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Knowledge Management Using Storytelling with Infographics to Develop Creativity of Undergraduate Students

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Abstract. Creativity is one of the most marketable skills in the digital age. The main purpose of this study is to explore and enhance the creativity of undergraduate students through knowledge management using storytelling with infographics. In this study, an experiment was conducted with 40 third- and fourth-year students from various majors of the Faculty of Arts at Silpakorn University. All participants had enrolled in the Multimedia Design and Production course. A one-group quasi-experiment with a pretest and posttest design was used. Several instruments were employed, including a creativity assessment form, a self-creativity assessment form, an infographic assessment form, and an infographic design attitudes questionnaire. Initially, participants were asked to complete the self-creativity assessment form and the creativity assessment form. During the sessions, all participants were taught using storytelling with infographics. After they finished designing the infographics, the instructor assessed the students' work using a rubric for infographic assessment. Additionally, students evaluated their own work. At the end of the course, the students were asked to retake the self-creativity assessment form and creativity assessment form. The results showed that students' creativity scores were significantly higher in all components (e.g., originality, fluency, flexibility, and elaboration). Moreover, most students received average scores in infographic design at the advanced level. However, students were found to lack confidence and courage in expressing diverging ideas. This highlights the challenges for instructors and learning designers in researching and developing suitable and effective methods to boost students' confidence and encourage thinking outside the box.

Keywords: creativity; infographics; knowledge management; storytelling

1. Introduction

Innovation and technology have numerous benefits that impact various aspects of our lives, society, and the economy. Conversely, various technologies have

rendered many professions obsolete or will replace more professions in the future (Verhoef et al., 2021; Vial, 2021). Consequently, undergraduate students without an advantage over the inexorably improving technology may find it difficult to survive the fierce competition in the labor market. Relying solely on academic knowledge from the university is no longer sufficient; undergraduate students must possess other skills in demand in the digital age.

Creativity stands as one of the most marketable skills in the labor market, as creative individuals exhibit initiative, flexible imagination, and the ability to generate new concepts or methods for problem-solving and improvement, directly or indirectly benefiting organizations (Di Battista et al., 2023). Therefore, a challenge in the digital age, where technology and creativity play pivotal roles in development and competition, lies in developing preparatory programs for undergraduate students to equip them for the labor market, aid self-discovery, and enhance their skills and knowledge.

Currently, the information on the Internet is massive and dispersed. True and false information seem to be blending on the Internet. With more people consuming news online, a concerning consequence is the inadvertent spread of fake news about health, international events, and political issues. Furthermore, fake news on Twitter and LINE is more likely to be retweeted or shared (Rocha et al., 2021; Pennycook & Rand, 2021; Pierri & Ceri, 2019). Communication through LINE or Facebook groups can have more adverse effects on society due to a high level of trust compared to interactions with strangers. Prolonged and repeated interactions with like-minded individuals and exposure to the same data set lead to a one-sided information reception or selective information intake, commonly referred to as an "Echo Chamber." This phenomenon entails the selective reception of news and media, primarily from like-minded sources and may lead individuals to perceive their ideas as the absolute and irrefutable truth, leaving no room for dissenting voices (Terren & Borge-Bravo, 2021; Cinelli et al., 2021). Another issue arises in close-group communication among senior citizens, as they may struggle with search engine usage compared to other age groups, leading to closed groups becoming sources of fake news. Additionally, sharing misleading content might lead to cyberbullying and hate speech (Giumetti & Kowalski, 2022; Craig et al., 2020; Matamoros-Fernández & Farkas, 2021; Paz et al., 2020; MacAvaney et al., 2019). Sharing incorrect or distorted information immeasurably affects the world community. Therefore, students in the digital age must possess knowledge and critical thinking skills to discern and exchange factual and reasonable information in society.

Given the aforementioned reasons, the researcher emphasizes the importance of classroom knowledge management, creating an environment where students can search, screen, and share knowledge in the digital age, where information volume is massive. The knowledge management process entails knowledge identification, creation, acquisition, organization, codification, refinement, sharing, and application (Ammirato et al., 2021; De Bem Machado et al., 2022). In this study, the researcher integrated the design process with learning activities and instructed students to summarize information or knowledge in infographic

form. This is because infographics allow audiences to understand the content quickly and clearly. Furthermore, human brains process and respond to pictures faster than text, making infographics more likely to be read than plain text information (Apriyanti et al., 2020; Dorneles et al., 2020; Habeeb, 2020).

Silpakorn University's Faculty of Arts covers diverse fields of science, including linguistics, library science, history, geography, social sciences, philosophy, and drama and music. One of the core competencies of the institute is integrated teaching and learning across sciences to develop the skills needed for 21st-century learners. Faculty members of the Faculty of Arts focus on developing students' creative thinking as it is one of the most important skills for workers in the digital age. This aligns with the World Economic Forum's Future of Jobs 2023 report that creativity is the top job market skill (Di Battista et al., 2023).

In this study, I attempt to examine and develop the creativity of undergraduate students of the Faculty of Arts, Silpakorn University through knowledge management using storytelling with infographics. I aim to address the following research questions:

1. What is the level of undergraduate students' creativity after learning activities?
2. What are the undergraduate students' attitudes toward their own creativity after learning activities?
3. How are the undergraduate students' infographic design skills?
4. What are the undergraduate students' attitudes toward their own infographic design?

2. Literature Review

2.1 Creativity in the Digital Age

Many people tie the word "creativity" with "artistic skills," such as drawing and playing musical instruments, to the point they associate the usefulness of creativity only with artistically capable people. However, creativity is accessible to everyone and is among the most marketable skills today. The World Economic Forum's Future of Jobs 2023 report finds analytical thinking, creative thinking, artificial intelligence, and big data will be top in-demand skills by 2027. In 2023, companies consider analytical thinking to be the strongest core skill, while ranking creative thinking second. However, by 2027, creative thinking is projected to grow in importance slightly more rapidly than analytical thinking (Di Battista et al., 2023).

Creativity is not limited to people in the art community, even doctors need creativity because they have to face diverse situations about patient care. Doctors often face complex, urgent problems that need immediate solutions. In addition to the rapidly changing healthcare system, they need more creativity, especially if the doctor has the job to create or develop an effective patient care system. Such development requires a specific innovation for the context the doctor is operating in (Ten Haven et al., 2022). In today's rapidly changing world, scientists need to leverage creativity to advance science and technology. Scientists need to use their creativity to produce new knowledge or develop

innovative solutions to address increasingly complex problems (Shen, 2023). Creativity is key for many professions and not just for professionals in art and design communities.

Advancements in the world community from the past to the digital age—full of news, information, media, and technologies—could be attributed to the creativity of persons that developed innovations, leading to more flexibility and national development. Many countries have included creativity development in international policy. This is covered in the educational policy, national education plan, and curriculum and activities. The government provides support for projects improving citizen creativity. Hence, it can be concluded that the more creativity among the citizenry, the more development and prosperity for a country. This is especially true in the 21st century, the era of innovation and technology that has advanced by leaps and bounds. The students in this era should receive creativity development support to live effectively in a world full of competition and technological advancement (Gube & Lajoie, 2020; Puccio, 2017).

The researcher examined the components of creativity (Hendrik, 2022; Handayani et al., 2021; Almeida et al., 2008) and found four major parts: 1) originality: a new idea that born of imagination and thinking outside the box or combination and adaptation of old ideas to a new one; 2) fluency: an ability to think of things in quantity within a limited time; 3) flexibility: an ability to think diversely and avoid repetition and redundancy, which is highly important; 4) elaboration: an ability to think in details to fill up the gaps in the main concept. Elaboration is related to attention to detail skills, which will be expressed in finely crafted work. According to four components of creativity, the researcher is interested in measuring the students' creativity skills through these four components.

2.2 The Knowledge Management in Classroom Context

“Knowledge management” is perceived to be a process designed to create, organize, manage, and utilize knowledge within large organizations. In reality, knowledge management is not location dependent. Knowledge management could be done within small classrooms (Thongkoo et al., 2019). There are two types of knowledge: 1) tacit knowledge gained through experience, gift, or intuition of a person in understanding things. This is knowledge that cannot be easily translated into words or text (e.g., working skills, crafting skills, or critical thinking). 2) explicit knowledge can be collected and passed on through text, theories, and manuals. Knowledge management requires a process and knowledge management tool. Much research work in the past proposed knowledge management through various processes and tools such as storage of knowledge in a database, big data-based knowledge management (Sumbal et al., 2021), ontology-based knowledge management (Osman et al., 2022), after action reviews (Vukanović-Dumanović et al., 2022; Keiser & Arthur Jr, 2021), mentoring system (Papadopoulou et al., 2016; Bencsik et al., 2014; Srivichai et al., 2012), cross-functional team (Mohamed et al., 2004; Majchrzak et al., 2012), workshop and brainstorming (White et al., 2022; Evans, 2012), and communities

of practice (Arthur, 2016; Reaburn & McDonald, 2017; Lewis & Rush, 2013; Annala & Mäkinen, 2017; McDonald & Cater-Steel, 2016). Very few works use storytelling for knowledge management. In this study, the researcher is interested in using storytelling with infographics as a knowledge management tool to provide empirical evidence that can help clarify its efficiency in classroom context.

2.3 Storytelling with Infographics

Storytelling with infographics has a significant impact on students' creativity in several ways. Infographics combine text, images, and visual elements to convey information. This multimedia approach engages both the left and right brain hemispheres, stimulating creativity. Visual cues can spark creative thinking by making complex data or concepts more accessible and memorable (Aldalalah, 2021). Effective infographics distill complex information into concise, easy-to-understand visuals. This simplification allows individuals to focus on creative problem-solving rather than grappling with data overload (Barlow et al., 2021). Infographics often include data and statistics, requiring students to analyze and interpret information. This analytical thinking can spur creativity as students explore patterns, draw conclusions, and generate new ideas based on the data they encounter (Chicca & Chunta, 2020). Infographics follow a narrative structure, presenting information in a logical sequence. This storytelling aspect can help students organize their ideas creatively, enabling them to convey complex concepts in a coherent and compelling way (Tsai et al., 2020). Infographics frequently use visual metaphors to represent abstract concepts or relationships. Encountering these metaphors can encourage students to think metaphorically and make imaginative connections between different elements, fostering creative thinking (Ocobock, 2020). Creating infographics often involves gathering information from various sources and condensing it into a concise and visually appealing format. This process requires students to synthesize information creatively, highlighting key points and leaving out nonessential details (Jones et al., 2019). Designing an infographic involves making decisions about layout, color schemes, typography, and visual elements. This design process encourages students to think creatively about how to present information in a visually appealing and accessible way (Aldalalah, 2021). Infographics require students to communicate information clearly and concisely. Developing these communication skills is essential for creative thinking, as it helps students express their ideas and insights effectively. Students may need to overcome challenges when creating infographics, such as finding the best way to represent complex data or choosing the most suitable visual elements. These problem-solving activities can stimulate creativity by encouraging students to find innovative solutions (Jones et al., 2019).

In summary, incorporating infographics into learning activities can be a valuable tool for improving students' creativity by combining visual learning, data analysis, narrative structure, and problem-solving. Infographics also draw from multiple disciplines, combining data analysis, graphic design, and storytelling. Engaging with infographics can expose students to diverse perspectives and ideas, fostering creativity through cross-disciplinary learning.

3. Methodology

3.1 Participants

My sample group comprised 40 undergraduate students enrolled in the Multimedia Design and Production course. All participants were third- and fourth-year students of the Faculty of Arts at Silpakorn University. Participants comprised 10 men and 30 women, and they were taking different majors—information and library science (16), linguistics (13), social sciences and history (7), and performing arts (4).

3.2 Research Instruments

This research used the following measuring tools: 1) creativity assessment form 2) self-creativity assessment form 3) infographic assessment form, and 4) infographic design attitudes questionnaire.

1) Creativity assessment form: The duration of the test was 30 minutes, consisting of three parts—picture construction (10 mins), picture completion (10 mins), and circles (10 mins). Each part was detailed as follows. Part 1: Draw additional pictures from the given geometric shapes. Try to be as unique as possible. Next, name the picture. Part 2: Draw the pictures from the given lines and name the pictures. Part 3: Draw 30 pictures from the given circle. Each picture must be different. Next, name the pictures. Pictures needed to be named in every activity of the creativity test to encourage students to practice their creativity in using words and language in addition to expressing their ideas through drawing. Table 1 shows a rubric for creativity assessment.

2) Self-creativity assessment form: this assessment was designed to measure students' attitudes toward their own creativity. Items in the assessment form were designed using a 5-point Likert scale (5 = "strongly agree," 4 = "agree," 3 = "neutral," 2 = "disagree," and 1 = "strongly disagree"). The reliability of the self-creativity assessment form was 0.84. The reliabilities of each dimension were 0.89 (creativity dimension), 0.80 (emotional dimension), and 0.84 (personality dimension). Table 2 shows the self-creativity assessment form.

3) Infographic assessment form: The evaluation of students' infographics included six aspects: design, composition, color, font, presentation, and source reliability. Table 3 shows the rubric for infographic assessment.

4) Infographic design attitudes questionnaire: I designed this questionnaire to measure students' attitudes toward their own infographic design. Items were designed using a 5-point Likert scale (5 = "strongly agree," 4 = "agree," 3 = "neutral," 2 = "disagree," and 1 = "strongly disagree"). The assessment form contains 13 items. The infographic design attitudes questionnaire had reliability of 0.79, indicating acceptable internal consistency.

Table 1: Rubric for creativity assessment

Creativity components	Proficient (3 points)	Developing (2 points)	Basic (1 point)
Originality	The work presents new and unique concepts.	The work presents new ideas. However, there are some parts of the work duplicated with other students.	The work is the same as most students in the class.
Fluency	Complete all assignments within the time limit.	Complete more than half of the total creativity test within the time limit.	Complete less than half of the total creativity test when the time runs out.
Flexibility	Create work in many ways.	Create many styles of work, but some styles are repeated.	Not a wide variety of creations and most of them have duplicate concepts.
Elaboration	The work has exhaustive details.	Some parts of the work lack important details.	Most of the work lacks details and refinement.

Table 2: Survey items of the self-creativity assessment form

Items
<p>1. Creativity dimension</p> <p>1.1 Originality: I have great imagination and dare to think and do unconventional and unique things.</p> <p>1.2 Flexibility: I accept new ideas and do not stick to original concepts.</p> <p>1.3 Fluency: I can develop many solutions within a limited time.</p> <p>1.4 Elaboration: I work with refinement, thoroughness, and meticulousness.</p>
<p>2. Emotional dimension</p> <p>2.1 Curiosity: I am observant and curious. I never give up looking for answers as long as my curiosity remains.</p> <p>2.2 Enthusiasm: I like seeking knowledge, and I am eager to learn.</p> <p>2.3 Sensitivity: I often perceive changes in the surrounding environment quickly.</p> <p>2.4 Humor: I am fun, friendly, and not stressed, and I like making others laugh.</p>
<p>3. Personality dimension</p> <p>3.1 Self-confidence: I have confidence in my ideas.</p> <p>3.2 Courage: I dare to decide even if my decisions differ from most people's.</p> <p>3.3 Commitment: I work hard and can endure difficult and time-consuming tasks.</p> <p>3.4 Independence: I can express my opinions openly without any concern.</p>

Table 3: Rubric for infographic assessment

Items	Advanced (4 points)	Proficient (3 points)	Developing (2 points)	Basic (1 point)
Design	Interesting theme and consistent with objectives and target groups.	Interesting theme, but inconsistent with objectives and target groups at some points.	No theme, but it aligns with objectives and target groups.	No theme and inconsistent with objectives and target groups.
Composition	The visual weight is distributed evenly across the composition and not too cluttered.	The composition is not too cluttered, but one side seems heavier than the other.	The layout of the composition is not as balanced as it should be, but it is not too cluttered.	The layout of the composition is excessively disorganized and cluttered.
Color	Use colors that match the content.	Use colors that match the content in some parts.	Use too many colors but remain consistent with the content.	Use too many colors that are not suitable for the content.
Font	The font styles are appropriate for the work. Font sizes vary according to content significance.	The font styles are suitable for the work, but the font is the same size for the whole work.	Font sizes vary according to content priority but use too many font styles.	Use the same font size for the whole work and use too many font styles.
Presentation	The presentation of information is concise and accurate.	The presentation of information is concise and accurate but is misleading in some parts.	The presentation of information is concise and accurate but is misleading in some parts. There are some misspellings.	Lack of information summary and organization. There are many misspellings.
Source reliability	Sources are highly reliable.	Some sources are not reliable.	Many sources are not reliable.	No references.

3.3 Procedure

I conducted experimental research for 2.5 hours per week over 4 months. Initially, participants were asked to complete the self-creativity assessment form and creativity assessment form. The teaching and learning processes for this course were synthesized into six key steps, as follows: 1) problem analysis, 2) knowledge creation and acquisition, 3) knowledge codification and refinement, 4) design, 5) knowledge sharing, and 6) evaluation.

1) Problem analysis is the step wherein students analyzed the current social issues and turned them into infographics for storytelling. In this step, the instructor allowed the students to freely select their topics to open their minds, without limiting their ideas to a certain scope. However, the chosen topic for the infographics must be informative and different from that of their classmates; 2) Knowledge creation and acquisition is the step wherein students searched for information from reputable sources. The instructor recommended that students selected sources with clear author names and reputable organizational websites that aligned with the chosen topic. For example, if the topic is about health and disease, students were encouraged to refer to hospital websites, the Ministry of Health's website, or reputable health organizations. 3) Knowledge codification and refinement involved students screening and compiling information obtained in the previous step. They were required to understand the content through reading and analysis. The instructor emphasizes that students should not copy and paste to avoid plagiarism. 4) Design is the step wherein students transformed the gathered information into infographics. The instructor then recommended that students used free and opensource software to design infographics. Using free and open-source software allowed students to access resources for design without worrying about copyright issues. 5) Knowledge sharing involves students presenting their work and exchanging knowledge with each other and with the instructor. 6) Evaluation is the step where the instructor assesses the students' work using the rubric for infographic assessment. Additionally, students evaluate their own work. At the end of the course, the students were asked to retake the self-creativity assessment form and creativity assessment form to compare the pretest and posttest results.

4. Results

4.1 Results of the Creativity Assessment

The researcher administered pretest and posttest creativity assessment forms to the students for comparison, with the aim of assessing their originality, fluency, flexibility, and elaboration scores. Table 1 presents the rubric used to assess creativity. The creativity test obtained from 1 to 4 points is evaluated as basic level. Creativity test scores ranging from 5 to 8 points are evaluated at the developing level, while scores above 9 points are considered proficient level. Table 4 presents the scores obtained in each creativity component. An average score for each component ranging from 2.50 to 3.00 points is categorized as proficient, scores from 1.50 to 2.49 points as developing, and scores below 1.50 points as basic. The results showed that students' creativity scores were significantly higher in all components. Moreover, they had average posttest scores in all creativity components at the proficient level, except in fluency. However, the difference between pretest and posttest scores proved that fluency had the highest development among students. Before the learning activities, most students could not finish the creativity assessment form within the time limit. However, after engaging in learning through knowledge management using storytelling with infographics, most students had improved their creativity proficiency, enabling them to complete the creativity assessment form within the time limit. This resulted in a higher fluency score compared to before the learning activities began.

Table 4: Results from the creativity assessment form

Creativity components	M	SD	Interpretation	t	p
Originality (pre)	1.95	0.316	Developing	10.817	<0.001**
Originality (post)	2.70	0.464	Proficient		
Fluency (pre)	1.08	0.350	Basic	14.552	<0.001**
Fluency (post)	2.35	0.483	Developing		
Flexibility (pre)	1.88	0.404	Developing	12.854	<0.001**
Flexibility (post)	2.85	0.362	Proficient		
Elaboration (pre)	1.78	0.480	Developing	9.067	<0.001**
Elaboration (post)	2.50	0.555	Proficient		
Total (pre)	6.68	0.917	Developing	21.241	<0.001**
Total (post)	10.40	1.215	Proficient		

** $p \leq 0.01$

4.2 Results of the Students' Attitudes toward Their Own Creativity

To gauge the students' attitudes toward their creativity, the instructor had them complete the self-creativity assessment form both before and after the learning activities. The results showed that after the knowledge management learning approach, the students exhibited a positive outlook on their creativity (see details in Table 5). They possessed greater imagination and dare to think and do unconventional and unique things. They developed more solutions within a limited time. They believed they could work with more refinement, thoroughness, and meticulousness. They liked seeking knowledge and are eager to learn. They believed they worked hard and could endure difficult and time-consuming tasks. They could also express their opinions openly without any concern. However, the pretest and posttest scores of self-confidence and courage had no statistically significant difference. This indicates that the instructor should focus on enhancing the students' confidence in expressing their creativity as prolonged low confidence may limit their ability to think creatively.

Table 5: Results of the self-creativity assessment

Items	M	SD	t	p
Originality (pre)	3.48	0.847	5.019	<0.001**
Originality (post)	3.95	0.714		
Fluency (pre)	3.33	0.797	3.219	0.003**
Fluency (post)	3.80	0.791		
Flexibility (pre)	4.35	0.580	0.467	0.643
Flexibility (post)	4.40	0.672		
Elaboration (pre)	3.55	0.846	4.309	<0.001**
Elaboration (post)	4.13	0.791		
Curiosity (pre)	4.00	0.716	2.223	0.032
Curiosity (post)	4.30	0.723		

Enthusiasm (pre)	4.05	0.714	4.201	<0.001**
Enthusiasm (post)	4.50	0.555		
Sensitivity (pre)	3.85	0.802	1.599	0.118
Sensitivity (post)	4.05	0.749		
Humor (pre)	3.95	0.815	2.223	0.032
Humor (post)	4.25	0.981		
Self-confidence (pre)	3.70	0.723	1.778	0.083
Self-confidence (post)	3.93	0.797		
Courage (pre)	3.65	0.802	1.030	0.309
Courage (post)	3.80	0.823		
Commitment (pre)	3.68	0.764	3.667	<0.001**
Commitment (post)	4.20	0.823		
Independence (pre)	3.75	0.809	2.726	0.010**
Independence (post)	4.15	0.700		

** $p \leq 0.01$

4.3 Results of the Infographic Assessment

Table 3 presents the rubric used to assess the infographic. Works wherein the obtained total score is lower than 7 points were considered basic. Works scored 7–12 points were evaluated as developing. Works scored 13–18 points were evaluated as proficient level. Those scored more than 18 points were evaluated as advanced. Table 6 shows the scores obtained in the sessions. Criteria for the assessment infographic were divided into six categories: design, composition, color, font, presentation, and source reliability. An average score in each item ranging from 3.50 to 4.00 points was categorized as advanced, scores from 2.50 to 3.49 points as proficient, scores from 1.50 to 2.49 points as developing, and scores below 1.50 points as basic. Figure 1 shows some examples of the students' infographics. The title of infographics translated into English was shown under each work. The analysis of the infographics produced by the students reveals that most students received average scores in source reliability at the advanced level, while average scores in other categories were at the proficient level. The average total scores were at the advanced level. Infographic work assessment showed that the students had good design skills and could select reputable information sources. Nevertheless, the students had the lowest scores in composition. Thus, the instructor should be more mindful of improving this skill of the students.

Table 6: Results of the infographic assessment by the instructor

Items	M	SD	Interpretation
Design	3.10	0.71	Proficient
Composition	3.05	0.71	Proficient
Color	3.28	0.75	Proficient
Font	3.10	0.67	Proficient
Presentation	3.15	0.83	Proficient

Source reliability	3.70	0.79	Advanced
Total	19.58	3.45	Advanced

4.4 Attitudes toward Infographic Design

After designing the infographics, the researcher had the students evaluate their infographic design. Table 7 presents their attitudes toward infographic design. Average scores can then be interpreted as follows. Average scores of 1.00–1.49 points were considered as strongly disagree. Average scores of 1.50–2.49 points were considered disagree. Average scores of 2.50–3.49 points are considered neutral. Average scores of 3.50–4.49 points are considered agree. Average scores of 4.50 to 5.00 points are considered strongly agree. The results showed that more students had a positive attitude toward their work, believing that their work was useful for others and acknowledging that with more practice in designing, they could produce even better work. Furthermore, most of the students demonstrated proficiency in using the design program and devoted considerable time to designing and creating their work because they aspired for their work to be the best.

Table 7: Attitudes toward infographic design

Items	M	SD	Interpretation
I have more confidence in designing.	4.20	0.608	agree
I am proud of my work.	4.42	0.747	agree
I am satisfied with my work.	4.35	0.662	agree
Practicing design more makes my work better.	4.65	0.580	strongly agree
The infographic came out exactly as I expected.	4.10	0.744	agree
I am fluent in designing.	3.70	0.939	agree
It took me a long time to create a great design.	4.15	0.700	agree
It took me a long time to design because of a lack of expertise in using the program.	3.40	1.172	neutral
I can solve problems on my own without asking for help from the instructor.	3.70	0.823	agree
My work is creative and unique.	3.62	0.740	agree
My work is elaborate.	3.80	0.791	agree
My work is interesting.	4.03	0.660	agree
My work is helpful to others.	4.52	0.751	strongly agree



Depression: What You Need to Know (Informational Infographic)



The Benefits of Cold and Hot Showers (Comparison Infographic)



The American Civil War (Informational Infographic)



Sea Bunny: Adorable Sea Rabbit (Informational Infographic)



5 Benefits of Eating Yogurt Before Bed (List Infographic)



Evolution of Music Machines (Timeline Infographic)



Types of Coffee Drinks (List Infographic)



8 Versatile Mushrooms (List Infographic)



How to Make Soy Sauce (Process Infographic)

Figure 1: Students' infographics examples

5. Discussion

The findings suggest that students experienced increased creativity after learning through knowledge management using storytelling with infographics. This could be attributed to the learning process, which allowed the students to freely express their creativity without limitations on the topic. The students could express themselves freely relative to the knowledge that they had researched and synthesized in infographic storytelling.

Furthermore, students' higher levels of creativity may come from practicing telling stories with infographics. Designing an infographic involves making decisions about layout, color schemes, typography, and visual elements. This design process encourages students to think creatively about how to present information in a visually appealing and accessible way. Infographics often draw from multiple disciplines. Engaging with infographics can expose students to diverse perspectives and ideas, fostering creativity through cross-disciplinary learning. This is consistent with the research of Yang et al. (2022), which examined the effectiveness of digital storytelling on foreign language learners' English speaking and creative thinking. In their study, digital storytelling was realized in the form of an interdisciplinary project integrated into a partnership between an English course and a computer course, with the class time of the former devoted to the content design and that of the latter to the multimedia design of learner-generated digital stories. The participants were required to work in small groups to create their digital stories in the target language, English, under an eight-week interdisciplinary curriculum. A two-group quasi-experiment with a pretest and posttest design was then conducted to compare the participants' learning outcomes. The findings revealed the meaningful learning opportunities that digital storytelling fostered in the students' development to become proficient English speakers and creative thinkers.

Another notable observation was that the students demonstrated more fluent thinking skills, enabling them to generate many ideas in a limited time. This finding aligns with Handayani et al. (2021), who also noted that practicing thinking skills through learning by doing fosters creativity, particularly fluency in thinking. Students produce many ideas and various answers within a limited time.

Moreover, in addition to their developed creativity, the students excelled in obtaining information from reputable sources. This outcome could be attributed to the knowledge creation and acquisition step, during which the teacher provided guidance on obtaining information from reputable sources. As a result, the students were able to disseminate accurate information, contributing to the creation of a society where people share information and express their opinions based on facts and reasons (Ammirato et al., 2021; De Bem Machado et al., 2022).

However, when the students evaluated their creativity before and after the learning activities, it became evident that they still lacked the confidence and courage to express differing ideas. This indicates the need for the instructor to work on instilling more confidence in the students, as prolonged low confidence might hinder their ability to think creatively and outside the box. This result corresponds to the findings of Ten Haven et al. (2022), which emphasized the importance of the courage to make mistakes and learn from trial and error as a factor in promoting creativity. To foster creativity effectively, students must be open-minded, confident in their own ideas, and willing to think unconventionally. Cultivating such confidence in students is not an easy task, and it presents challenges for instructors and learning designers in researching

and developing suitable and effective methods to increase students' confidence and courage to think outside the box.

6. Conclusion

Innovations and technologies have currently replaced many professions. Undergraduate students must possess various skills to survive the competition in the labor market. Creativity is one of the most in-demand skills in the digital age. Graduates with a high level of creativity are likely to be more desirable to employers than those who are not. In this study, knowledge management using storytelling with infographics was used as an intervention to improve the creativity of undergraduate students enrolled in the Multimedia Design and Production course. In this study, we classified creativity into four components: originality, fluency, flexibility, and elaboration. The results show that students' creativity scores were significantly higher in all components. The students had average posttest scores in all creativity components at the proficient level, except in fluency. However, the difference between pretest and posttest scores showed that fluency had the highest development. Before the learning activities, most students could not finish the creativity assessment form within the time limit. However, after engaging in learning through knowledge management using storytelling with infographics, most students had improved their creativity proficiency, enabling them to complete the creativity assessment form within the time limit. Furthermore, most students received average scores in infographic design at the advanced level. Therefore, it can be concluded that knowledge management using storytelling with infographics could raise the creativity of undergraduate students. However, the pretest and posttest scores of self-confidence in this study had no statistically significant difference. This indicates that the instructor should focus on enhancing the students' confidence in expressing their creativity as prolonged low confidence may limit their ability to think creatively.

7. Limitations and Suggestions for Further Research

One limitation of this study is its sample, which only includes students from the Faculty of Arts at Silpakorn University enrolled in the Multimedia Design and Production course. As such, it may not be representative of all undergraduate students in the Faculty of Arts in Thailand. Future research could address this limitation by examining undergraduates from multiple universities in Thailand. Additionally, future studies may use qualitative data collection and analysis to get more insights. Conducting semi-structured interviews with open-ended questions allows participants to provide data that is richer and more nuanced than what can be captured through a survey using a 5-point Likert scale.

Ethical Consideration

This research is certified by the human research committee at Silpakorn University under the Declaration of Helsinki. This research work complies with international ethical principles and the laws, regulations, and requirements of Thailand. This research work is subjected to an exemption review with Certification No. 66.0103-001

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