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The Effect of Motion Infographics on the Learning of Third and Fourth Grade Resource Classes and Regular Classes in Elementary School

Shih-Ting Tsai[1], Hsin-Yi Huang[2], Teng-Wen Chang[3]

Abstract

The elementary school system in Taiwan currently does not have dedicated learning content for the resource classes. As the existing worksheets and online resources designed for regular classes are often not applicable for resource classes, the teachers of resource classes need to develop their own materials to accommodate the diverse needs of students with various situations. To address the issue, this research aims to design a motion infographics system that serves as an additional resource for the resource classes, to improve the students' learning.

Motion infographics combines the quality of infographics and motion graphic, in order to simplify the information presented and to create a deeper impression in the audience. The topic used in this study is carbon footprint, a highly recognized and commonly adopted concept across the globe. The experiment conducted in this research indicates that motion infographics are effective in teaching resource classes. Compared to the control group of the resource class, the experimental group of the resource class using the motion infographics system showed greatly improved exam scores and learning effectiveness. The experimental group from the resource class also demonstrated greater command and comprehension of the image shapes than that from the regular class.

Keywords: Resource Class; Infographics Design; Motion Infographics; Information Visualization; Carbon Footprint

1. Introduction

1.1 Background and motivation

In the modern digital era, digital contents have changed the way people read and acquire new knowledge, and this trend of digitalization is likely to continue (R.-L. Chen, 2018). Therefore, in response to this trend, increasing numbers of schools are promoting multimedia digital content in classrooms (Balogh & Kuchárik, 2019; Ministry of Education, 2016). Given that the delivery of digital content is not restricted by time or location, the adoption of Internet-based education or e-learning systems has grown exponentially ([Liao] & [Wang], 2016). In the 21st century, digital resources are introduced into teaching through digital communication systems and e-learning platforms, which effectively improve the learning process (Ministry of Education, 2016). Teachers have also realized that the current curriculum and teaching methods are designed for the previous generation, and might no longer be suitable for the next generation of students.

[1,2] Graduate School of Design, National Yunlin University of Science and Technology, Yunlin, Taiwan
[3] Department of Digital Media Design, National Yunlin University of Science and Technology, Yunlin, Taiwan
* Corresponding Author: Teng-Wen Chang, E-mail: tengwen@gemail.yuntech.edu.tw

In addition, through well-designed training, the skill sets and creativity of students can be improved (Chen, 2017; Lai, 2011; Su, 2010). In response to the trend of digitalization in the modern educational system, many teachers have started to adopt digital materials to improve the students' learning, such as using motion graphics to supplement textual descriptions ([Chu], 2011; Hung & Tsai, 2015).

Fleming and Levie (1993) considered that charts and images can bring about students' learning motivation. Rieber (1994) pointed out that human response to text understanding is the acquired learning, while image stimulation is the acquired learning, as well as an instinct. Therefore, images are comparatively apt to learn. After the planned reorganization of images, image messages can be delivered in a more systematic way, making it easy for students to integrate knowledge and enhance thinking, understanding and learning (Zeng & Chang, 2013). Ministry of Education (2016) also indicated that the application of digital technology in learning is the key system endowed with expectations. In consequence, the transmission function and feature as images of the information image allow it to become the digital system customized for resource classes. As the majority of Taiwanese schoolchildren are familiar with computers and smartphones, motion graphics is the most familiar media format that can attract their maximum attention. This study, taking advantage of the motion infographics features, presents knowledge in the motion infographics system, and deconstructs the text content in the original textbook through images, allowing students in resource classes to learn and absorb the knowledge through motion graphics.

1.2 Infographics

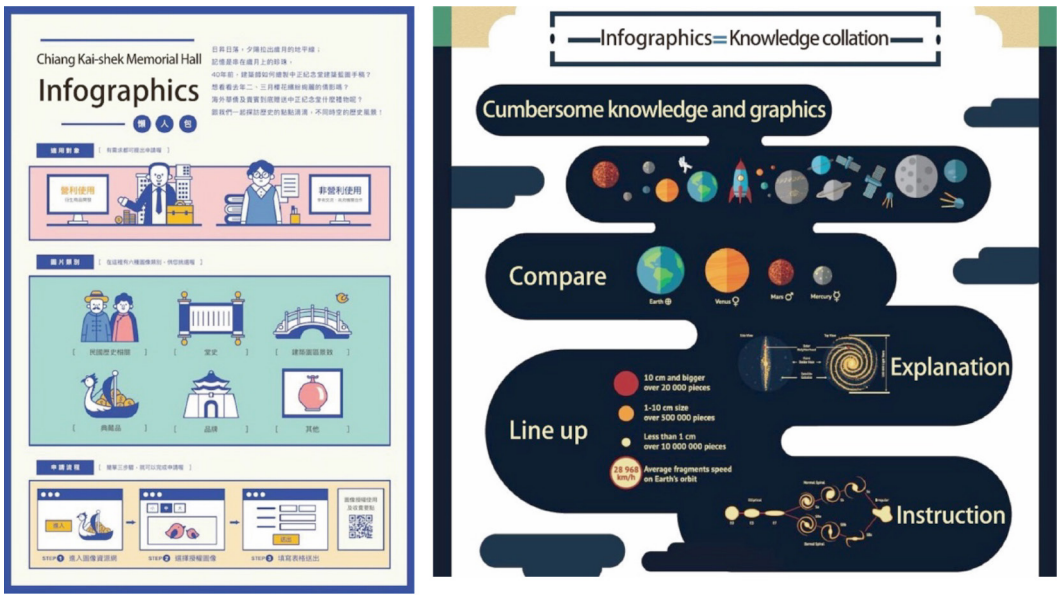
Most studies on schoolchildren's learning effectiveness show that graphs and images can motivate students to learn. It is believed that humans are more instinctively responsive to motion images than to texts; therefore, materials presented with motion images would be easier to understand (Cai & Meng, 2020; Chiou et al., 2018; Hsu, 2019).

Infographics is a combination of the terms "information" and "graphics." Through the presentation of images and visualized texts, the information or knowledge from rigid texts and data can be made more interesting, so that it is easier for readers to understand and remember (Figure 1) (Brath & Jonker, 2015; Scott et al., 2017).

The main applications of infographics are scenarios where very complex and large amounts of information need to be explained clearly and precisely. Images are used to replace text explanations in different types of texts, such as documents, maps, signs, news, teaching, posters, graphic design, advertising, media, etc. The main idea when designing the infographics is to simplify the complicated content (Brath & Jonker, 2015; Steele & Iliinsky, 2010).

The common use of infographics is to deliver key messages that are easy to understand, via the use of coherent themes and images. Infographics is more eye-catching than paragraphs of text; thus, in today's world, they are gradually becoming regarded as an important tool for information delivery. In the process of communication, the different modes of information delivery, such as language, text, and images, are different ways to express meaning. Among these different modes of delivery, images provide more intuitive

Figure 1. Example of Infographics – Designing Illustration Based on Text & Information

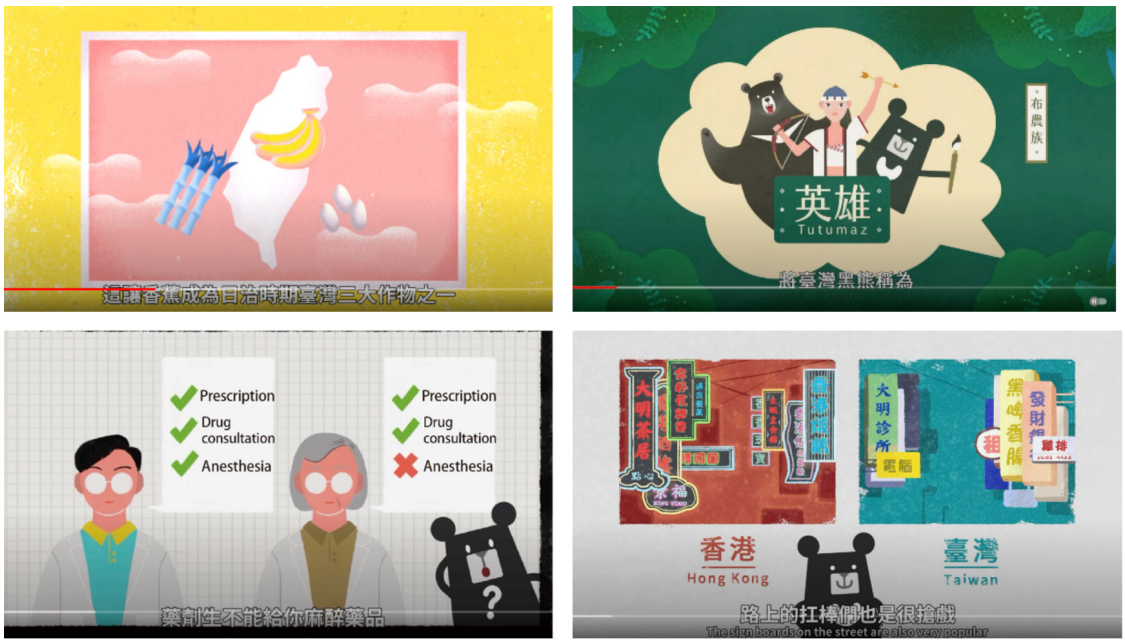


Note. From Re-lab (https://relab.cc/portfolio?floor=none).

communication to the human brain. The purpose of using motion graphics in teaching materials is to help students understand the difficult wordings in textbooks, on topics such as climate. Images are generally better accepted by most learners, and static or dynamic images are the most effective and direct way to acquire knowledge during the learning process. With images organized in a coherent and systematic manner, it is easier for the learners to process the message delivered, and to comprehend the knowledge and concepts presented.

The motion infographics used in this study are based on the infographics. In addition to the original static information display, it also incorporates scripts, scenes, sound effects, and commentary. It tells the story with a set of complete and continuous screens that distribute the original content, which is concentrated on one piece of infographics, into each different scene to facilitate the reading and absorption as the story goes. For example, elementary school teachers often use the history and nature commentary videos of the YouTube channel "Taiwan Bar" (Figure 2). The channel has also used a large number of motion infographics in its production of videos. Teachers of regular and special education classes mentioned in the focus group interview that as motion infographics is time-based and storytelling, it aids weak students in understanding the teaching content. As a result, this type of videos is often used as teaching materials in the classroom. Taiwan's Ministry of Education (2016) also pointed out that the application of digital technology in teaching materials is a highly anticipated key initiative. Therefore, infographics may be a suitable format for digital materials use in resource classes, due to their easily understandable nature.

Figure 2. Example of Motion Infographics



Note. From Taiwan Bar (https://taiwanbar.cc).

1.3 Target group: Resource class

Resource classes are designed for students who are academically challenged, have obvious difficulties in adapting to regular classes, and require special educational services (Chen et al., 2013; [Huang], 2013). It is a unique system in the Taiwanese educational system, and sits between regular classes and special education classes. The targets of resource classes are mildly disabled students and gifted students (Ministry of Education, 2016). Past researches focusing on resource classes and the experience of resource class teachers show that such students have a good command of phonetics and glyphs of single characters, but often encounter problems when dealing with the full texts (Huang & Yu, 2017), such as not being able to understand the text and to acquire the information from it; not knowing the right approach to the text and subject in order to grasp the main points; or not being able to comprehend the meaning. These difficulties affect the students' learning of various subjects ([Hu], 2014). However, research on students with learning disabilities show that images can improve their problem-solving abilities and have positive effects on their overall learning, given that tangible, visible objects, such as images and illustrations, are generally easier to understand than abstract concepts (van Garderen, 2007).

In the aspect of learning effects, the main reason for the only adoption of the examination method at the present stage is that the students in resource classes would return to their original classes in formal examination, and take the same examination and use the same official textbook exercises as regular classes. The current education

system hopes that students in resource classes can be as close to the study and lifestyles of regular classes as possible, instead of being educated in a different education mode. Therefore, the current examination method of the school is adopted in this study. The features of information images are mainly adopted to help students in resource classes understand and absorb the knowledge in the official textbooks, in addition to observing the learning and test results of the resource class and the regular class in the same system. Although digital teaching materials are prevailing now, there are no customized courses for resource classes. Also, the transformation from complex words to easily discernible information images adopted in this study aims to assist students in resources classes to the greatest extent in the case of conforming to the educational scene.

1.4 Research aims

The resource class focused in this manuscript is for those students who only need to attend the resource class for 2 to 3 subjects. Through focus group interviews with the experience of resource class teachers, and through observations at the teaching site, it was learned that the failure to concentrate of most of these students were caused by their own conditions, and some students seemed to lack interest in teaching materials with mostly text content. In order to solve this problem, resource class teachers also used videos and animations on related topics on the Internet. Although this can attract the attention of school children, it will also give rise to another problem. Most of these online resources are designed for audiences of higher age or with certain thinking ability, so the contents are beyond the understanding of the students in the resource class. The students in the resource class are also less able to absorb such information or organize it systematically. This is also the reason why this study used motion infographics. The information is organized and systematized through the motion infographics produced for the students in the resource class, and there are key reminders by easy-to-understand vector images animation. This is different from the full text commentary in textbooks and the online resources that are less focused on the audience, so that the purpose of assisting the students in the resource class to learn is achieved.

Infographics can simplify and communicate large amount of information and stories with very simple visuals. This research aims to utilize this quality of infographics to facilitate the learning process of students from resource classes and regular classes. With the use of motion graphics, the text and information can be animated and simplified. Students can be relieved from reading large amounts of text in order to understand the course contents. In the United States, many teachers are using the concept of Design for Science (DS) to design contents with their own teaching experience, in addition to the designated textbooks for natural science classes. With digital design, teachers can iterate and revise their own content to achieve the purpose of adaptive learning (Tsai & Huang, 2019). Consequently, the "motion infographics system" in this article is to create the topics of the designed infographics dynamic and extend them into a series of curriculum systems that can assist in teaching. This approach is similar to YouTube "Taiwan Bar" that has designed historical knowledge into infographics and make

them dynamic. The topic selection of Taiwan Bar is more current-affair-oriented, while this paper expects to be based on the syllabus of Ministry of Education and support the resource class tutorials, thus resource class teachers can use systematic content when matching them with textbooks.

2. Materials and Methods

There are obvious benefits for the application of infographics various fields to make charts or to convey messages in social media, but the research on infographics used in teaching field is quite limited. Therefore, this paper attempts to experiment with the school teaching model and establish the first-step measurable preliminary explorations and examples.

The experiment was conducted using the quasi-experimental research method; the subjects were students from the resource class and regular class from an elementary school in New Taipei City. Both the resource class and the regular class were divided into an experimental group and a control group. The courses of the experimental groups were delivered using motion infographics, while those of the control groups were delivered using the original teaching method. The experimental group and the control group of the same class were taught by the same teacher, to ensure the consistency of all variables other than the teaching material. Group discussions and evaluations were conducted after the course, to allow the students to discuss and reflect on the course content. We then observed the outcome of these group discussions.

The focus group interviews were made before, during and after the design of all the motion infographics teaching materials as well as the pre-test and post-test papers in the paper. The carbon footprint topic was also designed in accordance with the "Natural Science Field," the Ministry of Education's "National Basic Education Curriculum: National Primary and Secondary Schools and General Senior High Schools." The materials have been developed and edited by the teaching group of the elementary school where the experiments were conducted, and were all reviewed by the resource class teacher group and the teaching team leader to be consistent with the textbook level, and the motion infographics were revised through four meetings during the design process.

2.1 Topic: Carbon footprint

This topic was chosen because although the syllabus of Ministry of Education included carbon footprint, the length of "carbon footprint" in the textbook is much shorter than that of the two main concepts of environment and energy (Figure 3), and there is no complete explanation and illustration on the regulations in various parts of the world and Taiwan.

Therefore, teachers must supplement the data or online resources organized by themselves, and online information is not necessarily suitable for reading in resource classes. In summary, in the study, the content of the current school textbook was used for the pre-test, and the complete carbon footprint content of this study was used for the post-test. The pre-test and the post-test are related and about the same concepts, so that we can observe whether the prior knowledge affects subsequent learning.

Environmental protection has been an important topic in recent years. Saving energy and reducing carbon emission are important issues

Figure 3. Chapters in the Official Textbook on Carbon Emission: Environment and Energy

in every country, and they have also become an integral subject in Taiwan's elementary education. The new concept of "carbon footprint" was designed to evaluate the impact of carbon emission on people's lives (Environmental Information Center, 2018).

Carbon footprint refers to the volume of greenhouse gases (in terms of carbon dioxide, or CO_2) emitted by each person, family, or company; this figure is used to measure the impact of human activities on the environment (Environmental Information Center, 2018). The difference between the term "carbon footprint" and "greenhouse gas emissions" is that the former calculates emissions from the end-consumers' point of view, meaning that it includes emissions from all activities throughout the product life cycle (including the mining and processing of raw materials; the manufacturing of the product itself; and the packaging, distributing, and recycling of the product). By contrast, greenhouse gas emissions of enterprises and industries generally refer to only the emissions related to the manufacturing of the specific parts or products. Carbon footprint (Figure 4) has become a widely adopted metric for governments and companies to evaluate and communicate environmental impacts (Environmental Protection Administration, n.d.).

The course designed for this experiment introduced the concept of carbon footprint using potato chips—a very familiar product for the students—as an example. Motion infographics, lively narratives, and highlighted keywords were used together, to illustrate the carbon emission of each stage of manufacturing potato chips, starting from raw materials sourcing and processing, through to product processing, packaging, and transportation.

2.2 Motion infographics system: Design and development

The script of this motion infographics system was mainly compiled based on the official documents from the Environmental Protection Administration in Taiwan. The infographics was designed using simple vector objects with high color contrasts. The main plot was presented with a story narrative and titles to emphasize the keywords and key concepts. The overall production was jointly supervised by the teachers

Figure 4. Carbon Footprint

Note. Adapted from *[Tan biao qian jie shao],* by Carbon Footprint Information Platform (n.d.).

of resource classes and regular classes, to ensure that the difficulty levels of the content and exams were suitable for students from both classes.

The images used in the motion infographics system were drawn using Adobe Illustrator, the video editing was done using Premiere, and the post-production and sound effects were created using After Effect (Figure 5 to 10).

2.3 Experimental object and venue

The subjects of the experiment were 60 students from an elementary school in New Taipei City, comprising 30 students from resource classes and 30 from regular classes (Table 1). The students were aged 8 to 10 years. The instructor split the students from each class into an experimental group and a control group, with 15 students in each group. The average semester grade of the experimental group and the control group of the same class were the same. Teachers confirmed that all 60 students were not familiar with the topic of carbon footprint before the experiment.

The resource class students selected for the experiment required special attention in only two or three subjects, and they had not reached the level of intellectual disability recognized by the Education Department of New Taipei City Government. The class structure in the experiment followed the school's original class composition. This was to create a comfortable and natural setting where the students would behave normally, while ensuring that the course content was applicable in normal classroom settings. This design enables in-depth observations of the differences in behavior during the experiment (C.-C. Chen, 2018).

The experiment was conducted in computer classrooms with computers, projection screens, and audio-visual equipment. To eliminate bias in the research results, the students were not informed that the experiment was taking place, so that they would behave naturally in this learning environment—all students were notified that the motion infographics system would be brought into the course, and they were only not informed of the content of the pre-test and post-test, which is indeed to get the reliability and validity data. After the experiment, the experimental group and the

Table 1. Grouping

Group	Class (students)	
	Resource class (n = 30)	Regular class (n = 30)
Experimental	15	15
Control	15	15

Figure 5. Motion Infographics: Main Page

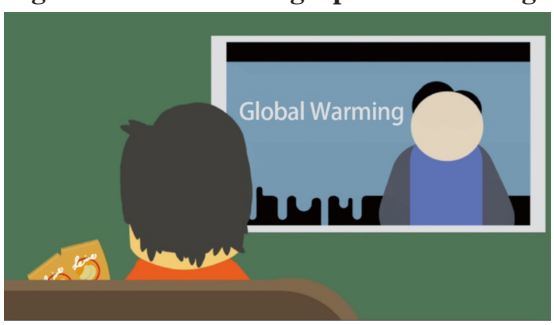
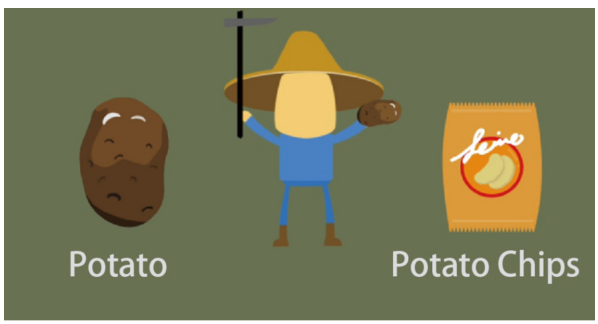


Figure 6. Motion Infographics: Raw Materials



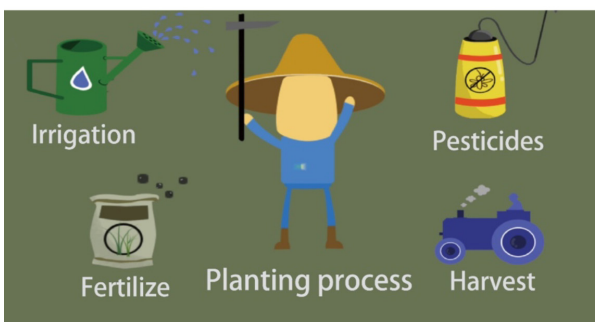


Figure 7. Motion Infographics: Processing and Manufacturing

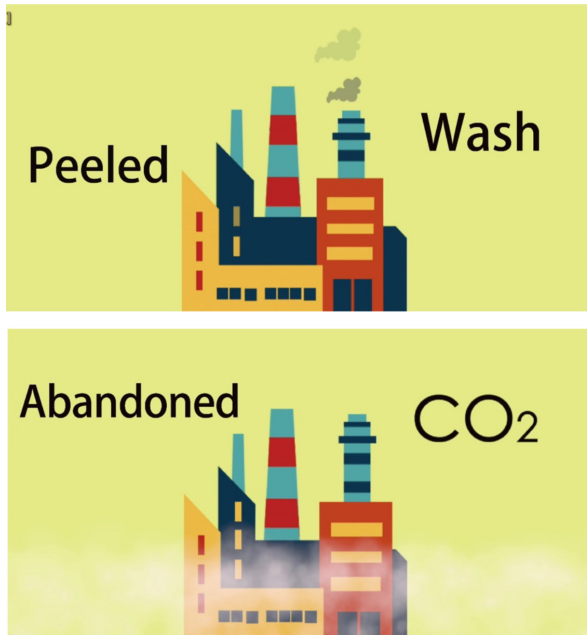


Figure 8. Motion Infographics: Packaging

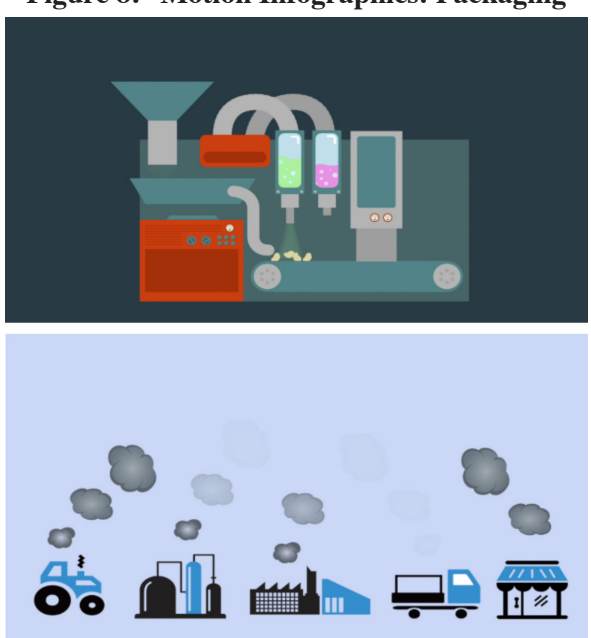


Figure 9. Motion Infographics: Sales and Disposal

Figure 10. Explanation of the Carbon Footprint Label

control group in each class were allowed to watch the other group's course content, and the teacher would then explain the purpose of this experiment.

2.4 Experimental process

The experiment was conducted in four one-hour sessions over four weeks. The purpose of the one-week intervals was to validate whether the students had indeed memorized the content of each week after the courses.

The first week involved a pre-exam on natural science, with no content related to carbon footprint. The format of the exam was the same as the term exams for elementary schools in Taiwan. Starting from the second week, the classes of the experimental groups and the control groups were conducted in different ways. The classes of experimental groups were conducted using motion infographics, and those of the control groups were conducted using the original teaching methods, typically with textbooks, worksheets, materials that the teacher compiled from other books and the Internet, and occasionally videos from YouTube or the Internet. The third week consisted of reviews and group discussions led by the teacher, relating to the second week's content. The students were prompted to discuss the impact of the carbon footprint system in Taiwan and what they had seen with regard to the carbon footprint system in their daily lives. For the last week, an exam on carbon footprint was conducted (Table 2).

2.5 Evaluation

In terms of the definition of learning effectiveness, under the current education system, resource classes and regular classes still have to undergo the same assessment, tests, and examinations and another version of the test paper with lower difficulty for resource classes are not available. Therefore, this study used the characteristics of infographics to assist the learning of the resource class and apply them to the school's teaching and evaluation mode.

The format of the assessment followed the typical exam formats used in Taiwanese elementary schools, as prescribed by the school. This structure was based on the Elementary Secondary School Exam Question Bank provided by the National Academy for Educational Research (n.d.); the assessment was compiled by a group of teachers, to ensure that the exam would be understood properly and would be considered as a formal exam by the students. The design of all the teaching materials of motion infographics

Table 2. Testing Schedule

Group	Week1	Week2	Week3	Week4
Experimental	Pre-test: General natural science (common sense of carbon)	Motion infographics on carbon footprint	Group discussion	Post-test: Carbon footprint
Control		Materials from teachers on carbon footprint		

in this manuscript as well as the pre-test and post-test papers were reviewed by the resource class teacher group and the teaching team leader to match the level of difficulty of the textbook. The script of the motion infographics was also revised through four meetings during the design process. The full score of the test was 100 points. Through this standardized assessment across the control groups and the experimental groups, the effect of using the motion infographics could be evaluated using the same standard.

3. Results and Discussion

3.1 Data analysis

Regular Class Based on paired-sample *t*-test analysis, Table 3 shows that the experimental group of the regular class had an average score of 76.33 in the pre-test, and 81.33 in the post-test. The average improvement between the two tests was about 5 points. The control group had an average score of 77 in the pre-test and 78 in the post-test. The average improvement between the two tests was 1 point. The result for both groups was not statistically significant.

Resource Class Based on paired sample *t*-test analysis, Table 4 shows that the experimental group had an average score of 70.66 in the pre-test and 86 in the post-test. The average improvement between the two tests was 15.34 points. The control group had an average score of 68.66 in the pre-test and 64 in the post-test. There was a drop of 4.66 points between the two tests. The result of the experimental group was statistically significant ($t = -3.826, p < .01$).

As shown in the chart, the difference in average pre-test scores for the two groups from the resource class was greater than 1 point. To confirm whether different prior knowledge levels had a significant impact on the learning results,

Table 3. Test Scores of the Control and Experimental Group of the Regular Class

Group	No. of students	Pre-test score		Post-test score		Difference between pre- and post-test score	*t*
		M	*SD*	*M*	*SD*		
Experimental	15	76.33	13.15	81.33	10.60	+5	-1.252
Control	15	77.00	11.30	78.00	10.82	+1	-.315

Table 4. Test Scores of the Control and Experimental Group of the Resource Class

Group	No. of students	Pre-test score		Post-test score		Difference between pre- and post-test score	*t*
		M	*SD*	*M*	*SD*		
Experimental	15	70.66	17.09	86.00	12.98	+15.34	-3.826**
Control	15	68.66	14.07	64.00	16.38	-4.66	-1.200

** $p < .01$.

the pre-test results of the two groups were used as a common variable to conduct a one-way analysis of covariance; this shows that prior knowledge did have an impact on the result of the post-class exam. However, the significant improvement of the experimental group's post-test results, compared to that of the control group, nevertheless demonstrated that motion infographics was beneficial to the learning of the resource class students.

3.2 Discussion

Both groups of the regular class showed an improvement of around 5 points in the average post-test exam scores, compared to the pre-test. The experimental group using the motion infographics system was 4 points higher than the control group, but the results were not statistically significant. The experimental group of the resource class had a significant improvement of 15.34 points, while the control group had a drop of 4.66 points.

With motion infographics, the average test score improvement of the resource class experimental group was statistically significant and was three times greater than that of the regular class. Based on the result, we observe that motion infographics, complemented by coherent storylines, highlighted keywords, and key concepts, could effectively attract the attention of the students in resource classes. For example, in the question and answer part of the assessment, most students in regular classes could respond in a narrative manner; while in the past, students in resource classes were generally less able to answer or left blank to questions that required a complete description of the situation. However, after learning with motion infographics, they could provide short keywords and processes in the answer, and even draw pictures on the screen instead of text when they forget how to write the keyword. Moreover, their interest in learning could also be increased, which enabled them to comprehend complicated concepts, such as the carbon footprint systems, more naturally and effectively.

Based on the experiment process and data points collected, we could see that the students were relatively familiar with the content of the pre-test, which was general natural science knowledge that the students had previously been exposed to. However, topics regarding carbon footprint, such as the impact of the carbon footprint and how it had been adopted worldwide, were more focused and complicated than the general topics. Without tailor-made video content, it was difficult for students from the resource class to grasp the concepts merely from textbooks and static pictures.

Furthermore, the motion infographics used potato chip packages as an example to illustrate the concept of carbon footprint. By using the label of a very accessible and popular product, the students were able to understand how the carbon footprint labels were presented on product packaging. This familiar example enabled the students in resource classes, who had weaker comprehension, to learn this complicated concept with reduced resistance, thereby improving their learning.

4. Conclusion

The demographic of the resource classes is often quite diverse. Participants of this study included students with high-functioning autism, Asperger's syndrome, language difficulties,

academic difficulties, personality withdrawal, inattention, learning difficulties, social difficulties, lack of learning motivation, hyperactivity, and emotional instability. Through the use of infographics, the course content can be delivered in a simpler, clearer, and more memorable manner; the use of digital motion graphics can make the presentation of the content smoother and more coherent. Motion infographics combines the advantages of motion graphic and infographics. They improve the resource class students' learning on more complicated natural science topics, such as carbon footprint, which fulfills the original intention of this study. It is hoped that this study will serve as a basis for further related research.

Motion infographics has become increasingly common in the past two years because of their memorable and easily understandable nature. They can be seen in various visual designs, as well as in the mainstream media: for example, in the main visuals of the Golden Horse, Golden Bell, and Golden Melody Awards in Taiwan, and YouTube channels such as "Taiwan Bar (https://taiwanbar.cc)."

Although infographics have been popular for some time, and they do help most readers to read and perceive, improve impression and memory, they are rarely used in the field of education or help students with academic difficulties, especially in resource classes, where customized teaching materials and methods are required. The starting point of this study was to bring the characteristics of infographics into the resource class teaching materials, and to systematize the content of the course through the description of infographics narratives, as infographics provide both knowledge and the advantage of animation that can attract attention and interest. Based on the experiment conducted in the resource class and the regular class, this research demonstrates that motion infographics is significantly effective in improving the learning of students from resource classes. Moreover, this research can serve as a basis for further in-depth study of the effect of motion infographics on single-behavior groups in resource classes.

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動態資訊圖像對小學中年級資源班與普通班之學習影響

The Effect of Motion Infographics on the Learning of Third and Fourth Grade Resource Classes and Regular Classes in Elementary School

蔡仕廷[1]　黃馨儀[2]　張登文[3]
Shih-Ting Tsai[1], Hsin-Yi Huang[2], Teng-Wen Chang[3]

摘　要

臺灣的小學目前較無專門針對資源班的學習內容。由於現有專為普通班設計的內容與資源往往不適用於資源班，因此資源班教師有時需自行開發補充資料，以適應不同情況學生的多樣化需求。本研究旨在設計動態資訊圖像系統協助資源班，改善學習。動態資訊圖像結合了資訊圖像和動態圖像的優點，以歸納後統整的資訊使觀眾有深刻印象。本動態資訊圖像主題為碳足跡，碳足跡在全球是討論度相當高的環境議題，也常出現於教科書中。研究進行的實驗表明，動態資訊圖像系統應用於資源班具有成效，使用動態資訊圖像系統的資源班實驗組考試成績和學習效果有明顯的提高。而資源班實驗組對圖像形狀的理解程度，相對於普通班的表現也較為顯著。

關鍵字：資源班、資訊圖像設計、動態資訊圖像、資訊視覺化、碳足跡

[1,2] 國立雲林科技大學設計學研究所
Graduate School of Design, National Yunlin University of Science and Technology, Yunlin, Taiwan
[3] 國立雲林科技大學數位媒體設計系
Department of Digital Media Design, National Yunlin University of Science and Technology, Yunlin, Taiwan
* 通訊作者Corresponding Author: 張登文Teng-Wen Chang, E-mail: tengwen@gemail.yuntech.edu.tw
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