論文

Developing Effective Multimedia Educational Contents: Research and Design

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This paper reports on a pilot study carried out by students and teachers on how to create effective multimedia educational content. As one of the post-field study activities connected to the Nepal field study program, an accredited study abroad course offered at Tokyo City University, multimedia educational content, authored by three students, was piloted at three private Japanese universities. Results from the research identify the effective design features that should be adopted when creating multimedia content for Japanese university students. In addition, the findings support the shift from a teacher-centered model to a learner-centered model of pedagogy as a way to enrich student learning in the future.

Keywords: Nepal, biogas technology, Nepal Project, multimedia educational design, student-centered learning

1 Introduction

As one of the academic study abroad programs in the Faculty of Environmental and Information Studies at Tokyo City University, the Nepal Project and field study program targets student-centered learning through participatory research in selected sites in Nepal. Over the past six years the Nepal Project research activities in the field have focused on environmental management at the community level both in urban and rural settings (Bushell & Goto, 2006). And while "hands-on/minds-on" work in the field represents the core of the program, integral to the learning process are the post field study activities where students utilize the information technology and technical support staff on campus at Tokyo City University to synthesize the information they have gathered in the field, creating educational contents that can be used in a variety of ways on campus, including as a pre-departure orientation for students, as independent student learning resources, or for use by professors as part of their lecture content. As a result of the research from 2004 to 2008, five multimedia education modules have been created using a variety of technology tools including video, 3D graphics and power point data, as well as still photos, music, text subtitles and dialogs in English (Goto, Bushell & Hara, 2005). Each module varies in design and content. While the enlistment of technology has allowed for creative design of these education modules, the effectiveness of the contents as a learning tool has yet to be investigated, therefore, the research of this paper will report on a pilot study which focuses on the evaluation of the educational contents and its design, based on the field data gathered in Nepal from 2008 to 2009.

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2 Synthesis of the Literature on Multimedia Design

When developing multimedia educational contents it is important to consider the pedagogical design in relation to the learning styles, knowledge base and engagement attitudes of the learners. Research in multimedia design suggests that learning requires visual plus auditory stimulus, particularly when technology is being used to promote cognitive processing and to engage the learner (Harry, 1999; Kalyuga, Chandler & Sweller, 2000). According to the information-delivery view of multimedia design (Petraglia,1998) the information to be learned should be delivered in sequence (i.e., words, followed by pictures, or vice versa). This however contradicts the research of Mayer (2001, 100) who argues that "Humans are sense-makers who engage in active cognitive processes, selecting and integrating relevant information from both visual and auditory pathways to create meaning." Mayer argues that on the basis of the cognitive theory of multimedia learning, learners are more likely to retain visual and verbal input in working memory if presented at the same time, then if presented separately.

Drawing on extensive research, Mayer and Anderson (1992) describe key learning principles which are relevant to designing multimedia educational content. These include:

- multimedia principle - learning is improved using words and pictures in preference to words alone;
- contiguity principle - learning is improved when pictures and related words are presented at the same time or next to each other;
- modality principle - spoken words are better than printed text for explaining images;
- signaling principle - learning material should be organized with clear outlines and headings; and
- personalization principle - a conversational style is better than a formal style for learning

Research by Sorden (2005) confirms that using a framework based on the above principles is essential for producing effective multimedia teaching materials.

In addition, when considering how to design multimedia content, important issues to consider are the learners' existing or prior knowledge of the content as well as their spatial ability - the ability to generate, store and process mental and visual images (Carroll, 1993). The research informs that learners possessing high prior knowledge of the content can learn effectively, even when the visual and auditory are presented separately, whereas learners with low prior knowledge learn best when the visual and auditory are delivered at the same time (Brown, 2001). Therefore, we can conclude that low-knowledge learners would benefit most from implementing the contiguity principle of learning. Finally, Brown's research suggests that both high and low spatial learners learn at similar levels when poorly designed multimedia content is used, while high spatial learners learn more quickly using well designed multimedia content. Evans and Nation (2000) suggest that positive attitudes about learning from multimedia content result when visuals are presented together with on-screen text or subtitles.

3 The Multimedia Contents

The creation of the multimedia educational contents for this pilot study was guided by the key findings in the review of the literature, and from students' evaluation of the five educational contents created in previous years from the Nepal Project field research. The contents is eight minutes in length, recorded on DVD, and focuses on biogas technology - an indigenous technology to Nepal which converts animal, human and household waste into energy for cooking and heating (see Figure 1).

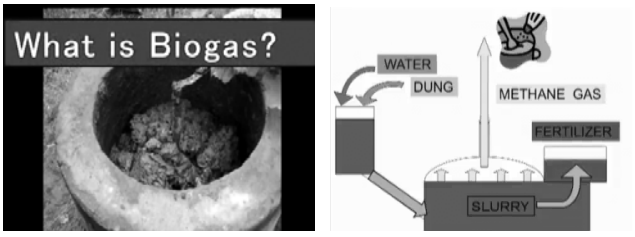

Fig. 1 Images from the multimedia educational contents on biogas in Nepal

This biogas technology is recognized not only as an alternative and sustainable energy source, but also as a way of alleviating poverty, promoting gender equality and conserving forest resources in Nepal. In addition, under the Clean Development Mechanism (CDM)

of the Kyoto Protocol, it has become the first greenhouse gas emission (GHG) reductions project in Nepal (2005). The mechanism allows industrialized nations to offset some of their emissions by investing in Nepal's biogas energy program. It is expected that Nepal can be paid to reduce its emissions by one million tonnes from 2005 to 2012 through the World Bank's Community Development Carbon Fund. Even though Nepal's per capita green gas (GHG) emission from energy use is insignificant in global terms, it is important for Nepal to adopt environmentally friendly energy options based on local resources as a best practice for sustainable development.

The biogas educational module, created by Ms. Keiko Shimizu, Ms. Manami Shiihashi and Mr. Yoshiteru Takinoiri was awarded the Commendable Prize in the Global Education Contest 2009, by the Ministry of Foreign Affairs in Japan.

Fig. 2 Awards Ceremony

Figure 2 shows Ms. Manami Shiihashi (left) and Ms. Keiko Shimizu (right) receiving the Commendable Prize at the awards ceremony held in Osaka on February 7, 2010. Absent on that day was Mr. Yoshiteru Takinoiri.

4 Pilot Study Research Design and Procedure

To determine the effectiveness of the contents as an educational tool, a pilot study was carried out in various steps from May through November, 2009. The framework of the pilot study is summarized in Figure 3. As a first step, a survey was created and students who previously participated in the field study program were asked to evaluate the five existing multimedia educational modules by viewing them on the YouTube site. Using this input and guided by the review of the literature, the student team created the multimedia contents using video clips, photos and hard data collected on the theme of biogas technology in Nepal over the past two years. The evaluation consisted of pre and post questionnaires using a 5-point rating scale (-2 = do not agree; +2 = do agree), with an additional comprehension-test component. Section A of the pre-questionnaire included 10 questions focused on student attitudes, while Section B tested students' knowledge of the 10 environmental terms to be presented in the multimedia contents (Appendix 1). The post questionnaire consisted of three sections: Section A tested students comprehension of the multimedia content, Section B tested the students knowledge of the ten environmental terms, and Section C asked students to rate the design components of the multimedia contents (Appendix 2).

As the multimedia content is targeted at low-knowledge learners (those learners having no, or very little information about Nepal) the participants for this study were selected based on this feature. The pilot study included 461 undergraduate students from three private universities: 371-1st and 2nd-year students from the Dept. of Environmental and Information Studies and the Dept. of Information Ecology Studies at Tokyo City University, Yokohama Campus; 58-2nd-year students from the Dept. of English Language and Literature and the Dept. of International Relations at the University of the Sacred Heart, Tokyo; and 32-1st and 3rd-year students from the Dept. of Social Innovation at Seijo University, Tokyo. The students first answered the pre-questionnaire, then after viewing the multimedia contents, answered the post questionnaire.

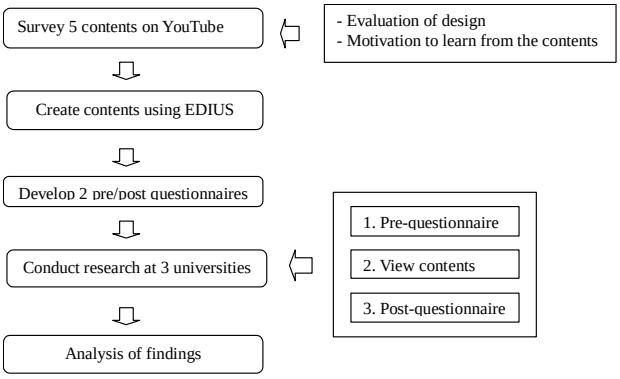

Fig. 3 Procedure of Pilot Study

5 Findings

A total of 425 participants completed the pre and post questionnaires, including 148 females and 277 males. The following is a snapshot of the findings.

5．1 Learning attitudes of all students

The total averages of the pre and post questionnaires targeting learner attitudes are summarized in Figure 4. In general, students had a high positive response rate to questions D, E and H, in both the pre and post questionnaire. The total average response rate for question D, "It is important for me to learn about the present environmental condition of other countries," was 1.41 in the pre questionnaire, while the post total average was slightly lower at 1.39. For question E, "It is beneficial for me to learn the approach to environmental problems of other countries," the total average for the pre questionnaire was 1.40 while the post was again slightly lower at 1.38. The total average response rate for question H, "Environmental education is important," was found to be 1.38 in the pre and 1.40 in the post questionnaire. A positive notable difference was found in questions J and A. The total average for question J, "I want to contribute to the solution of environmental problems in foreign countries," was found to be 0.68 in the pre and 0.83 in the post questionnaire, while the post total average in question A, "I want to learn environmental terminology in English," was 0.26 points above the total average of that in the pre-questionnaire. The greatest difference in the pre and post total average was found in question G, "Economic development is connected to the solution of environmental problems," in which the total average of the pre questionnaire was -0.21, while the post questionnaire was 0.10.

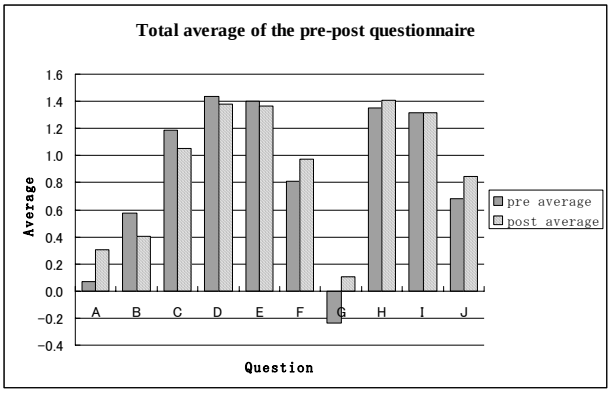

Fig. 4 Learning Attitudes of all Student Responses

5．2 Learning attitudes of Tokyo City University Students

Focusing specifically on student learning attitudes at Tokyo City University, several differences could be found between the two departments (see Figure 5). One difference was found in question G, "Economic development is connected to the solution of environmental problems," where the total average in the Dept. of Environmental and Information Studies was 0.38 while the total average for the Dept. of Information Ecology was 0.21. Another difference was found in the total average for question A, "I want to learn environmental terminology in English." The total average was found to be 0.26 for students in the Dept. of Information Ecology, and 0.20 for students in the Dept. of Environmental and Information Studies. Students from both departments showed a similar positive attitude to question J, "I want to contribute to the solution of environmental problems in foreign countries," with 0.22 from the Dept. of Information Ecology and 0.21 from the Dept. of Environmental and Information Studies. Of interest was the low rating given to question I, "I need to increase my knowledge about environmental problems." Negative ratings were found in both departments; -0.01 in the Dept. of Environmental and Information Studies, and -0.05 in the Dept. of Information Ecology. Additionally, students in both departments responded with low ratings for question D, "It is important for me to learn about the present environmental condition of other countries." The total average was found to be -0.03 from the Dept. of Information Ecology and -0.08 from the Dept. of Environmental and Information Studies.

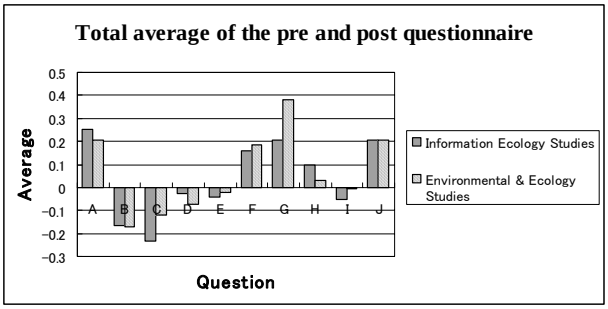

Fig. 5 Learning Attitudes of Tokyo City University Students

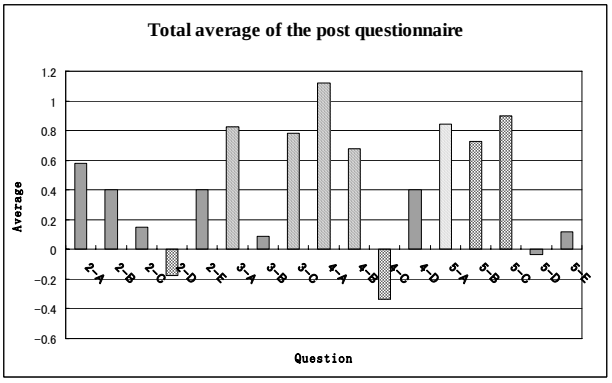

Fig. 6 Evaluation of the Contents as a Learning Tool

6 Evaluation of the Multimedia Contents as a Learning Tool

To evaluate the multimedia contents as a learning tool the students were asked to respond to a total of 17 questions in the post questionnaire (Appendix 2, Section C, Post 2 to Post 5). Figure 6 represents the total average of the student responses. In identifying the most effective way to learn both content and language, the statement in Post 4-A, "It is good to use subtitles along with pictures for learning vocabulary," was rated most favorably by the students with a total average of 1.10, while Post 5-A, "Using subtitles, pictures, together with narration," revealed a lower total average of 0.82. Additionally, the total average for Post 3-A, "The pictures helped me to understand the video," was found to be 0.81, while the total average of Post 3-C, "The contents can be understood through the use of subtitles," was found to be 0.79. While pictures and subtitles were rated as important design principles, the total average score of Post 4-B, "The narration helps in learning English vocabulary," was valued as less important with a total average of 0.69.

As well as the design principles, the students were also asked to rate the contents for overall interest and use as a teaching aid. Question Post 2-A, "The contents are interesting," received a total average score of 0.59, while Post 2-B, "This video can make a good teaching aid," received a total average score of 0.40. Post 4-D, "It is possible to learn environmental vocabulary from this video," received a total average score of 0.40, and finally the total average of 5-D, "Motivation to study English with this video increased," was found to be -0.03.

7 Discussion and Conclusions

For the purposes of this paper the findings focused on two components of the pilot study; student learning attitudes from viewing the content, and the evaluation of the design of the educational content. From the first component on learning attitudes, we could find there was a slight increase in the belief that environment education is important after viewing the content, based on the total average of the pre and post questionnaire, however; students from both departments at Tokyo City University responded less positively, especially in the Dept. of Environmental and Information Studies. A possible reason could be that these students believe they already know about environment problems and are not convinced that environment education is part of the solution to solving environment problems. There was however a marked increase in the desire to contribute to the solution of the environmental problems in foreign countries in the total post average. Notably, students from Seijo University had the highest value of difference between the pre and post average. As this may be their first time to experience learning about environment issues in a developing country, they may be highly motivated to take action after viewing the learning content. The total pre-post averages also reveal that students believe it is beneficial to learn how different countries approach environmental problems, although the post average shows a less positive attitude. Students from Tokyo City University had a low response rate to learning from the approaches in different countries. Possibly due to their lower English ability they could not understand the content and became disengaged; the

narration may have been too fast and the content too complex for students to understand.

One of the interesting findings was the value of the differences in the average between students from the three universities connected to the impact of economic development on the solution of environmental problems. While there was an overall total average increase in the positive attitudes of students after viewing the contents, students in the Dept. of Environmental and Information Studies at Tokyo City University showed the highest total post average of 0.38, while student ratings from the Dept. of Information Ecology Studies were found to be 0.20. We could assume the reason for this is because students in the Dept. of Environmental and Information Studies may have a greater awareness of the connection between the economy and the environment through the classes they are taking. Finally, evidence from the findings indicates that particularly the students from Tokyo City University were not highly motivated to learn environment vocabulary in English after viewing the learning contents. This evidence suggests that students may not think it is necessary to understand environment terms in English while studying about the environment. Also, general comments from students indicate that there was too much information to absorb in a limited time, given that the narration was in English. However, the value of the difference in the average for students from Seijo University was much higher after viewing the contents. The reason could be because the two classes in which the data were gathered focus on Media English and TOEIC, therefore, the students may be highly motivated to learn vocabulary in English through media-generated content, regardless of the subject matter.

The second component related to the evaluation on the design of the educational content. The findings inform us that using multimedia materials is a good way to study English, and that multimedia content created by students is valued as a learning tool. This should encourage professors to incorporate multimedia materials in their classes, and also to shift from a teacher-centered didactic model to a learner-centered constructivist model of pedagogy in the future.

Specifically focusing on the multimedia design, the results indicate that the pictures in combination with the subtitles were more effective than the combined pictures, subtitles and narrative. There may be various reasons for this; the narration may be too rapid, the pronunciation may not always be clear or fluent enough, and for some learners, the narration may interfere with the cognitive process, particularly in the case of the low level language and knowledge learner. This can be considered a valuable finding, and one that is in contradiction to previous research, therefore more research is needed in this area. However, based on language skill level, it may be more effective to keep the narration at a minimum and include sidebars, information balloons or key words to support students' comprehension. Additionally, the findings confirm that there is a need for longer intervals when introducing vocabulary and content. Students from Tokyo City University commented that the pace was too fast and the information too detailed. Results from the comprehension tests after viewing the content revealed that the students had minimal understanding of the contents. Therefore, one way to enhance comprehension is to break the contents into shorter sections based on the components of the topic, allow students to view each section several times, and to include one key question per section so that students can focus on the discrete points. Additionally, the contents can be offered online, accessible to students at all times.

While it is always a challenge for Japanese students to embrace English as a means to learn content, it may be important for them to be exposed to English and to use it within the academic environment, given the face of the global society. This point is confirmed by the three students who created the learning contents for this pilot study. Through the process of this research, both their English skills and understanding of the educational content improved dramatically. Based on the findings from this pilot study, the design of the multimedia educational modules based on the Nepal field study research can be improved in the future, so that the process of learning both English and content can become significantly richer.

Acknowledgements

１．The authors gratefully acknowledge the support of the Ministry of Education, Sports, Science and Technology Grant-in-Aid for Scientific Research (B) 20402005 in work related to this report.

２．The authors would like to thank Mr. Hiroshi Kurata of Sound System Inc. for his technical support during the field study programs in Nepal, and for the time he has dedicated in helping students create the educational modules on campus at Tokyo City University.

日本語要旨

本稿は、学生と教員によって実施された効果的なマルチメディア教育コンテンツの作り方についてのパイロットスタディについて報告を行っている。東京都市大で行われているネパール海外研修に関連した事後のフィールド研究の一つとして、３人の学生によって作成されたマルチメディア教育コンテンツが日本の３つの私立大学で上映された。調査の結果から、日本の大学生に対する効果的な教育コンテンツのデザインを作成する際に考慮すべき特徴が認識された。加えて、将来における学習の質を高めるための方法として教師中心から学習者中心の教育法のモデルへの変化が必要であることが分かった。

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Appendix 1

Evaluation of DVD Learning Contents (Sept. 2009)
Pre-questionnaire

氏名：＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿ 学番：＿＿＿＿＿＿＿＿＿＿

学科：環境情報・情報メディア　授業名：＿＿＿＿＿＿＿＿＿＿

年齢：＿＿＿＿＿＿才　　性別：男・女

Section A.それぞれの設問に対して数字の部分に○をしてください。

	そう思わない	あまりそう思わない	わからない	少しそう思う	そう思う
A. 英語で環境用語を学びたい。	-2	-1	0	+1	+2
B. 発展途上国の人は生活に必至で環境問題に取り込む余裕がない。	-2	-1	0	+1	+2
C. 途上国の問題解決には、先進国の技術を取り組むことは重要である。	-2	-1	0	+1	+2
D. 他国の環境問題の現状を学ぶことは、有益である。	-2	-1	0	+1	+2
E. 他国の環境問題への取り組み事例を学ぶことは、有益である	-2	-1	0	+1	+2
F. 途上国の技術や知識には先進国が学ぶべきことはたくさんある。	-2	-1	0	+1	+2
G. 経済発展をすることが環境問題を解決へと繋がる。	-2	-1	0	+1	+2
H. 環境教育は重要である。	-2	-1	0	+1	+2
I. 自分自身の環境問題に対する知識をもっと増やす必要がある。	-2	-1	0	+1	+2
J. 諸外国の環境問題の解決に貢献できるようになりたい。	-2	-1	0	+1	+2

Section B. Vocabulary check

以下の説明文は、下記の点線内の単語のどれかについて説明したものである。どの単語の説明文として適切であるかを点線内の(a)～(j)より選び、下線部に番号を記述しなさい。

(a) Biogas	(b) Buffer zone	(c) Subsidy	(d) Deforestation	(e) Fertilizer
(f) Ecosystem	(g) Community forest	(h) Firewood	(i) Sustainable energy	(j) Wildlife

1. _____ : money that is provided freely to households
2. _____ : all plants and living creatures in a particular area considered in relation to their physical environment
3. _____ : forested area where people and wildlife live together
4. _____ : people join it and protect the forest
5. _____ : animals, birds, insects, etc. that are wild and live in a natural environment
6. _____ : a substance added to soil to make plants grow more successfully
7. _____ : use of animal and plant waste to create renewable energy without destroying the environment in the future
8. _____ : a natural energy source created by low technology which people use for cooking
9. _____ : the act of cutting down or burning the trees in an area
10. _____ : it is used for cooking and other household needs when biogas is not available

事前問題はここで終了です。これから、ビデオ鑑賞になります。
ビデオの最中は問題用紙を開かないでください。

Appendix 2

Evaluation of DVD Contents (Sept. 2009)
Post-questionnaire
DVD Biogas Project in Rural Nepal

点数： ____/20

開始の合図に従って、時間内に以下の問題を解いてください。

Section A. Content Comprehension. 合っていると思うものに○をしてください。

1. What country is the setting of the DVD?
a. Japan
b. Nepal
c. India

2. The problem for developing countries is ….
a. no local technology
b. high levels of poverty
c. decreasing population

3. The use of firewood is the cause of ….
a. deforestation
b. poverty
c. forest fires

4. The biogas plant makes …… which is used for cooking.
a. green house gas
b. CO2
c. methane gas

5. In the buffer zone, local people can collect fuel wood but sometimes
a. they eat poisonous food
b. they are attacked by wildlife
c. they fight and kill wildlife

6. One benefit of biogas is to ….
a. increase women's working time
b. decrease the number of family members
c. improve sanitation in the home

7. What is one problem of biogas?
a. People who are poor cannot install biogas.
b. It is hard to cook food using biogas.
c. There is not enough biogas in summer.

8. Why has biogas become popular in Sauraha?
a. To protect the local people from wildlife and to protect the forest resources.
b. Because the local people can make more money by using biogas.
c. Because many people do not have domestic animals there.

9. The important sources of income for Nepal are……
a. tourism and industry
b. tourism and agriculture
c. industry and agriculture

10. To realize a sustainable society, it is important to……
a. install new and high technology
b. consider the culture and situation of the economy
c. get money from the government

開始の合図に従って次のページに進んでください。

Section B. Vocabulary Check

以下の説明文は、下記の点線内の単語のどれかについて説明したものである。どの単語の説明文として適切であるかを点線内の(a)～(j)より選び、下線部に番号を記述しなさい。

(a) Community forest (b) Buffer zone (c) Ecosystem (d) Biogas (e) Fertilizer (f) Subsidy (g) Deforestation (h) Firewood (i) Sustainable energy) (j) Wildlife

11. _____ : people join it and protect the forest
12. _____ : all plants and living creatures in a particular area considered in relation to their physical environment
13. _____ : forested area where people and wildlife live together
14. _____ : money that is provided freely to households
15. _____ : it is used for cooking and other household needs when biogas is not available
16. _____ : a substance added to soil to make plants grow more successfully
17. _____ : use of animal and plant waste to create renewable energy without destroying the environment in the future
18. _____ : a natural energy source created by low technology which people use for cooking
19. _____ : the act of cutting down or burning the trees in an area
20. _____ : animals, birds, insects, etc. that are wild and live in a natural environment

開始の合図に従って次のページに進んでください。

Section C. Post 1.　下記の設問について、現在の考えとして最も近いものに○をして下さい。

	そう思わない	あまりそう思わない	わからない	少しそう思う	そう思う
A. 英語で環境用語を学びたい。	-2	-1	0	+1	+2
B. 発展途上国の人は生活に必死で環境問題に取り込む余裕がない。	-2	-1	0	+1	+2
C. 途上国の問題解決には、先進国の技術を取りこむことは重要である。	-2	-1	0	+1	+2
D. 他国の環境問題の現状を学ぶことは、有益である。	-2	-1	0	+1	+2
E. 他国の環境問題への取り組み事例を学ぶことは、有益である。	-2	-1	0	+1	+2
F. 途上国の技術や知識には先進国が学ぶべきことはたくさんある。	-2	-1	0	+1	+2
G. 経済発展をすることが環境問題を解決へと繋がる。	-2	-1	0	+1	+2
H. 環境教育は重要である。	-2	-1	0	+1	+2
I. 自分自身の環境問題に対する知識をもっと増やす必要がある。	-2	-1	0	+1	+2
J. 諸外国の環境問題の解決に貢献できるようになりたいと思う。	-2	-1	0	+1	+2

Post 2.　このビデオについての印象

	そう思わない	あまりそう思わない	わからない	少しそう思う	そう思う
A. このビデオの内容は興味深い。	-2	-1	0	+1	+2
B. このビデオは、教材として良く出来ている。	-2	-1	0	+1	+2
C. 他にもこのような教材があれば利用したい。	-2	-1	0	+1	+2
D. 内容を理解するのに時間は、 (短い-2、最適 0、長い+2	-2	-1	0	+1	+2
E. このビデオの内容から環境用語について学ぶことができた。	-2	-1	0	+1	+2

Post 3. ビデオについての理解しやすさ

	そう思わない	あまりそう思わない	わからない	少しそう思う	そう思う
A ビデオに出てくる写真によって内容を理解することができた。	-2	-1	0	+1	+2
B ビデオのナレーションによって内容を理解することができた。	-2	-1	0	+1	+2
C テロップによって内容を理解することができた。	-2	-1	0	+1	+2

Post 4. 語彙についての学び方

	そう思わない	あまりそう思わない	わからない	少しそう思う	そう思う
A. テロップと写真を一緒に使うことは語彙を学ぶいい方法である。	-2	-1	0	+1	+2
B. ナレーションを聞いて語彙を学ぶことは良い方法である。	-2	-1	0	+1	+2
C. 環境用語が出てくる間隔は理解するのに、(短い-2、最適 0、長い+2	-2	-1	0	+1	+2
D. このビデオから環境用語を学ぶことができた。	-2	-1	0	+1	+2

Post 5. 教育の教材に対するあなたの意見

私の意見では	そう思わない	あまりそう思わない	わからない	少しそう思う	そう思う
A. 今回のビデオの中にサブタイトル、絵、ナレーションを使うことは、英語を勉強する良い方法である。	-2	-1	0	+1	+2
B. 学生が作ったビデオから英語を学ぶ事ができるのは良いことである。	-2	-1	0	+1	+2
C. 大学においてビデオを使って英語を勉強するのは良い方法である。	-2	-1	0	+1	+2
D. このビデオによって英語の勉強に対するモチベーションが上がった。	-2	-1	0	+1	+2
E. このビデオをみて、持続可能について考えるきっかけになった。	-2	-1	0	+1	+2

このビデオを見て良かった点・悪かった点・改善点 などがあれば記入して下さい。

本アンケートは統計処理の上、学術的に利用し、個人情報を流出することはございません。

ご協力ありがとうございました。

ネパールプロジェクト