChatGPT into pre-production workflows can reduce cognitive load and enhance learning effectiveness (Ginting et al., 2024). AI tools are capable of automating tasks like initial scriptwriting and concept visualization, allowing students to concentrate on the technical aspects of animation development. However, the use of AI must be guided to ensure it remains ethical, accurate, and aligned with learning objectives.

The *2D Animation Proposal Development Model (2DTAP)* is introduced as a pedagogical solution that combines AI tools with structured learning guidance. This model aims to accelerate and streamline the pre-production process, giving students more opportunities to refine production techniques. Empirical studies have demonstrated that AI integration in animation production improves both efficiency and the final output quality (Chen et al., 2024). In addition, AI in arts and design education not only improves productivity but also enriches students' creative experiences. In the context of digital storytelling, AI helps learners overcome technical hurdles and fosters greater creative engagement (Prabowo et al., 2025). The 2DTAP model is aligned with these insights, offering a development tool that is tailored to the learners' proficiency levels. Therefore, this study seeks to evaluate the effectiveness of 2DTAP in enhancing learning experiences and project outcomes in 2D animation courses. By reducing cognitive load and expediting the pre-production process, the model is also expected to enhance the competitiveness of graduates in the increasingly demanding animation industry.

1.1 Human-Centred Artificial Intelligence (HCAI) in 2D Animation

Human-Centred Artificial Intelligence (HCAI) is a growing conceptual and practical approach within the realm of educational technology. Unlike fully automated systems, HCAI emphasizes the design and development of AI systems that prioritize the needs, control, values, and safety of human users (Shneiderman, 2020). In essence, AI technologies are not intended to replace humans, but rather to empower them by simplifying complex tasks and fostering synergy between human capabilities and intelligent algorithms.

A comprehensive HCAI framework in response to concerns about opaque and overly autonomous AI systems (Shneiderman, 2022). HCAI outlines three core principles for human-centred AI systems: (i) Trustworthy design, (ii) Responsible performance, and (iii) Alignment with human values. In the context of education, these principles imply that AI should not operate independently of pedagogical goals or without sensitivity to the learning environment.

In the context of 2D animation education, applying the HCAI framework ensures that AI tools like ChatGPT are used to support—not supplant—creative thinking and instructional integrity. AI serves as a facilitator in pre-production stages, allowing learners to ideate, iterate, and visualize their animation proposals more effectively while maintaining ethical oversight and student agency.

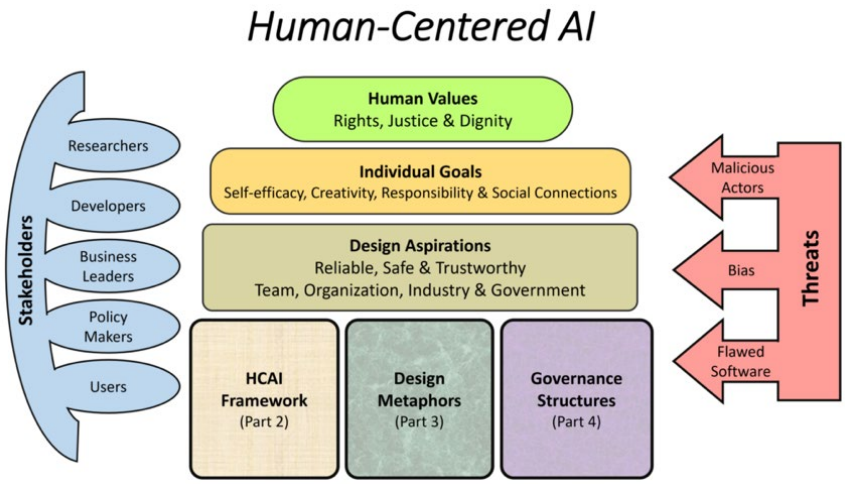

Figure 1 Human-Centred AI
(Source: Shneiderman, 2021), Copyright Consent: Permissible to Publish

AI systems must operate within clearly defined ethical boundaries, especially when applied in socially sensitive sectors such as education, healthcare, and law (Winfield & Jirotka, 2021). In the context of higher education, students are not merely end-users of AI systems; they are also active knowledge constructors. Therefore, AI tools such as chatbots, script generators, or visual suggestion systems must be designed to enhance students' ability to create, edit, and critically evaluate content rather than provide "instant answers" that could undermine their cognitive processes. Furthermore, the Human-Centred Artificial Intelligence (HCAI) approach calls for human intervention at every stage of the AI system's lifecycle from development and implementation to the evaluation of its effectiveness. A recent systematic study emphasizes that successful educational AI systems are those that allow students to control both the input and output of the AI, and that provide clear justification for the system's suggestions or generated content (Le Dinh et al., 2025). This is essential to foster trust in the technology and to ensure that students can critically assess the information provided.

In the context of animation education, HCAI is particularly relevant as the field demands a balance between creativity and technical proficiency. The pre-production phase encompassing story development, scripting, and visual conceptualization. Its requires continuous interaction between human ideas and reference materials. AI can play a pivotal role as a tool for idea generation, stylistic inspiration, or narrative structuring. However, students remain responsible for selecting, refining, and finalizing their creative outputs. This is where the value of HCAI becomes evident: AI supports the creative process, but humans retain control, creativity, and ethical accountability in the production of their work (Amershi et al., 2019).

In conclusion, the Human-Centred Artificial Intelligence approach provides a strong foundation for integrating AI into educational frameworks such as the 2DTAP model. It ensures that students are guided in using AI as a strategic learning and creative partner, not merely as an automated tool. This approach not only supports academic performance but also cultivates 21st-century skills such as critical thinking, self-regulation, and ethical design.

1.2 Principles of Human-Centred AI in Education

The Human-Centred Artificial Intelligence (HCAI) approach emphasizes that AI systems must be ethically, transparently, and responsibly designed, with human needs, values, and control at the core of their implementation. In the context of education, the principles of HCAI serve not only as technical guidelines but also as a pedagogical foundation to ensure that AI use supports effective and meaningful learning. These principles can be distilled into four key aspects: augmentation versus automation, human-centred design, transparency and trust, and human control over AI systems.

Augmentation refers to the use of AI to empower human capabilities, whereas automation implies the replacement of human roles by technology. In education, the principle of augmentation requires AI to be designed to support students' thinking, creativity, and efficiency, not to replace teachers or the learning process itself (Shneiderman, 2020). AI-assisted approaches that enhance student performance in complex tasks such as scriptwriting or visual storytelling. It can improve comprehension, intrinsic motivation, and achievement (Luckin et al., 2021). For instance, in the 2DTAP model, students may use ChatGPT to generate a first draft of a script or story outline, but refinement, enhancement, and final evaluation remain the responsibility of the student.

Human-centred design emphasizes that AI systems should be developed based on a deep understanding of the users' contexts, goals, and challenges (Amershi et al., 2019). In education, this means that AI systems must be sensitive to students' diverse backgrounds, learning styles, and skill levels. Smart learning systems designed with user input and feedback are more effective in supporting personalized learning processes (Holstein et al., 2020). In the 2DTAP model, for example, the AI interface and workflow must be student-friendly, allowing for flexible interaction, creative reflection, and full control over the output. Transparency in AI refers to the system's ability to explain how suggestions or decisions are made. In education, transparency is crucial for building students' trust in the technology and encouraging them to evaluate information critically. Students are more likely to engage with AI tools when they understand the logic and data sources behind the system's recommendations (Abdul et al., 2020). In the context of 2DTAP, when AI suggests narrative structures or visual designs, it should provide clear justification, such as referencing the chosen genre, animation history, or specific art styles, so that students can make informed decisions.

Finally, human control is a core principle that differentiates responsible AI use from potentially harmful automation. In education, students and educators must retain ultimate authority to accept, modify, or reject AI-generated suggestions. Students who have autonomy in using AI tools demonstrate better performance and a stronger sense of ownership over their creative outputs (Dai et al., 2025). In the 2DTAP model, human control is reflected in the freedom students have to choose genres, alter storylines, and develop unique visual identities, AI acts merely as a supportive tool, not as the decision-maker.

These four principles of Human-Centred AI provide a vital foundation to ensure that AI integration in education enhances learning effectiveness while preserving the essential human elements of the educational process. In the context of the 2DTAP model, these principles enable students to engage with AI strategically, responsibly, and creatively positioning AI as a collaborative partner that empowers their full potential in the field of animation.

1.3 Applications of Human-Centred AI in 2D Animation Education

2D animation is a creative discipline that demands the integration of technical skills, visual imagination, and complex narrative storytelling. In educational contexts, the process of producing an animated work involves multiple stages—from idea generation and story structuring to character development, animation, and post-production. However, research indicates that a significant portion of students' time is consumed by pre-production phases, often resulting in cognitive and emotional strain (Chen et al., 2024). Therefore, integrating Artificial Intelligence (AI) technologies grounded in Human-Centred Artificial Intelligence (HCAI) principles can accelerate, simplify, and enrich the student learning experience in this field.

One of the key applications of HCAI in 2D animation education lies in supporting students during idea generation and narrative development. At this stage, students frequently encounter creative blocks or struggle to initiate a compelling and coherent script. Ethically integrated tools such as ChatGPT and other generative AI systems can provide initial suggestions, basic story structures, and character variations based on students' inputs. The use of AI in digital storytelling enhances students' ability to experiment with diverse narrative styles without the pressure of time constraints (Ginting et al., 2024).

However, the HCAI framework ensures that these systems do not provide "definitive answers," but instead function as brainstorming partners. Students remain the central decision-makers, tasked with interpreting and refining AI-generated inputs, in line with the principles of augmentation and human control.

In 2D animation education, visual style development and character design are highly dependent on students' individual creativity. Nevertheless, HCAI-based AI tools can assist by providing personalized visual references based on genre, cultural context, or desired emotional expression. For instance, tools like DALL·E or Stable Diffusion can generate diverse character variations from text descriptions (text-to-image generation), enabling students to explore multiple visual styles before settling on a final design. Studies show that students in visual arts courses who use AI as a style exploration tool produce more diverse concepts and report higher satisfaction with their creative outputs (Park et al., 2023). In accordance with HCAI principles, students retain full control to accept or reject AI suggestions, and are also informed about the source and rationale of generated visuals—thus supporting transparency and trust.

Given that the pre-production phase is time-consuming and mentally demanding, many students often lack sufficient opportunity to focus on technical aspects such as keyframe animation, timing, squash and stretch, and lip sync—essential components for mastering 2D animation production. With the implementation of models such as 2DTAP that apply HCAI principles, students are supported in the pre-production stage through AI assistance, thereby freeing up more time to concentrate on these complex technical skills.

Moreover, HCAI does more than accelerate student workflows. It cultivates reflection and critical thinking in creative decision-making. In animation education, where students must make numerous design and narrative choices, AI systems capable of offering justifications such as "this style suits your character because they are a traditional Malay warrior" encourage critical thinking. HCAI-based systems promote healthy cognitive friction (Dai et al., 2025), wherein AI provides constructive yet challenging feedback, prompting students to make context-driven evaluations. This aligns closely with the principles of project-based learning, a core pedagogical approach in 2D animation courses. The application of Human-Centred AI in 2D animation education through models like 2DTAP not only enhances student efficiency and creativity but also reinforces pedagogical values such as critical thinking, self-regulation, and ethical design. In this context, AI does not replace instructors or learning processes, but rather acts as a complementary tool. Designed to be transparent, trustworthy, and empowering. Thus, HCAI provides a robust foundation for optimizing 2D animation teaching and learning in higher education.

2 2DTAP FRAMEWORK

The conceptual framework integrates the principles of Human-Centred Artificial Intelligence (HCAI) into the implementation of the *2D Animation Proposal Development Model* (2DTAP). At its core, HCAI principles serve as the foundation guiding the system's design, which includes the augmentation of student capabilities (rather than full automation), human-centred design, system transparency, and human control over AI-generated outputs.

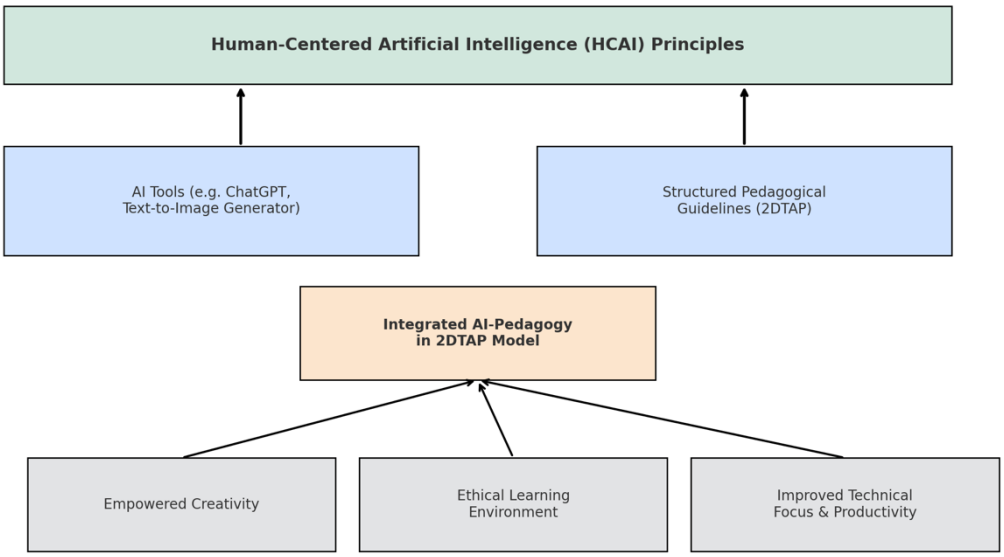

Figure 2 Conceptual Framework 2DTAP

Two key components operate synergistically within this model (i) the use of AI tools, and (ii) a structured pedagogical guideline embedded in the 2DTAP model. AI functions as a creative support tool, while the pedagogical framework provides a structure for student engagement, ethical reflection, and self-evaluation. Together, these components form an AI-Pedagogy integration system, wherein students receive technological support without relinquishing intellectual ownership of their ideas and outcomes. Through this approach, students are able to generate animation content more efficiently while remaining within an authentic and responsible learning context.

This model yields three significant impacts on the teaching and learning of 2D animation. (i) It enhances student creativity by providing intelligent support during the ideation and visualization phases without replacing the student's role as the primary creator. AI functions as a brainstorming and exploratory tool, offering a range of narrative ideas and visual styles that stimulate imagination and promote divergent thinking. However, students retain full authority to modify, adapt, or discard these suggestions, thereby maintaining ownership and originality in their creative work.

(ii) The model fosters a safe and ethical learning environment that aligns with the HCAI principle of responsible design. By embedding ethical considerations such as transparency of AI outputs, traceability of sources, and user control into the AI-pedagogical interaction, students are trained to engage critically with technology. This builds digital literacy, encourages reflective practice, and mitigates the risk of over-reliance on automated tools. Moreover, the structured pedagogical framework ensures that students are guided to use AI constructively, reinforcing academic integrity and responsible innovation.

(iii) The model promotes greater focus on technical proficiency and productivity. Since a substantial portion of cognitive effort is alleviated during the pre-production phase—thanks to AI-assisted idea generation and design prototyping—students can allocate more time and energy to mastering essential animation skills such as keyframe animation, timing, and visual continuity. This shift not only improves learning efficiency but also ensures that students graduate with a more balanced and industry-relevant skill set, blending both creativity and technical execution.
Overall, this framework demonstrates how HCAI functions not only as a technical foundation, but also as a critical driver in shaping an animation education system that is balanced, responsible, and responsive to the future needs of the creative industry.

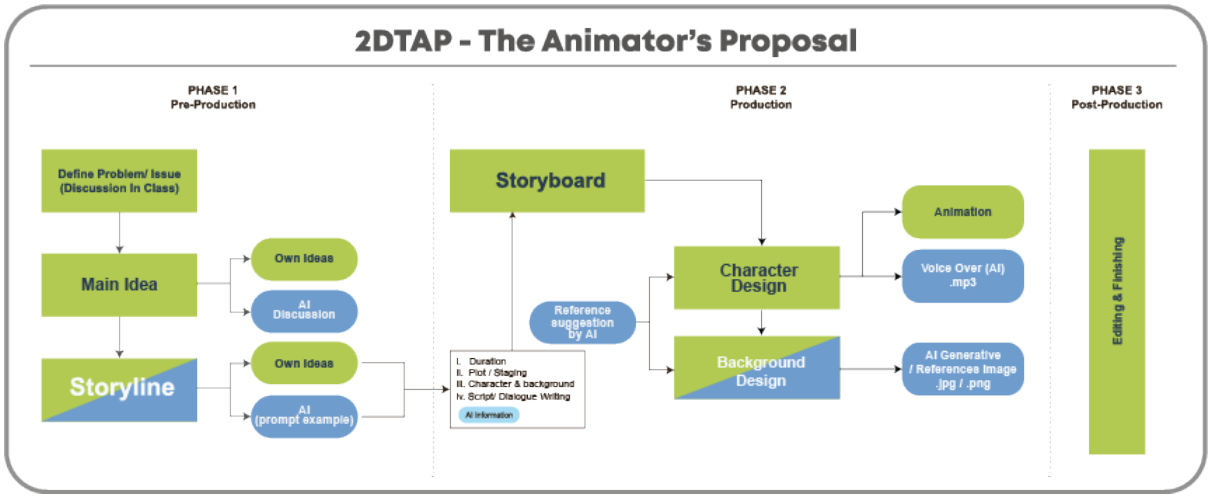

Figure 3 2DTAP Model

The *2D Animation Proposal Development Model* (2DTAP), grounded in the principles of Human-Centred Artificial Intelligence (HCAI), holds strong potential for formal integration into the curriculum of 2D animation courses at higher education institutions. This model can be effectively implemented during the early phase of the course, particularly in the weeks focused on pre-production activities such as idea generation, story development, character design, and initial scriptwriting. By embedding 2DTAP into the curriculum structure, students are not only provided with a systematic framework for developing their animation proposals but also equipped with adaptive and responsive AI support. This enables them to carry out creative tasks more efficiently without compromising pedagogical integrity or ethical learning values.

Moreover, the use of 2DTAP aligns well with the implementation of project-based learning, a common instructional approach in animation courses, where AI serves as a collaborative partner in idea exploration, while students maintain full ownership of the final creative output. The model is also highly adaptable to different proficiency levels—novice learners can benefit from more guided AI suggestions, while advanced students may leverage it for deeper creative exploration. Therefore, integrating 2DTAP into the curriculum will contribute to more structured, inclusive, and industry-aligned learning experiences in digital animation education.

3 FUTURE WORK

To evaluate the effectiveness and usability of the *2D Animation Proposal Development Model* (2DTAP) in an educational context, a quantitative quasi-experimental study will be conducted. This research design is appropriate for real-world educational settings where researchers cannot fully control the assignment of subjects to treatment or control groups (Cook & Campbell, 1979). In this study, two student groups will be formed: (i) an experimental group that will use the 2DTAP model integrated with AI technologies such as ChatGPT and visual support systems, and (ii) a control group that will conduct the pre-production process using conventional methods without AI assistance.

The sample will be selected through purposive sampling, involving students from semesters 2 to 4 enrolled in Diploma programs in Graphic Design or 2D Animation at public higher education institutions. These students are selected because they are currently enrolled in 2D animation courses that include pre-production components and have been introduced to basic animation software. A total sample size of 60 students is proposed, with 30 in the experimental group and 30 in the control group, in line with the minimum sample size recommendations for detecting statistically significant effects in educational quantitative studies (Cohen, 1992).

Participants will be drawn from the population of first- and second-year students enrolled in Diploma programs in Animation or Multimedia Design at UiTM or equivalent institutions offering structured animation courses. Selection criteria include students who have completed foundational design subjects and have basic experience in scriptwriting, storyboarding, and character design. This ensures that all participants begin the study with a relatively equivalent level of knowledge.

The primary research instrument will be the User Experience Questionnaire (UEQ), developed by Laugwitz, Held, and Schrepp (2008). The UEQ is suitable for assessing the usability and user experience of interactive technology systems in educational contexts, covering aspects such as usability, efficiency, stimulation, and system dependability. The questionnaire consists of six main scales and employs a seven-point bipolar semantic differential scale, allowing respondents to provide nuanced feedback on their experience using the system. For data analysis, both descriptive and inferential statistical methods will be employed. Mean scores, standard deviations, and UEQ scale scores will be calculated and compared between the experimental and control groups. An Independent Samples t-Test will be used to determine statistically significant differences between the two groups. If the data do not meet normality assumptions, the Mann-Whitney U Test will be used as a non-parametric alternative (Field, 2018). Data analysis will be conducted using SPSS version 28 or JASP software.

In summary, this quasi-experimental research design aims to assess the effectiveness of the 2DTAP model in terms of system usability and student satisfaction, in line with the principles of Human-Centred AI, which emphasize user-friendly interaction, human control, and designs that support active learning. The findings from this study are expected to provide empirical validation of the 2DTAP model prior to its broader implementation within the 2D animation curriculum in higher education institutions.

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AUTHOR CONTRIBUTIONS

The author made a substantial contribution to all aspects of this research.

CONFLICT OF INTEREST

The author declares no potential conflict of interest with respect to the research, authorship, and publication of this article.

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