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Animation and Game Design Effectiveness Analysis for Skill Development: An Analytical Framework using Neutrosophic Hesitant Fuzzy Set

Na Ji[1], Xiao'ou Ji[2]*

[1]Animation/Film Visual Image Setting, Communication University of Shanxi, Jinzhong, Shanxi, 0306191, China

[2]College of Architecture & Art, Taiyuan University of Technology, Jinzhong, Shanxi, 0300602, China

*Corresponding author, E-mail: oamm339@163.com

Abstract: In a variety of educational situations, animation and game design have become effective tools for helping students acquire both technical and non-technical abilities. An analytical approach for assessing how animation and game design promote creativity, technical mastery, teamwork, and problem-solving is presented in this study. The framework emphasizes how digital media may improve experiential learning and skill development by fusing educational ideas with real-world strategies. Research demonstrates the diverse possibilities of animation and games as skill development platforms by defining important criteria and alternatives, which range from concept art workshops and 3D modeling to simulation-based game creation and group projects. This study uses neutrosophic framework to overcome uncertainty information. This study uses the Neutrosophic Hesitant Fuzzy Set methodology to rank the alternatives. According to the findings, animation and game design foster critical thinking, collaboration, and flexibility in addition to creative and technical skills, making them crucial for 21st-century education and industry preparedness.

Keywords: Animation and Game Design; Skill Development; Neutrosophic Hesitant Fuzzy Set; Uncertainty.

1. Introduction

It turns out that in such a complex decision-making scenario, Hesitant Fuzzy Set (NHFSs) are more useful than simple Neutrosophic Sets. NHFS allows decision-makers (DMs) to show hesitation to reflect the ambiguity and uncertainty that are present in each criterion in the real world[1]. The nuances of partial truth, indeterminacy, and untruth can be more accurately represented by NHFS than by traditional Neutrosophic Sets. This is crucial in circumstances when gathering accurate data is challenging or inherently ambiguous[2].

1.1 Contributions of this study

The creation of a unique decision-making framework that incorporates single-valued neutrosophic hesitant fuzzy sets (SVNHFSs) into the decision-making methodology is the primary contribution of this research. The suggested SVNHFS approach is especially made to deal with decision-making issues in an atmosphere of hesitancy, ambiguity, and indeterminacy. The suggested strategy improves the ability to capture the ambiguity and complexity present in real-world decision issues by integrating hesitant fuzzy information in a neutrosophic framework.

1.2 Structure of this study

The following convention governs the structure of this text. Section 2 shows the literature review. Along with other pertinent material regarding SVNHFSs, Section 3 reviews the evaluation and parameter selection process. Section 4 reviews the concepts of SVNHFEs, HFEs (hesitant fuzzy elements). In Section 5, the steps of the proposed approach are suggested. Section 6 establishes the ranks of alternatives. Section 7 shows the conclusion of this study.

2. Literature Review

Taylor et al. [3] investigated how animation may be used to enhance the teaching of vector and matrix algebra, two mathematical topics that are fundamental to computer game development activities. A group of undergraduate computer students in the UK participated in an experiment to assess the perceived value of static versus animated learning resources for imparting these kinds of concepts. In the UK, undergraduate computer game creation courses are becoming increasingly popular. Mathematical modeling of two- and three-dimensional computer game objects and their interactions is frequently used in computer game creation. Overall, research seems that undergraduate computer game students found animated learning resources more helpful than traditional ones when it came to understanding these kinds of ideas.

Character design has become a crucial component of modern entertainment due to the rapid growth of animation, which calls for experienced animators who possess both technical proficiency and creative understanding. Higher education institutions are faced with the problem of integrating industry standards into their courses as the animation business grows internationally. The balance between creative expression, technical skill, and narrative coherence is examined in this study of character design education in animation. It examines the difficulties that teachers and students encounter, offering suggestions for improving curricula and teaching methods. The literature study explores the function of character design by following its development and a variety of instructional strategies. With the goal of enhancing students' comprehension of the larger industrial landscape, the study presents the ACG Animation Studio idea, which combines animation, comics, and gaming[4].

Game development is an interdisciplinary subject that demands a strong love for at least one area and some understanding of both the technical and artistic. A four-way collaboration involving computer science, digital media studies, electronic media arts design, and studio art forms the foundation of two new game creation majors. With research and scholarship focused on "humane gaming," which encompasses socially aware gaming as well as medical and educational game applications, the University of Denver started offering game development majors in 2004. Argent et al. [5] have a stewardship duty and an opportunity as scholars involved in the emergence of a new field with a big social effect to investigate positive game applications and to increase the inclusion of women and underrepresented groups in game creation.

3. Preliminaries

This section shows definitions of neutrosophic set[6].

Definition 1

Single valued neutrosophic set (SVNS) can be characterized by:

$$G = \{T_G(H), I_G(H), F_G(H)\}$$

$$0 \leq T_G(H) \leq 1$$

$$0 \leq I_G(H) \leq 1$$

$$0 \leq F_G(H) \leq 1$$

$$0 \leq T_G(H) + I_G(H) + F_G(H) \leq 3$$

Definition 2

The single valued neutrosophic hesitant fuzzy set (SVNHFS) is characterized by:

$$G = \{T_G(H), I_G(H), F_G(H)\}$$

4. Distances and measures of NHFS

Definition 3

Let two SVNHFS such as:

$G_1 = \left(T_{G_1}(H), I_{G_1}(H), F_{G_1}(H)\right)$ and

$G_2 = \left(T_{G_2}(H), I_{G_2}(H), F_{G_2}(H)\right)$

The SVNHFS Hausdorff distance is characterized by:

$$D_{\text{SVNHFS}} = \frac{1}{3}\left[d\left(T_{G_1}(H), T_{G_1}(H)\right) + d\left(I_{G_1}(H), I_{G_1}(H)\right) + d\left(F_{G_1}(H), F_{G_1}(H)\right)\right]$$

$$d\left(T_{G_1}(H), T_{G_1}(H)\right) = \max\left\{\max\min\left|T_{G_1}(H) - T_{G_2}(H)\right|, \max\min\left|T_{G_2}(H) - T_{G_1}(H)\right|\right\}$$

$d\left(I_{G_1}(H), I_{G_1}(H)\right) = \max\{\max\min\left|I_{G_1}(H) - I_{G_2}(H)\right|, \max\min\left|I_{G_2}(H) - I_{G_1}(H)\right|\}$

$d\left(F_{G_1}(H), F_{G_1}(H)\right) = \max\{\max\min\left|F_{G_1}(H) - F_{G_2}(H)\right|, \max\min\left|F_{G_2}(H) - F_{G_1}(H)\right|\}$

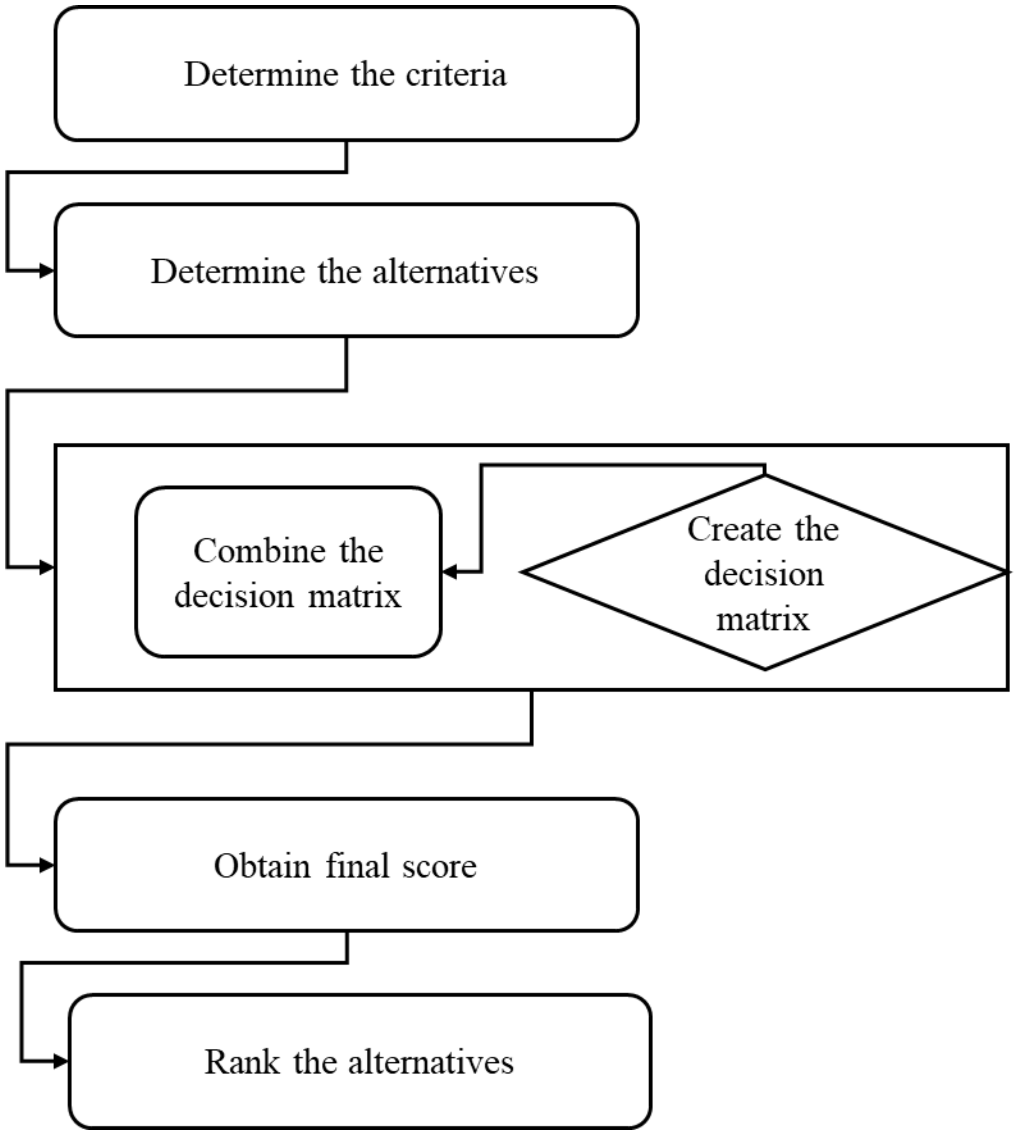


Figure 1. Diagram of the proposed approach.

5. Problem description

This study uses collection of alternatives $NHFA = \{NHFA_1, NHFA_2, \ldots., NHFA_m\}$, collection of criteria $NHFC = \{NHFA_1, NHFA_2, \ldots., NHFA_m\}$ and collection of experts and decision makers $NHFK = \{NHFK_1, NHFK_2, \ldots., NHFK_k\}$.

The steps of the proposed approach are shown in Figure 1. The steps of the proposed approach are shown as follows:

Create the decision matrix by set of experts and decision makers. Experts are used the NHFS number to evaluate the criteria and alternatives.

Combine the decision matrix using the SVNHFS Hausdorff distance to obtain single matrix instead of different matrices.

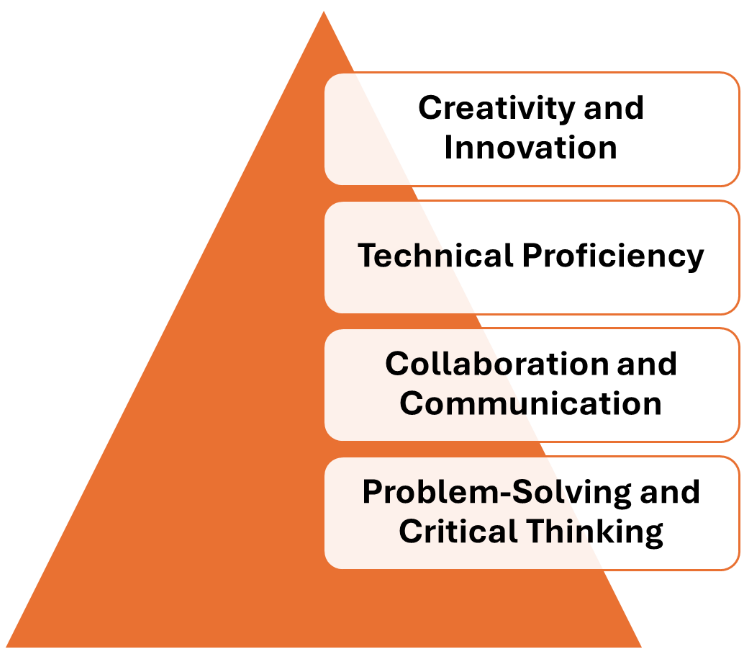
The SVNHF Euclidean-Hausdorff distance is used to obtain single value of each alternative.

Rank the alternative.

6. Case Study

One of the most well-liked and effective uses of computer technology is computer gaming. Computer games have been utilized in teaching and educational settings; thus, they are not always just for amusement. Hundreds of thousands or even millions of lines of program code can be found in a modern computer game. A group of experts, including programmers, designers, testers, artists, and animators, may be involved in creating such a computer game. On the other hand, computer game creation is still a developing field. Among the commercially used computer game design approaches are flowcharts, state transition diagrams, and storyboards.

This study gathers four criteria and ten alternatives as shown in Figure 2.



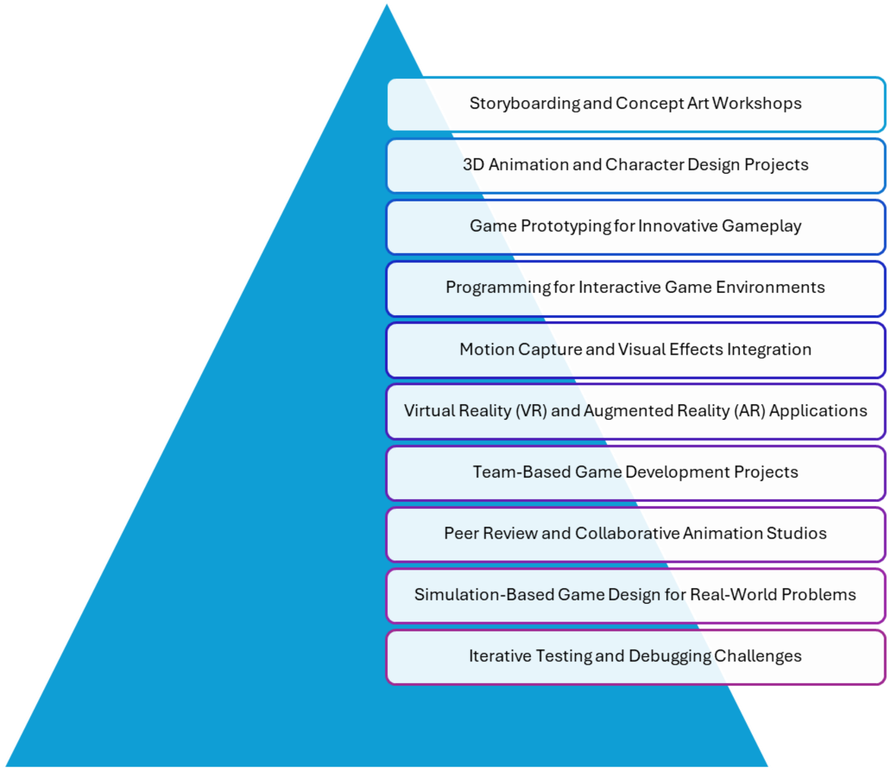


Figure 2. Standards.

Three experts created the decision matrix as shown in Table 1.

Table 1. Decision matrix.

	NHC1	NHC2	NHC3	NHC4
NHA 1	({0.60,0.70},{0.10,0.20},{0.20, 0.30})	({0.50,0.60},{0.30,0.40},{0.20, 0.30})	({0.70,0.80},{0.10,0.20},{0.10, 0.20})	({0.20,0.30},{0.10,0.20},{0.50, 0.60})
NHA 2	({0.60,0.70},{0.10,0.20},{0.20, 0.30})	({0.20,0.30},{0.60,0.70},{0.50, 0.60})	({0.10,0.20},{0.80,0.90},{0.70, 0.80})	({0.30,0.50},{0.20,0.30},{0.10, 0.20})
NHA 3	({0.50,0.60},{0.30,0.40},{0.20, 0.30})	({0.70,0.80},{0.10,0.20},{0.10, 0.20})	({0.20,0.30},{0.10,0.20},{0.50, 0.60})	({0.30,0.50},{0.20,0.30},{0.10, 0.20})
NHA 4	({0.20,0.30},{0.10,0.20},{0.50, 0.60})	({0.70,0.80},{0.10,0.20},{0.10, 0.20})	({0.50,0.60},{0.30,0.40},{0.20, 0.30})	({0.60,0.70},{0.10,0.20},{0.20, 0.30})
NHA 5	({0.30,0.50},{0.20,0.30},{0.10, 0.20})	({0.20,0.30},{0.10,0.20},{0.50, 0.60})	({0.70,0.80},{0.10,0.20},{0.10, 0.20})	({0.50,0.60},{0.30,0.40},{0.20, 0.30})
NHA 6	({0.30,0.50},{0.20,0.30},{0.10, 0.20})	({0.30,0.50},{0.20,0.30},{0.10, 0.20})	({0.20,0.30},{0.10,0.20},{0.50, 0.60})	({0.30,0.50},{0.20,0.30},{0.10, 0.20})
NHA 7	({0.20,0.30},{0.60,0.70},{0.50, 0.60})	({0.70,0.80},{0.10,0.20},{0.10, 0.20})	({0.20,0.30},{0.10,0.20},{0.50, 0.60})	({0.20,0.30},{0.60,0.70},{0.50, 0.60})
NHA 8	({0.60,0.70},{0.10,0.20},{0.20, 0.30})	({0.20,0.30},{0.10,0.20},{0.50, 0.60})	({0.30,0.50},{0.20,0.30},{0.10, 0.20})	({0.10,0.20},{0.80,0.90},{0.70, 0.80})
NHA 9	({0.50,0.60},{0.30,0.40},{0.20, 0.30})	({0.30,0.50},{0.20,0.30},{0.10, 0.20})	({0.60,0.70},{0.10,0.20},{0.20, 0.30})	({0.50,0.60},{0.30,0.40},{0.20, 0.30})
NHA 10	({0.70,0.80},{0.10,0.20},{0.10, 0.20})	({0.10,0.20},{0.80,0.90},{0.70, 0.80})	({0.70,0.80},{0.10,0.20},{0.10, 0.20})	({0.20,0.30},{0.10,0.20},{0.50, 0.60})
	NHC1	NHC2	NHC3	NHC4
NHA 1	({0.20,0.30},{0.10,0.20},{0.50, 0.60})	({0.50,0.60},{0.30,0.40},{0.20, 0.30})	({0.70,0.80},{0.10,0.20},{0.10, 0.20})	({0.20,0.30},{0.10,0.20},{0.50, 0.60})

NHA 2	({0.70,0.80},{0.10,0.20},{0.10, 0.20})	({0.20,0.30},{0.60,0.70},{0.50, 0.60})	({0.10,0.20},{0.80,0.90},{0.70, 0.80})	({0.20,0.30},{0.10,0.20},{0.50, 0.60})
NHA 3	({0.50,0.60},{0.30,0.40},{0.20, 0.30})	({0.70,0.80},{0.10,0.20},{0.10, 0.20})	({0.20,0.30},{0.10,0.20},{0.50, 0.60})	({0.70,0.80},{0.10,0.20},{0.10, 0.20})
NHA 4	({0.60,0.70},{0.10,0.20},{0.20, 0.30})	({0.70,0.80},{0.10,0.20},{0.10, 0.20})	({0.50,0.60},{0.30,0.40},{0.20, 0.30})	({0.50,0.60},{0.30,0.40},{0.20, 0.30})
NHA 5	({0.20,0.30},{0.60,0.70},{0.50, 0.60})	({0.20,0.30},{0.10,0.20},{0.50, 0.60})	({0.70,0.80},{0.10,0.20},{0.10, 0.20})	({0.60,0.70},{0.10,0.20},{0.20, 0.30})
NHA 6	({0.20,0.30},{0.10,0.20},{0.50, 0.60})	({0.20,0.30},{0.10,0.20},{0.50, 0.60})	({0.20,0.30},{0.10,0.20},{0.50, 0.60})	({0.20,0.30},{0.60,0.70},{0.50, 0.60})
NHA 7	({0.20,0.30},{0.60,0.70},{0.50, 0.60})	({0.70,0.80},{0.10,0.20},{0.10, 0.20})	({0.60,0.70},{0.10,0.20},{0.20, 0.30})	({0.30,0.50},{0.20,0.30},{0.10, 0.20})
NHA 8	({0.20,0.30},{0.10,0.20},{0.50, 0.60})	({0.20,0.30},{0.10,0.20},{0.50, 0.60})	({0.20,0.30},{0.60,0.70},{0.50, 0.60})	({0.10,0.20},{0.80,0.90},{0.70, 0.80})
NHA 9	({0.70,0.80},{0.10,0.20},{0.10, 0.20})	({0.30,0.50},{0.20,0.30},{0.10, 0.20})	({0.20,0.30},{0.10,0.20},{0.50, 0.60})	({0.70,0.80},{0.10,0.20},{0.10, 0.20})
NHA 10	({0.50,0.60},{0.30,0.40},{0.20, 0.30})	({0.10,0.20},{0.80,0.90},{0.70, 0.80})	({0.10,0.20},{0.80,0.90},{0.70, 0.80})	({0.20,0.30},{0.60,0.70},{0.50, 0.60})
	NHC_1	NHC2	NHC3	NHC4
NHA 1	({0.60,0.70},{0.10,0.20},{0.20, 0.30})	({0.50,0.60},{0.30,0.40},{0.20, 0.30})	({0.70,0.80},{0.10,0.20},{0.10, 0.20})	({0.20,0.30},{0.10,0.20},{0.50, 0.60})
NHA 2	({0.20,0.30},{0.60,0.70},{0.50, 0.60})	({0.20,0.30},{0.60,0.70},{0.50, 0.60})	({0.10,0.20},{0.80,0.90},{0.70, 0.80})	({0.30,0.50},{0.20,0.30},{0.10, 0.20})
NHA 3	({0.10,0.20},{0.80,0.90},{0.70, 0.80})	({0.60,0.70},{0.10,0.20},{0.20, 0.30})	({0.20,0.30},{0.10,0.20},{0.50, 0.60})	({0.30,0.50},{0.20,0.30},{0.10, 0.20})
NHA 4	({0.30,0.50},{0.20,0.30},{0.10, 0.20})	({0.20,0.30},{0.60,0.70},{0.50, 0.60})	({0.60,0.70},{0.10,0.20},{0.20, 0.30})	({0.60,0.70},{0.10,0.20},{0.20, 0.30})
NHA 5	({0.20,0.30},{0.10,0.20},{0.50, 0.60})	({0.10,0.20},{0.80,0.90},{0.70, 0.80})	({0.20,0.30},{0.60,0.70},{0.50, 0.60})	({0.60,0.70},{0.10,0.20},{0.20, 0.30})
NHA 6	({0.70,0.80},{0.10,0.20},{0.10, 0.20})	({0.30,0.50},{0.20,0.30},{0.10, 0.20})	({0.10,0.20},{0.80,0.90},{0.70, 0.80})	({0.20,0.30},{0.60,0.70},{0.50, 0.60})
NHA 7	({0.20,0.30},{0.60,0.70},{0.50, 0.60})	({0.70,0.80},{0.10,0.20},{0.10, 0.20})	({0.30,0.50},{0.20,0.30},{0.10, 0.20})	({0.20,0.30},{0.60,0.70},{0.50, 0.60})
NHA 8	({0.60,0.70},{0.10,0.20},{0.20, 0.30})	({0.20,0.30},{0.10,0.20},{0.50, 0.60})	({0.20,0.30},{0.10,0.20},{0.50, 0.60})	({0.10,0.20},{0.80,0.90},{0.70, 0.80})
NHA 9	({0.20,0.30},{0.60,0.70},{0.50, 0.60})	({0.30,0.50},{0.20,0.30},{0.10, 0.20})	({0.60,0.70},{0.10,0.20},{0.20, 0.30})	({0.50,0.60},{0.30,0.40},{0.20, 0.30})
NHA 10	({0.10,0.20},{0.80,0.90},{0.70, 0.80})	({0.10,0.20},{0.80,0.90},{0.70, 0.80})	({0.70,0.80},{0.10,0.20},{0.10, 0.20})	({0.20,0.30},{0.10,0.20},{0.50, 0.60})

We combine the decision matrix as shown in Table 2.

Table 2. Combine the decision matrix.

	$T_{G_1}(H)$	$T_{G_2}(H)$	$I_{G_1}(H)$	$I_{G_2}(H)$	$F_{G_1}(H)$	$F_{G_2}(H)$
NHA_1	0.066667	0.1	0.033333	0.066667	0.066667	0.1
NHA_2	0.066667	0.1	0.033333	0.066667	0.033333	0.066667
NHA_3	0.033333	0.066667	0.1	0.133333	0.066667	0.1
NHA_4	0.066667	0.1	0.033333	0.066667	0.033333	0.066667
NHA_5	0.066667	0.1	0.033333	0.066667	0.033333	0.066667
NHA_6	0.066667	0.1	0.033333	0.066667	0.033333	0.066667
NHA_7	0.066667	0.1	0.2	0.233333	0.166667	0.2
NHA_8	0.066667	0.1	0.033333	0.066667	0.066667	0.1
NHA_9	0.066667	0.1	0.033333	0.066667	0.033333	0.066667
NHA_{10}	0.033333	0.066667	0.033333	0.066667	0.033333	0.066667

	$T_{G_1}(H)$	$T_{G_2}(H)$	$\boldsymbol{I}_{G_1}(H)$	$\boldsymbol{I}_{G_2}(H)$	$\boldsymbol{F}_{G_1}(H)$	$\boldsymbol{F}_{G_2}(H)$
NHA1	0.166667	0.2	0.1	0.133333	0.066667	0.1
NHA2	0.066667	0.1	0.2	0.233333	0.166667	0.2
NHA3	0.2	0.233333	0.033333	0.066667	0.033333	0.066667
NHA4	0.066667	0.1	0.033333	0.066667	0.033333	0.066667
NHA5	0.033333	0.066667	0.033333	0.066667	0.166667	0.2
NHA6	0.066667	0.1	0.033333	0.066667	0.033333	0.066667
NHA7	0.233333	0.266667	0.033333	0.066667	0.033333	0.066667
NHA8	0.066667	0.1	0.033333	0.066667	0.166667	0.2
NHA9	0.1	0.166667	0.066667	0.1	0.033333	0.066667
NHA10	0.033333	0.066667	0.266667	0.3	0.233333	0.266667
	$T_{G_1}(H)$	$T_{G_2}(H)$	$\boldsymbol{I}_{G_1}(H)$	$\boldsymbol{I}_{G_2}(H)$	$\boldsymbol{F}_{G_1}(H)$	$\boldsymbol{F}_{G_2}(H)$
NHA1	0.233333	0.266667	0.033333	0.066667	0.033333	0.066667
NHA2	0.033333	0.066667	0.266667	0.3	0.233333	0.266667
NHA3	0.066667	0.1	0.033333	0.066667	0.166667	0.2
NHA4	0.166667	0.2	0.033333	0.066667	0.066667	0.1
NHA5	0.066667	0.1	0.033333	0.066667	0.033333	0.066667
NHA6	0.033333	0.066667	0.033333	0.066667	0.166667	0.2
NHA7	0.066667	0.1	0.033333	0.066667	0.033333	0.066667
NHA8	0.066667	0.1	0.033333	0.066667	0.033333	0.066667
NHA9	0.066667	0.1	0.033333	0.066667	0.066667	0.1
NHA10	0.033333	0.066667	0.033333	0.066667	0.033333	0.066667
	$T_{G_1}(H)$	$T_{G_2}(H)$	$\boldsymbol{I}_{G_1}(H)$	$\boldsymbol{I}_{G_2}(H)$	$\boldsymbol{F}_{G_1}(H)$	$\boldsymbol{F}_{G_2}(H)$
NHA1	0.066667	0.1	0.033333	0.066667	0.166667	0.2
NHA2	0.066667	0.1	0.033333	0.066667	0.033333	0.066667
NHA3	0.1	0.166667	0.033333	0.066667	0.033333	0.066667
NHA4	0.166667	0.2	0.033333	0.066667	0.066667	0.1
NHA5	0.166667	0.2	0.033333	0.066667	0.066667	0.1
NHA6	0.066667	0.1	0.066667	0.1	0.033333	0.066667
NHA7	0.066667	0.1	0.066667	0.1	0.033333	0.066667
NHA8	0.033333	0.066667	0.266667	0.3	0.233333	0.266667
NHA9	0.166667	0.2	0.033333	0.066667	0.033333	0.066667
NHA10	0.066667	0.1	0.033333	0.066667	0.166667	0.2

The score value of each alternative is computed using the SVNHF Euclidean-Hausdorff distance as shown in Figure 3. Ranks of alternatives are shown in Figure 4.

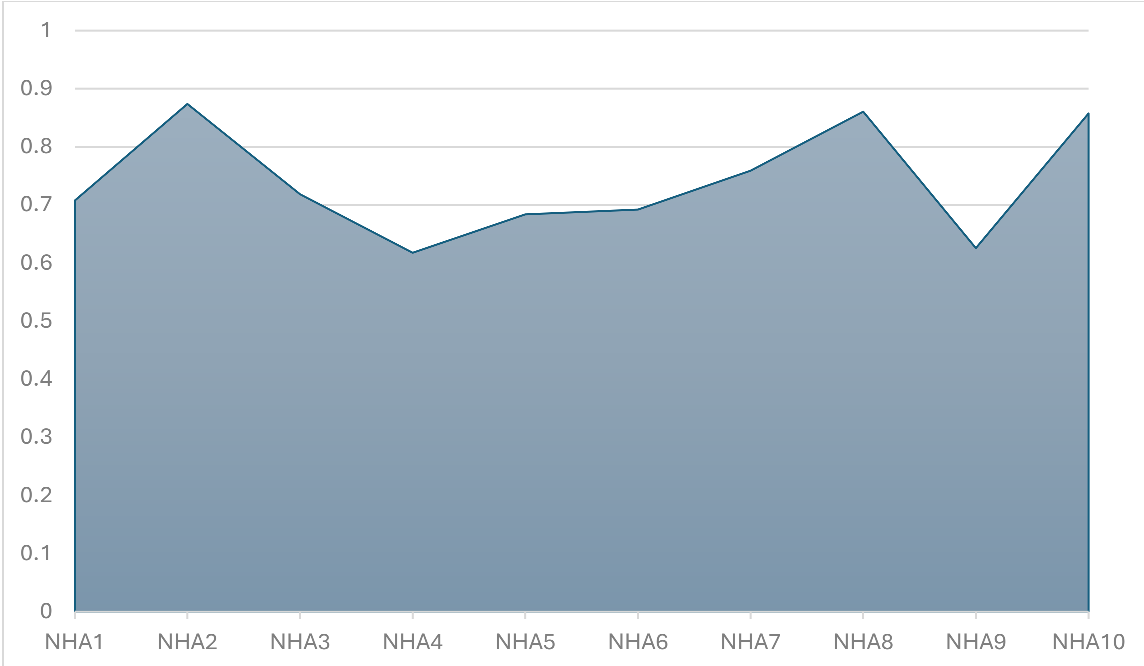


Figure 3. Final score.

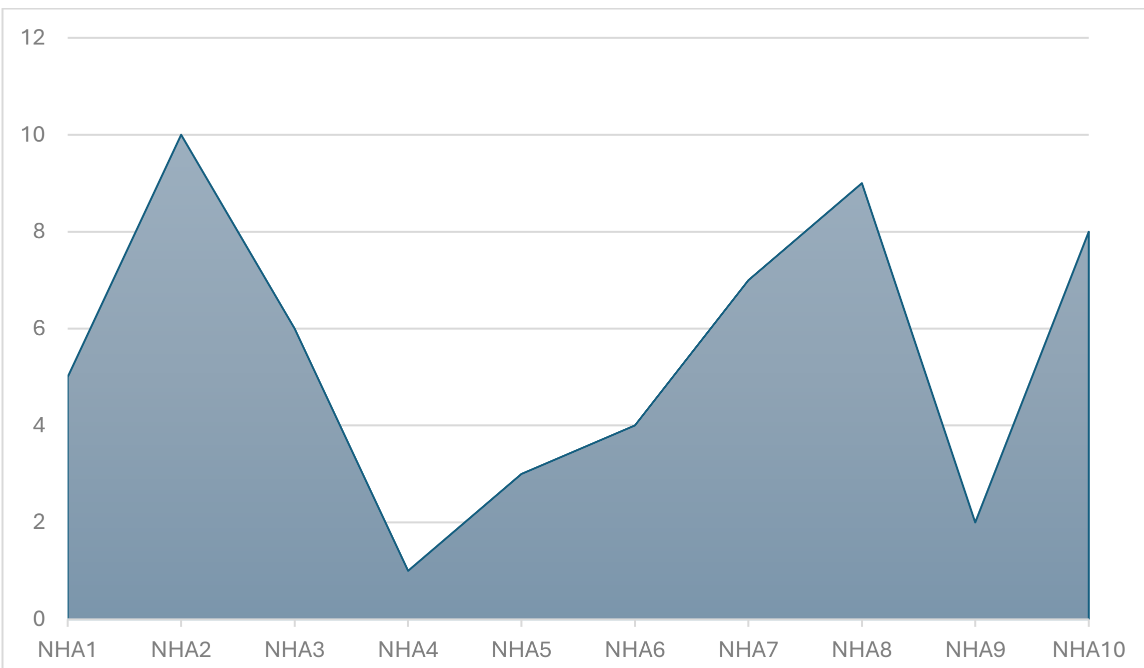


Figure 4. Final value.

7. Conclusions

The examination emphasizes that game design and animation provide significant chances for comprehensive skill development that go beyond simple amusement. This study used the neutrosophic to solve uncertainty information in decision-making processes. This study used the Neutrosophic Hesitant Fuzzy Set methodology to rank the alternatives.

The suggested framework offers an organized method for incorporating creativity, technical proficiency, teamwork, and problem-solving into learning and professional development settings. The study concludes that integrating game design and animation into courses enhances students' abilities to be creative and flexible while connecting theory to real-world application. However, to optimize effectiveness, successful implementation necessitates careful consideration of instructional design, evaluation techniques, and available resources.

8. Future Directions

This study shows set of future directions such as:

Expanded Empirical Studies: To assess the framework's adaptability and results, further studies should implement it in many educational contexts, including K–12, higher education, and vocational training.

Investigating how animation and game design may converge with domains like engineering, healthcare, and the social sciences to foster the development of specialized skills is known as cross-disciplinary integration.

Technological Developments: Evaluating how new tools like extended reality, metaverse platforms, and AI-assisted design affect the efficacy of learning.

Assessment Models: Creating reliable assessment instruments that gauge problem-solving, creativity, and teamwork in game-based and animation-driven contexts.

Industrial Collaboration: To better match skill development with professional standards and labor market demands, academic institutions and industrial relationships are being strengthened.

Global and Cultural Perspectives: Examining how local design customs and cultural narratives might enhance the universal appeal of animation and game-based learning.

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