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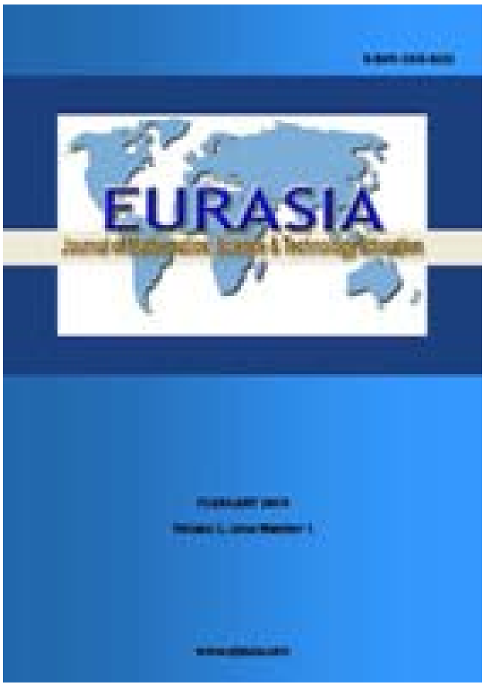

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The purpose of this study was to explore the effects of a learning activity based on Science Fiction (SF) film (movie) on the technological creativity of middle school students. A quasi- experimental design was employed, and 132 middle school students were included in this study. The following conclusions were reached based on the data analysis: 1) SF film can stimulate middle school students' technological creativity. 2) Appropriate hands-on learning activities designed on the basis of students' learning styles are effective for stimulating students' technological creativity.

Keywords: cognitive styles, middle school students, science fiction film, technological creativity

INTRODUCTION

Lewis (2005) noted that keeping pace with rapid technological developments and changing social trends requires that technology education not rely on only knowledge of materials, mastery of technical skills and techniques, or the correct use of equipment; instead, it should also aim to develop creativity. Lewis' (2005) viewpoint has been supported by the International Technology Education Association (2006), which defined technology as "Human innovation in action." Williams (1999) believed that the most common type of innovation involves developing new products and improving existing ones. This perspective underscores the value of developing individuals' creativity or innovative ideas through hands-on learning activities (Kowaltowski, Bianchi, & de Paiva, 2010; Bruton, 2011).

Although creativity is important in technology education, efforts to develop creativity often focus on thinking, and education about technology tends to focus on practical hands-on skills and products. Technological creativity, defined as the means by which individuals design and make products and, as a result, improve the overall quality of peoples' lives, plays a crucial role in the modern age (Chang, Lee, Yu, & Lin, 2009; Yeh & Wu, 2006).

Johnson and Daugherty (2008) identified technological creativity as an emerging research topic in the domain of technology education. Siu (2003), for example, indicated that the pedagogical approach to product design within technology education is often limited due to its over-emphasis on technological knowledge and skills, which results in not cultivating critical thinking skills. He proposed that product-design

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State of the literature

- Current research offers a large number of references about students' performance in technological creativity.
- Current research focused on stimulating students' imagination through science fiction film, but lack of exploring effects on students' technological creativity.
- Typically, visual-type students have better performance in visual learning environment.

Contribution of this paper to the literature

- This paper offers ways to utilizing SF film in stimulating students' imagination during the process of hands-on learning activity.
- This paper explores the effects of SF film on the technological creativity of middle school students.
- This paper proves to design a hands-on learning activity according to students' learning style are effective for stimulating their technological creativity.

courses focus on factors such as creativity and critical thinking to strengthen its educational impact. Cropley and Cropley (2010) echoed the thoughts of Johnson and Daugherty (2008) by confirming the importance of technological creativity in technology-design education. This underlines need to explore using technology-design education to cultivate student creativity.

Although technological creativity is crucial to technology education, it lacks a substantial research base and a comprehensive framework for classroom-based education as it is a relatively new discipline (Mawson, 2007). Thus, questions about how students' technological creativity can be improved during classes on product design form an important basis for this study. To embed instructional materials in a learning-centered environment and to help students develop their technological creativity, a science fiction (SF) film (movie) was presented to stimulate students' imagination (Gravoso, Pasa, Labra, & Mori, 2008). This genre was chosen because many of the original technological concepts referenced by SF films can be converted into practical use, thus stimulating students' imaginations. For example, the film used in this study alluded to the development of nano-robotics, nuclear submarines, and the space shuttle. Following this reasoning, Blythe and Wright (2006) utilized a pastiche scenario based on Miss Marple in their user-centered design. The results showed that this was a useful complementary method, and that it helped designers think about the social and cultural impact of new technology.

The ways in which students organize and deal with information differ due to differences in their cognitive styles and learning preferences (Kirby, Moore, & Schofield, 1988; Riding & Rayner, 1998). According to Ormrod (2008), students using a verbal-type style performed better in processing verbal information, whereas students who are more visually oriented performed better when dealing with visual information. Thus, relationships between cognitive styles and learning environments were also explored in this study. The primary research purposes of this study included the following: 1) to explore the effects of using a SF film to stimulate middle school students' technological creativity; and 2) to analyze the different cognitive styles used during this learning activity in terms of their effects on the technological creativity of middle school students.

Recent research regarding technology education has placed considerable emphasis on exploring what happens to students in the classroom. In other words, compared with the past, when research tended to focus on classroom materials (such as curricula and equipment) and consequently neglected student learning behavior during the classes themselves, research regarding technology education has gradually moved from a focus on "what is" to a focus on "what ought to be" (McCormick, 2004). This study focused primarily on the effectiveness of using a SF film to stimulate students' imaginations and on the results of applying the ideas that emerged as a consequence of this activity to the development of ideas about actual products. This study will also consider issues related to cognitive style to further understand whether students with different verbal and visual learning styles performed differently after exposure to the film.

LITERATURE REVIEW

Relevant studies on technological creativity

Scientific literacy is placed on an appreciation of the nature of science and the development of personal attributes; however, technological literacy is the ability to use, manage, evaluate, and understand technology (Holbrook & Rannikmae, 2009; International Technology Education Association, 2006). In the technological world, one of the most important elements of technological literacy is technological creativity. Technological creativity refers to the creativity shown by students during hands-on activities. Lin and Yu (2004) reviewed the literature on technological creativity and found that the "creative process" and the "creative product" were the two major factors in technological creativity. Hong, Lin, and Lin (2007) and Lee and Chang (2000) worked from a viewpoint emphasizing the creative process and defined technological creativity as a process involving problem solving. However, Wu and Yeh (2003) worked from a perspective emphasizing the creative product and defined technological creativity in terms of an innovative product. This suggests that technological creativity differs from creativity more generally and that it could be defined as the creation of an innovative product and described in terms of dimensions of materials, style, structure, and function (Chu, 2008).

Using the previous definition, additional studies have focused on exploring technological creativity. Chang, Lee, Yu, and Lin (2009) explored the effects of set examples and hands-on experience on technological creativity in junior high school students, and the results showed that hands-on experience had a significant effect on the development of creative styling and functional design. Cheng and Yeh (2006) emphasized how multiple systems influence the development of technological creativity and investigated relationships between technological creativity and style, domain knowledge, and creative life experiences. They investigated pupils' self-awareness and self-evaluations of their cognitive processes while they were performing problem-solving tasks involving technological creativity.

Most recent studies have focused on relationships between students' technological creativity and multiple systems, and some have tried to use different strategies to stimulate technological creativity. It is therefore important to understand how to stimulate students' technological creativity, especially through hands-on learning activities.

Relevant studies about the use of SF films

The use of films (including SF films) in education is not new (Bahrani & Sim, 2012; Barnett and Kafka, 2007; Carrier, Rab, Rosen, Vasquez, & Cheever, 2012; Lip, 2010; Mahmud & Ismail, 2003). Indeed, Freedman and Little (1980) confirmed the value of SF films for teaching the basic concepts of science and physics to university or senior high school students. Efthimiou and Llewellyn (2004) developed a physics curriculum that effectively used film to help students understand scientific principles. The results showed that students are able to view films or television from a critical scientific perspective. Films are considered valuable for teaching science because they induce longer-lasting mental images than do traditional approaches (Barnett and Kafka, 2007), which is especially useful in physics and chemistry (Liberko, 2004). However, not all studies support this conclusion. For example, Barnett, Wagner, Gatling, Anderson, Houle, and Kafka (2006) suggested that SF films have a detrimental effect on students' understanding of science. This suggests that the impact of SF films on learning scientific concepts requires further study.

Many studies have shown that positive effects are associated with the use of SF films. Indeed, films have been used to stimulate student interest in learning science; for example, Brake and Thornton (2003) suggested that using film clips to teach science is effective due to the high correlation between the films and the daily lives of the students. Laprise and Winrich (2010) have also used SF films to generate student interest in learning science. Their results show that SF films are able to stimulate interest in science among students who do not major in this domain. A study conducted by Larson (2008) on the use of SF films analyzed 10 popular SF films rather than investigating their use in science education. The results indicated that the future computing developments and trends shown in these 10 films were very limited in their scope, indicating that the content and vision of SF films are often constrained by the present state of technology. This suggests that the predictive power of SF films is inadequate. However, due to the ambiguity of the results obtained to date, this subject should be investigated further to try to understand both the real benefits gained from SF films and their impact on student conceptualizations of product-design improvements.

Relevant studies on cognitive styles

Cognitive styles are stable and consistent personal preferences for data organization and processing that are applied as an individual learns. Furthermore, cognitive styles do not change substantially over time or as a result of changes in the environment (Jonassen and Grabowski, 1993; Riding and Cheema, 1991; Riding and Rayner, 1998). Cognitive styles have been categorized into either "holistic–analytic" or "verbal–visual" style (Riding and Cheema, 1991). The holistic–analytic cognitive style refers to a method of data organization that focuses primarily on the overriding message and seeks to understand the relationship between various objects. It is characterized by an emphasis on particular details and the step-by-step processing of data (Riding and Cheema, 1991). The verbal–visual style refers to a focus on visual or verbal signals. Verbal-type individuals specialize in text-based work and are particularly proficient at semantic processing and analysis, making words the optimal learning medium for these individuals. Visual-type individuals obtain information from "watching" and have a preference for the use of non-textual data such as images, tables, or mathematical symbols (Jonassen and Grabowski, 1993; Kirby, Moore, and Schofield, 1988; Schuyten and Dekeyser, 2007).

This study used SF films and traditional hands-on activity as the primary methods of learning. Traditional hands-on activity is verbal representations, whereas SF films are non-verbal. Thus, the following section focuses on research relevant to verbal–visual cognitive styles, which has emphasized the correlation between cognitive style and learning effectiveness. For example, Effken and Doyle (2001) indicated that learners with different cognitive styles have different preferences for interacting with multimedia software, and that these preferences affect learning effectiveness. Riding and Cheema (1991) showed that learners learn more when they are placed in environments that conform to their preferred learning styles, and that they learn less when they are placed in environments that do not correspond to these learning styles. Schuyten and Dekeyser (2007) emphasized the relationship among students' cognitive styles, the frequency of using different representational modes, and learning performance. Their results showed that educational methods that do not correspond to learners' cognitive styles have limited benefits for enabling understanding.

In addition to exploring the correlation between cognitive style and learning performance, some studies have also examined learning processes. Riding and Sadler-Smith (1997) showed that differences in student cognitive styles primarily reflect qualitative rather than quantitative differences in thinking processes. For example, learners use their preferred learning styles (e.g., verbal–visual) to work out and solve problems. Thus, we not only explored differences in students' ability to improve product concepts based on their preferred cognitive learning styles (i.e., by comparing different pedagogical approaches such as traditional classroom settings vs. showing a SF film), but also analyzed whether students use their preferred learning styles to propose product improvements.

METHODS

This study explored the effects of a SF film on the technological creativity of middle school students. We also analyzed their use of different learning styles in terms of their technological creativity using SF-film-based learning activities.

Research design

We used quasi-experimental and unequal-control-group pre- and post-test design models (Table 1). To explore the effects of SF-film-based learning activities on middle school students' technological creativity, we used the Williams Creativity Scale as a pre-test to remove the influence of pre-existing differences in imagination. The post-test analyzed differences in technological creativity after SF-film-based learning activities. To ascertain whether learners with different cognitive styles produced different results based on the learning environment, we performed an analysis of covariance on learners with verbal and visual cognitive styles to explore the correlation between cognitive style and learning environment.

Research subjects

The students attended four different eighth-grade normal-placement classes at a normal teaching school in Taipei City. Sixty-three students from two classes acted as the control group, and 69 students from the remaining two classes formed the experimental group. The former engaged in product-design activities without viewing a SF film, and the latter engaged in product-design activities and viewed a SF film. The technology education course used in this study meets once per week for 45 minutes and is taught in a stimulating teaching environment with adequate equipment. This meant that the school and the research subjects were able to meet the requirements of this study, and it allowed for the control of relevant variables (e.g., the teaching method, conduct of the technology class, etc.), ensuring the reliability and validity of the experimental results.

Research implementation

The study was conducted for a total of 10 hours over the course of 10 weeks between April and June of 2011. We administered the Williams Creativity Scale, as revised by Lin and Wang (1994), during the first week to measure student creativity. The Williams Creativity Scale was drawn from the Creativity Assessment Packet developed by F. E. Williams (Williams, 1980), and the Style of Processing scale (SOP) developed by Childers, Houston, and Heckler (1985) was used to determine student cognitive styles as this instrument has a high degree of reliability. Students watched the SF film during the second to fourth weeks. The control group did not watch any SF films and instead simply discussed the topic that was introduced. During weeks 5 and 6,

Table 1. Research Design Model

Group	Pre-test	Experimental Treatment	Post-test
Control Group	*Williams Creativity Scale*	Traditional Hands-on Learning Activity (traditional worksheet adopted)	• Product-design Activity in Daily Life • SOP Scale
Experimental Group	*Williams Creativity Scale*	SF-film-based Hands- on Learning Activity (film worksheet adopted)	• Product-design Activity in Daily Life • SOP Sacle

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students were helped to deepen their understanding of the content of the SF film through the use of worksheets designed to facilitate reflection on the film and recollection of the passages and scenes from the film that were most effective in stimulating their imaginations. This activity was intended to help with the implementation of the subsequent product-design improvement activities. Weeks 7–10 were devoted to developing proposals for creative improvements in everyday products. The students were given an example of creative power outlet products for exploring how to design their improvements in everyday products. Students were asked to propose three product-improvement concepts each day of the 10-week learning activity and were then asked to use their best idea to create a schematic for a product design. Teachers evaluated the final schematics to identify improvements in the performance of the middle school students after the learning activities.

Research tools

The SF film used in this study was "I am Legend" (Matheson, 1997/2007). The primary reason behind selecting this SF film was the availability of a Mandarin Chinese translation of both the book and the film. Furthermore, unlike many other SF stories, which are published in serial form, this book consists of only a single volume, making it easier to use in this experiment.

We used Lin and Wang's (1994) Creativity Tendency Scale to measure middle school students' creativity. This scale includes four dimensions: risk-taking, curiosity, imagination, and complexity. The creativity portion was used to collect the pre-test data for the analysis of covariance, which excluded variation due to pre-existing differences in the creativity of students. Considerable data are already available from previous uses of this scale (2294 samples), and the norms for students in elementary through high school were established in 1994. The internal consistency coefficient ranged from .401 to .877, and the test–retest reliability was between .489 and .810. The reliability between grades was between .878 and .992, and all correlation coefficients reached the level of significance (.05) (Lin & Wang, 1994).

We used the SOP scale developed by Childers, Houston, and Heckler (1985) to measure middle school students' cognitive styles. This scale divides cognitive styles into two categories: 1) verbal, which involves a preference for the perception and processing of language and textual information and (2) visual, which involves a preference for the perception and processing of visual information (such as shapes and tables). The Cronbach's α coefficient was 0.81 for the verbal portion and 0.86 for the visual portion (Childers, Houston, and Heckler, 1985).

The primary purpose of the film worksheet was to help students reflect on relevant film content and guide them in remembering the portions of the film that most stimulated their imaginations. The worksheet included the following three questions: 1) What content left the deepest impression? 2) What content most stimulated your imagination? 3) What was your experience of the learning situation (i.e., your level of interest in the SF film and whether you read/watched the SF book/film in its entirety)? The worksheet was developed by two acting technology instructors, who carefully examined its content, and was revised three times before it was distributed to ensure it had a high degree of validity.

The students engaged in the following activities, which involved using their imaginations to propose design improvements in everyday products: defining the requirements, proposing the initial concept, selecting the best concept, developing concrete design proposals, and evaluating the design proposals. The proposals submitted by the students were then evaluated by teachers, as described above. We used the Product Innovation Assessment developed by Chang, Lee, Yu, & Lin (2009) as a basis for analyzing the design improvements proposed by middle school students. The seven content areas in this instrument were consolidated into four sections: materials, model, structure, and function. The following five ratings were used to assess student performance: 5, excellent; 4, good; 3, acceptable; 2, poor; and 1, extremely poor. The two acting technology instructors assessed the product-improvement concepts offered by the 63 students in the control group and the 69 students in the experimental group. The correlation coefficient for the two evaluations given by the two teachers was .92, which was significant.

Data analysis and interpretation

We used an analysis of covariance (ANCOVA) to analyze our data. Middle school student imagination, as measured by the Williams Creativity Scale, was used as the covariate to exclude any pre-existing differences in students' imaginations. Besides, the dependent variable is students' technological creativity and the independent variable is the SF film. This quantitative method enabled us to study the creative impact of using the SF film in middle school technology class. We also performed an ANCOVA to explore the relationship between cognitive style and group membership (control vs. experimental) on technological creativity.

Table 2. Results of the Williams Creativity Scale and the Technological Creativity Scales

Scale	Experimental Group (N = 69)		Control Group (N = 63)	
	Mean	*SD*	*Mean*	*SD*
Williams Creativity Scale (pre-test)*				
Risk-taking	25.97	3.10	27.03	3.13
Curiosity	29.26	4.33	28.14	3.99
Imagination	26.81	4.69	25.68	4.67
Complexity	28.13	4.01	27.05	3.76
Total Creative Thinking	110.17	13.23	107.90	12.81
Technological Creativity Scale (post-test)**				
Materials	3.65	0.98	3.49	1.19
Modeling	3.42	1.17	2.63	1.26
Structure	3.59	1.09	3.00	1.19
Function	4.07	0.96	3.76	1.04
Total Technological Creativity	14.74	2.64	12.89	3.21

**The highest score on the Williams Creativity Scale is 150, and the lowest score is 50.*

***The highest score on the Technological Creativity Scale is 20, and the lowest score is 4.*

Table 3. Analysis of Intragroup Regression Coefficient Homogeneity Test Results

Source	*SS*	*df*	*MS*	*F*
Materials	.005	1	.005	.004
Modeling	2.412	1	2.412	1.634
Structure	4.988	1	4.988	3.910
Function	0.965	1	0.965	0.959
Whole**	22.071	1	22.071	2.602

*$p < .05$

***Whole represents technological creativity.*

RESULTS AND DISCUSSION

Effects of a SF film on product-design concepts proposed by middle school students

Table 2 shows the results of the Williams Creativity Scale and the Technological Creativity Scale. Students in the experimental group obtained higher imagination scores (M = 26.81, SD = 4.69) than did those in the control group (M = 25.68, SD=4.67); they also performed better with regard to technological creativity (M = 14.74, SD = 2.64) than did students in the control group (M = 12.89, SD = 3.21).

As seen in Table 3, the analysis of intragroup regression coefficient homogeneity test results did not reach the significance, indicating that the relationship between the covariate (imagination) and dependent (technological creativity) variables was not affected by the different processing approaches of the different groups, which enabled us to continue with the ANCOVA. The data presented in Table 4 show that students have better performance in modeling and structure of product design when they involved in the SF-film-based hands-on learning activity. According to this research results, this study suggested that students' technological creativity with respect to modeling and structure were affected by differences in the pedagogical processes.

According to this research result, the SF film is not just able to stimulate students' interest (Laprise & Winrich, 2010), but also able to stimulate students' technological creativity. Besides, due to students' performance in materials, function and overall technological creativity did not reach significance, it is suggested that the future study can try to improve the SF-film-based hands-on learning activity for developing students' overall technological creativity.

Cognitive style and SF-film-based learning activities

Based on the results of the SOP, students were divided according to whether they used a verbal-type or a visual-type learning style to analyze their proposed improvements as a function of SF-film-based learning activities. Sixteen students had verbal-type learning styles, whereas 115 had visual-type learning styles. One student's learning style could not be determined by the test, and these data was not included. Of the 115

Table 4. ANCOVA Summary

Source	*SS*	*df*	*MS*	*F*	η^2
Materials					
Interaction	.645	1	.645	.545	0.00
Error	152.579	129	1.183		
Corrected Sum	154.242	131			
Modeling					
Interaction	19.633	1	19.633	13.240*	0.09
Error	191.286	129	1.483		
Corrected Sum	211.727	131			
Structure					
Interaction	10.964	1	10.964	8.406*	0.06
Error	168.262	129	1.304		
Corrected Sum	180.265	131			
Function					
Interaction	2.925	1	2.925	2.906	0.02
Error	129.826	129	1.006		
Corrected Sum	133.242	131			
Technological Creativity					
Interaction	22.071	1	22.071	2.602	0.02
Error	1085.852	128	8.483		
Corrected Sum	1226.265	131			

Note: **p* < .05.

Table 5. Visual-type students' performance on the Williams Creativity Scale and the Technological Creativity Scale

Scale Type	Visual Environment (*N* = 58)		Verbal Environment (*N* = 57)	
	M	*SD*	*M*	*SD*
Williams Creativity Scale (pre-test)*				
Risk-taking	26.00	3.07	27.30	2.99
Curiosity	29.47	4.28	28.40	3.92
Imagination	27.09	4.66	26.16	4.35
Complexity	27.78	4.07	27.26	3.52
Creative Thinking	110.33	13.48	109.12	11.96
Technological Creativity Scale (post-test)**				
Materials	3.69	0.98	3.51	1.18
Modeling	3.55	1.17	2.58	1.27
Structure	3.72	1.07	2.96	1.21
Function	4.09	0.98	3.75	0.99
Technological Creativity	15.05	2.67	12.81	3.04

*Note 1: *The highest score on the Williams Creativity Scale is 150, and the lowest score is 50. **The highest score on the Technological Creativity Scale is 20, and the lowest score is 4.*

Note 2: This study included a total of 132 junior high school students; of these, 58 were visual-type students placed in the visual environment, and 57 were verbal-type students placed in the verbal environment.

students with visual-type learning styles, 58 were in the experimental and 57 were in the control group.

Table 5 presents the results of the Williams Creativity and Technological Creativity Scale and shows that visual-type students demonstrated more imagination (M = 27.09, SD = 4.66) in the visual than in the verbal (M = 26.16, SD = 4.35) environment. These students also showed more technological creativity (M = 15.05, SD = 2.67) in the visual than in the verbal (M = 12.81, SD = 3.04) environment.

As seen in Table 6, the analysis of intragroup regression coefficient of middle school students with visual-type learning styles homogeneity test results did not reach the significance, indicating that the relationship between the covariate (imagination) and dependent (technological creativity) variables was not affected by the different processing approaches of the

Table 6. Intragroup regression coefficients of middle school students with visual-type learning styles

Source	*SS*	*df*	*MS*	*F*
Materials	.087	1	.087	.072
Modeling	1.601	1	1.601	1.608
Structure	3.734	1	3.734	2.885
Function	2.184	1	2.184	2.269
Technological Creativity	24.700	1	24.700	3.054

Note: $p < .05$

Table 7. Summary of ANCOVA results for middle school students with visual-type learning styles: Performance on materials, modeling, structure, function, and technological creativity in different learning environments

Source	*SS*	*df*	*MS*	*F*	η^2
Materials					
Interaction	.927	1	.927	.782	.007
Error	132.659	112	1.184		
Corrected sum	133.600	114			
Modeling					
Interaction	27.498	1	27.498	18.338*	.141
Error	167.946	112	1.500		
Corrected sum	195.443	114			
Structure					
Interaction	16.680	1	16.680	12.674*	.102
Error	147.400	112	1.316		
Corrected sum	164.087	114			
Function					
Interaction	3.256	1	3.256	3.346	.029
Error	109.016	112	.973		
Corrected sum	112.296	114			
Technological Creativity					
Interaction	146.290	1	146.290	17.765*	.137
Error	922.281	112	8.235		
Corrected sum	1068.574	114			

Note: $^*p < .05$

different groups, which enabled us to continue with the ANCOVA. The data presented in Table 7 shows the variations in the F-values for different groups; after allowing for the effects of student imagination, the va lues for materials, modeling, structure, function, and technological creativity were 0.78, 18.34, 12.67, 3.35, and 17.77, respectively. Modeling, structure, and technological creativity reached the level of statistical significance (0.05), showing that the technological creativity of students with visual-type cognitive styles was affected by differences in the pedagogical approaches.

This research results are corresponding to the previous studies, students with visual-type cognitive styles did have better performance in modeling, structure, and overall technological creativity (Effken & Doyle, 2001; Riding & Cheema, 1991; Schuyten & Dekeyser, 2007). Therefore, this result suggests that students with a visual-type cognitive style performed better with respect to design in the learning environment that included a SF film.

CONCLUSIONS

The main goal of this study was to investigate the effect of integrating a SF film into hands-on learning activities, allowing students to apply their imaginations to designing improvements in everyday products. We were able to conclude the following:

The effective use of SF films can stimulate middle school students' technological creativity and enhance their ability to design product improvements

Analysis of the results shows that middle school students exposed to practical technology-design education activities including a SF film performed better than did students who did not view the SF film. Thus, despite Larson's (2008) doubts about the usefulness of SF films for depicting future developments in computer technology, the integration of such films into practical educational activities can stimulate students' imaginations and enhance their ability to design product improvements. Some technology educators have thought that only a those SF films with direct relevance to product design would have a significant impact of students' performance, and others have believed that the SF content of "I am Legend" was outdated. However, as our data show, the SF film "I am Legend" was clearly effective in stimulating the imaginations of middle school students, contributing to their ability to develop concepts and product improvements.

Hands-on learning activities based on students' cognitive styles are effective in stimulating students' technological creativity

Our data also show that learners with visual-type cognitive styles perform better when engaging in practical technology-education design activities after seeing a SF film. Our results are consistent with those reported by Riding and Cheema (1991), Effken and Doyle (2001), and Schuyten and Dekeyser (2007). In other words, learners placed in environments matching their own cognitive learning styles demonstrate a superior learning performance. However, prior research has emphasized scientific knowledge and cognitive learning, whereas this study emphasized the learning of practical skills. We demonstrated the importance of matching learning environments to students' cognitive styles as a way to improve learning.

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