A Web-stress Evaluation on an On-line In-service Training Course

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***Abstract*—**There is a need to maintain web-service according to the real traffic required. The purpose of this study was to demonstrate how to apply traffic-stress on a web-based course of for adjusting learning activities. This sampled course is part of formal high school education for the technology Education subject under High-Scope Project. For integrating emerging technology into high-school learning content, the High-Scope Project had established for five years and is in the second stage. The digitizing course evaluation standard was applied to ensure the virtual learning quality. Based upon the evaluators' consistency, the reliability was reached 0.931. There are ten lessens. Those are "Introduction of Green Energy", "Characteristics and Application of Green Energy", "Green Energy Developing and Environmental Issues", "Principle and Application of Solar Energy", " Principle and Application of Fuel cell", " Principle and Application of Wind Energy", " Principle and Application of Hydraulic Energy", "The Trend of Green Energy Development", "The Industry of Green Energy", "The Impact of Green Technology". Based upon the evaluation results, it was confirmed that this web-based course is digital learning qualified.

***Keywords*—**Web-based course, Green energy, Technology Education, High-Scope Project

I. Introduction

There is a need to evaluate traffic conditions before and after implementing a web-based service. For ensuring on-line service quality, the aggregate traffic as seen by the server would play a key role. The typical usage might be the E-commerce server or the E-learning server. In this study would be focused on the e-learning service of a special project, so called High-Scope Project.

For coping emerging technology, educators in Taiwan have conducted High-Scope Project for five years to host high-school teachers creating courses, learning activities, and teaching aids for formal science education. The ultimate goal of the High-Scope Project is to integrating emerging technology into formal education.

In the learning environment, web-based learning support had become an unique and important element which provides both teacher and student with an anytime and anywhere ubiquitous supporting. This learning support is a new learning paradigm, known as ubiquitous learning or U-learning, which is supported by the ubiquitous computing technologies [1-6]. Ubiquitous computing can be considered as a new type in the information and communication world. It is normally associated with a large number or small electronic devices (hand-held devices) which have computation and communication capabilities such as smart phone, a laptop, a pad, or tablet pc which could be used in our daily life[5].

The web-based learning refers to learning that is operated in the web side environment, and the environment that can learn with internet communication. Different learning activity are required for support web-based learning.

There is a need to include emerging technology into formal education in order to prepare students with the perceptions of emerging technology. Web-based learning course should be organized for learners. It is required to verify the quality of web-based learning. The purpose of this study was to design an online course of introducing green energy for high-school students. For providing a quality service, it is required to explore web server's stress upon this specific service and to verify the feasibility of quality service providing.

II. E-learning web server

For a server providing learning communication functions, there is a need to ensure both learning material and service providing are all well organized. In this section, server stress evaluation and content evaluation would be presented.

Server Stress Evaluation

For understand server stress, there is a need to generate representative HTTP traffic. By probing the representative HTTP traffic, it is possible to study detailed web service and server's stress. There are two things should be constructed. Those are:

- Need to emulate user behaviour from aggregate traffic perspective.
- Need to emulate network impact on the traffic.

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Table 1 Comparisions of Web Stress tools

	WAS	SURGE
Strength	Secure requests to server. Can use multiple client boxes. Collects data from all clients and can collect data from the server under test. Good UI	Generates references matching Server File size distribution. Request Size distribution. Relative file popularity. Embedded File references.
Weaknes s	Emulates users directly => Cannot generate high traffic rates. Access characteristics must be set individually. Cannot specify arrival time distribution and hence cannot be used to generate "Burst" traffic. Cannot make secure requests via a proxy. Subject to implicit feedback from the server based on response time of the server. No access to source code.	Not based on aggregate traffic as seen by the server. Cannot generate traffic for overload studies. No capability of generating secure traffic.

For providing these two controlled environment, several tools would be available, such as Web Application Stress, WAS, and Scalable URL reference generator, SURGE. In table 1, the strength and weakness comparisons were illustrated. The traffic generator features could be summarized as follows.

- Flexible arrival process characteristics
  - Marginal distribution.
  - Includes user behaviour
  - Includes network effects.
  - Can generate non-stationary & overload situations.
- Request and Response features:
  - Request size distribution.
  - Popularity distribution of Files/ Directories.
- Generates aggregated traffic:
  - Not subject to implicit feedback from the server.
  - Scalable to high traffic levels.
- Can generate e-commerce traffic
  - Transactional classification.
  - Dependencies between successive user transactions.
- Other features:
  - Fine grained logging of response times and HTTP
  - response codes.
  - Secure and Non Secure Traffic, direct and via Proxy
  - servers
  - Custom HTTP Directives in the request.
  - Automatic distribution of traffic among a number of clients.

Architecture of Traffic Generator

Since the trace generation can be quite expensive, the waiting time for request generators must be minimized. Some flexibility are required, such as:

- Request generator could be driven from an actual trace.
- Trace generator run once and output used repeatedly.

A two-steps process is presented:
1. Trace generation
2. Request generation.

For the trace generation, there are two tasks is listed in the followings.
1. Generates request arrival times and parameters.
2. Traffic characterization of statistical data.

For the request generation, there are also two tasks should be accomplished.
1. Distributes trace files among clients.
2. Generates actual requests and handles responses.

Performance Issues

There are three factors of parameters for optimal performance and accuracy in request generation. Those are listed in followings.
1. Number of sender threads
2. Number of requests per attempt
3. Number of clients

Another performance issues is time slippage. The timing difference between actual request times and those in the trace file is the major consideration. The time slippage depends upon following factors.
1. Number of threads
2. Traffic rate per client
3. Traffic bursts.
4. Platform (processor and memory

Content Evaluation of E-learning

There is a need to include emerging technology into formal education in order to prepare students with the perceptions of emerging technology. Web-based learning course should be organized for learners. It is required to verify the quality of web-based learning. The purpose of this study was to design an online course of introducing cloud computing for high-school students. education is a subject area of common education and provides learner the opportunity of accepting technology. Innovative technology grows everyday and the information and knowledge of technology expands, too. Systems of technology in some areas are even exploded, such as energy & power technology and information & communication technology. In science education, how to integrating emerging technology into formal education becomes a concern. Education reform acts in Taiwan pointed out this trend and raised a "High Scope Curriculum Development" project to foster teachers to design teaching material and learning activities of emerging technology.

Technology Education

Technology education is a subject of studying technology in which learners could learn about the context, process, and knowledge related to technology[7]. Technology education is all about learning technology literacy.

Technological literacy is much more than just knowledge about computers and their application. It involves a vision where each citizen has a degree of knowledge about the nature, behavior, power, and consequences of technology from a broad perspective. Inherently, it involves educational programs where learners become engaged in critical thinking as they design and develop products, systems, and environments to solve practical problems. Through technology, people have changed the world. In the drive to satisfy needs and wants, people have developed and improved ways to communicate, travel, build structures, make products, cure disease, and provide food. This has created a world of technological products and machines, roadways and buildings, and data and global communications. It has created a complex world of constant change.

Technology education, as presented here, must become a valued subject at every level.

People make decisions about technological activities every day. However, the growing complexity of technological systems means that all technological decision-making should include an assessment of the impacts and consequences of an implemented or proposed technological system.

Green Energy

Green energy is also called renewable energy. Renewable energy is natural energy which does not have a limited supply. Green energy can be used again and again, and will never run out. Renewable energy has been in use for thousands of years in one way or another. An example of this is how our ancestors used the wind for sailing, and we now use the wind to generate electricity.

Renewable resources include solar energy, wind, falling water, the heat of the earth (geothermal), plant materials (biomass), waves, ocean currents, temperature differences in the oceans and the energy of the tides. Renewable energy technologies produce power, heat or mechanical energy by converting those resources either to electricity or to motive power.

Although any resource that relies on the heat or motion of the earth, the moon or the sun (or the sun's radiation) to produce power for human consumption is a renewable resource, the ways one harnesses the resources are sufficiently different that laws and regulations governing these resources usually deal with each resource on an individual basis - treating each resource as unique. At present, the major commercial grid-connected renewable resources are hydroelectric, geothermal, biomass, wind energy and solar. In the majority of legal regimes, hydroelectric and geothermal resources are identified as owned in common by the people of the country and husbanded by the government for their benefit.

Geothermal resources require extraction (and reinjection). Drilling for geothermal resources involves many of the same discrete considerations involved with drilling for petroleum (hydrocarbons) and individual treatment is prudent.

Hydroelectric resources are inextricably linked with surface water rights, including potable water, navigation, irrigation, navigation and recreational rights. The historical complexities of sorting out these juxtaposed rights usually dictate individual treatment of hydroelectric resource issues.

Wind energy and solar draw on resources - wind and sun energy - generally thought of as being free for the taking. The principal resource issue with both of these renewables is surface land. Therefore there is no general technical requirement for individual treatment.

Biomass is a broadly inclusive term, often encompassing wood and wood waste, agricultural waste and residue, energy crops, and - sometimes - landfill gas resources. Resource availability and cost can be highly variable, and resources may require management of a type not frequently required for other renewable. Individual treatment is one method of addressing this complication.

Although a complete list of the benefits of green energy technologies can be very extensive, they can be categorized under four headings: environment, diversification, sustainability and economics.

- Green energy resources are environmentally benign.
- Green energy resources promote energy diversification.
- The primary long-term benefit of green energy technologies is that once a green energy project has been constructed, and fully depredated, it becomes a permanent, environmentally dean, and low cost component of a country's energy system. In effect, the construction of a green energy energy project provides future generations a low cost, energy facility that produces power with little or no environmental degradation.

- Green energy resources are sustainable.

III. Evaluation Results

Results of Content Evaluation

In these lessons, learning contents were distributed in frame structure and interaction was designed to be triggered by questioning procedure. All ten lessons were listed in table with the corresponding frame and quiz information.

There are ten lessens. Those are listed in Table 2.

Table 2 Lesson Title and structure information

Lessons Title	Frame	Quiz
Introduction of Green Energy	34	10
Characteristics and Application of Green Energy	17	5
Green Energy Developing and Environmental Issues	34	5
Principle and Application of Solar Energy	26	10
Principle and Application of Solar Energy	38	10
Principle and Application of Wind Energy	20	10
Principle and Application of Hydraulic Energy	25	5
The Trend of Green Energy Development	23	10
The Industry of Green Energy	12	8
The Impact of Green Technology	20	10

The major flows of learning design was presented in Fig. 1. There are open session, illustration sessions, and conclusion-examination session. For the illustration session, it could be consisted more than one for clearing complexity of knowledge.

Fig. 1 Major flows of Learning Design

There were four dimensions of the Ministry of Education Digital Materials Evaluation Standard.

1. Contents & Structure
2. Material Design
3. Auxiliary Design
4. Media and Interface Design

According to standard, all requirements of four dimensions were met and the evaluators' agreement was calculated at 0.931 levels, 27 out of 29 items. The results of each dimension were described in following sessions.

Table 3 Summary table of evaluation

Dimension			Evaluator 1		Evaluator 2		Reached Items
	R	O	A	A+	A	A+	
1	7	3	1	9	1	9	10
2	6	3	1	8	2	7	8
3	1	3		4		4	4
4	5	1		6	1	5	5
							27

R: required items
O: optional items

Contents & Structure

The evaluation results of contents and structure are illustrated in this section.

- The web-based course web page would explain subjects and topics clearly. It provided all units' name, time plan, and user information.
- The web page provided learner with practical objects in cognition, skill, and attitude.
- The course materials covered all learning objects listed for this course.
- The level of both material and potential learner were matched.
- The content of materials was correct.
- The organization of material was in logical order and divided into specific units.

Material Design

The evaluation results of material design are illustrated in this section.

- The web-based course web page would initiate learner's motivation. It provided active information to draw the learner's attention.
- The material provided clear guide of how to join learning activities.

- Examples provided in the material were useful and appropriate.
- There were some interactions for learner to practice their thinking and skill.
- The page provided evaluation for learners to inform their own progresses.
- There were channels for feedbacks.
- The page provided suggestions of each learning session.

Auxiliary Design

The evaluation results of auxiliary design are illustrated in this section.

- The web-based course web page would be with detail browsing information. It provided identical layout, button directions, website map, and operating instructions.
- The material provided notable learning progress records.
- The system provided keyword index service.

Media and Interface Design

The evaluation results of media and interface design are illustrated in this section.

- The media quality of web-based course web page would be nice and with high quality in both vision and audio.
- The media could help learners in both vision and audio recognition and distinguishing.
- The material provided screen layout in outlook, color, function, and position.
- The operating interface was well designed in convenience, reliable and unify.
- The browser works well on the course material.

Results of Server Stress Evaluation

Evaluation Environment

In this section, the evaluation environment would be reported in following sessions:

1. URLs To Evaluate
2. Results per User
3. Results per URL
4. Transferred Data & CPU Load

In Table 4, The tested URLs are listed with their name, click delay time, and URL. There were sixteen URLs were evaluated. URL 1 to 4 are for the login process. URL 5 and 6 are for course selecting. URL 7 to 15 are for different learning activities. URL 16 is for the logout procedure.

In Table 5, evaluation results per user are listed with their clicks, hits, errors, average click time in ms, bytes, and speed in kbit/s. The clicks per user are between 63 and 66. The hits per user are also between 63 and 66.

Table 4 URLs to evaluate

URL#	Name	Click Delay [s]	URL
1	Web Side	5	http://stem.nknu.edu.tw/
2	Sub-service	5	http://stem.nknu.edu.tw/moodle
3	top page of elearning server	5	http://stem.nknu.edu.tw/moodle/login/index.php
4	loging	10	http://stem.nknu.edu.tw/moodle/login/index.php
5	couse selection	10	http://stem.nknu.edu.tw/moodle/course/view.php?id=64
6	top view of course	5	http://stem.nknu.edu.tw/moodle/mod/forum/view.php?id=1574
7	activity of disscusion	5	http://stem.nknu.edu.tw/moodle/mod/forum/post.php?forum=221
8	activity of forum page	5	http://stem.nknu.edu.tw/moodle/mod/forum/view.php?id=1574
9	activity of forum view	5	http://stem.nknu.edu.tw/moodle/course/view.php?id=64
10	activity of assignment page	5	http://stem.nknu.edu.tw/moodle/mod/assignment/view.php?id=1550
11	activity of assignment view	5	http://stem.nknu.edu.tw/moodle/course/view.php?id=64
12	activity of resource view	20	http://stem.nknu.edu.tw/moodle/mod/resource/view.php?id=1562
13	activity of scorm page	5	http://stem.nknu.edu.tw/moodle/file.php/64/moddata/resource/759/SCORM.htm
14	Activity of scorm package	5	http://stem.nknu.edu.tw/moodle/file.php/64/moddata/resource/759/scorm_support/scorm_support.htm
15	Activity of view material	30	http://stem.nknu.edu.tw/moodle/course/view.php?id=64
16	logout	0	http://stem.nknu.edu.tw/moodle/login/logout.php?sesskey=Qgj0EpRfVi

The testing errors is zero. The average click times are between 1.353 ms and 1.615 ms. The transfer amounts are between 1,656,529 Bytes and 1,405,939 Bytes. The speeds are between 111.16 kbit/s and 148.44 kbit/s. In summary, server evaluations among users are without error and stable.

Table 5 Results per user

User No.	Clicks	Hits	Errors	Avg. Click Time [ms]	Bytes	kbit/s
1	65	64	0	1,563	1,530,392	122.38
2	63	63	0	1,606	1,405,939	111.16
3	64	64	0	1,595	1,530,392	119.94
4	64	64	0	1,585	1,530,392	120.68
5	64	64	0	1,615	1,530,392	118.42
6	64	64	0	1,601	1,530,392	119.52
7	64	64	0	1,597	1,530,392	119.76
8	66	66	0	1,353	1,656,529	148.44

In Table 6, evaluation results per URL are listed with their number, errors, time spent in ms, and average click time in ms.

The clicks per URL are between 25 and 33. The testing errors is zero. The time spent between 6658 ms and 165,206 ms. The average click time are between 202 ms and 5,163 ms. In summary, server evaluations among URLs are without error and suitable for their own service purposes.

The first URL, web side, service took only 202 ms per click. It could be This would provide most user good image of this certain web service. The second URL, sub-service, took 0.005163 second for the click and 0.165206 second for getting information to show.

For learning activities, URL from 7 to 15, time spent is less than 0.05 second. All these nine learning activities could provide learner well service response.

Table 6 Results per URL

URL No.	Clicks	Errors	Time Spent [ms]	Avg. Click Time [ms]
1	33	0	6,658	202
2	32	0	165,206	5,163
3	32	0	29,748	930
4	32	0	25,834	807
5	32	0	41,648	1,301
6	32	0	38,253	1,195
7	32	0	38,936	1,217
8	32	0	35,318	1,104
9	32	0	33,045	1,033
10	32	0	32,195	1,006
11	32	0	34,676	1,084
12	32	0	37,218	1,163
13	32	0	33,771	1,055
14	32	0	32,796	1,025
15	30	0	50,660	1,689
16	25	0	123,391	4,936

In Fig. 2, the evaluation environment were illustrated according to the transferred data, system memory, CPU load used for this web server stress test. In summary of this test procedure, the system memory, network traffic, and local CPU load is under reasonable scale. The evaluation procedure could be conducted without resource limitation.

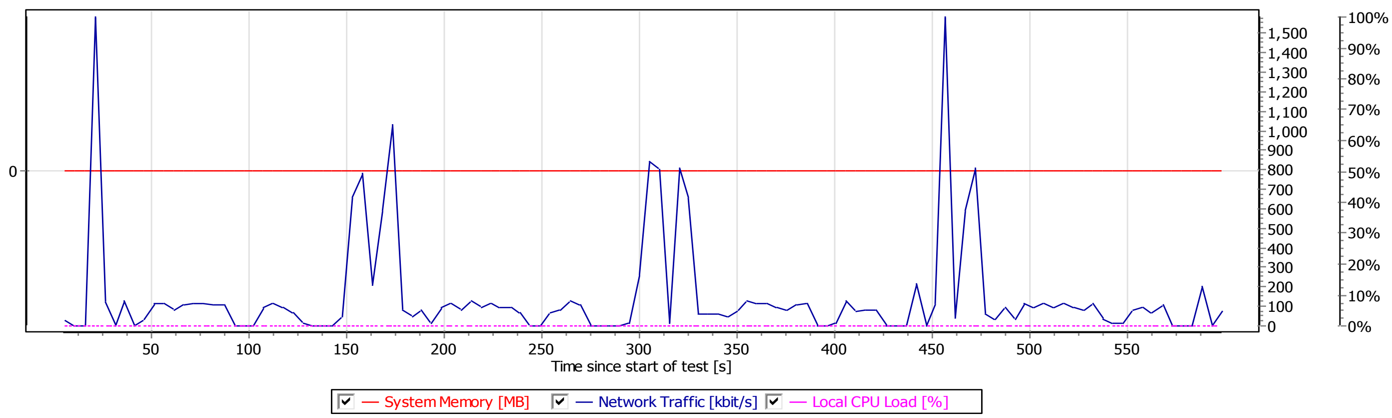

Fig. 2 Transferred data, system memory, and CPU load

Service Evaluation Results

In this session, the definitions of each term used in the fig. would first presented. for presenting results of evaluating the service, several figures were drawn. Those figures are listed in followings.

- Protocol times for all URLS
- Server and User Bandwidth
- Open requests and transferred data
- Spectrum of click times
- Hierachy and times of all hits
- Click time, hits/s, users/s for all URLs
- Click times and errors

Definitions of terms used in figures are described in followings.

- Click: A simulated mouse click of a user sending a request (one of the URLs from the URL list) to the server and immediately requesting any necessary redirects, frames and images (if enabled).
- Request: A HTTP request sent to the server regardless of an answer.
- Hit: A completed HTTP request (i.e. sent to the server and answered completely). Hits can be the PAGE request of a "click" or its frames, images etc.
- Time for DNS: Time to resolve a URL's domain name using the client system's current DNS server.
- Time to connect: Time to set up a connection to the server.
- Time to first byte (TFB): Time between initiating a request and receiving the first byte of data from the server.
- Click Time: The time a user had to wait until his "click" was finished (including redirections/frames/images etc.).
- User Bandwidth: The bandwidth a user was able to achieve.
- Sent Requests: Number of requests sent to the server during a period.
- Received Requests: Number of answers received from the server during a period.

For exploring the time used in different HTTP request stages, protocol times were collected and the protocol times graph were drawn in Fig.3. The line of click time is in red. The line of time to first byte is in green. The line of time to connect is in black. The line of time for DNS is in blue. The line of time for local socket is in orange. According to Fig 3., it is summarized that time used by all URLs in HTTP request stages is shorter than 0.01 second. All URLs provide high efficient service in time.

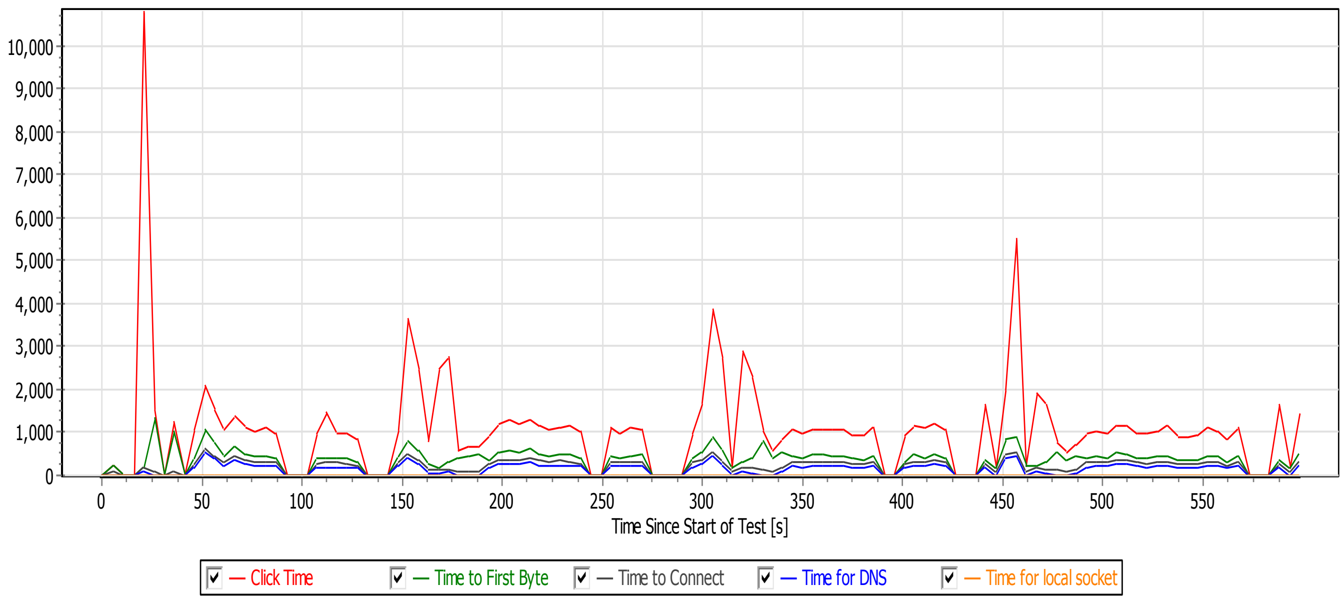

Fig. 3 Protocol times for all URLS

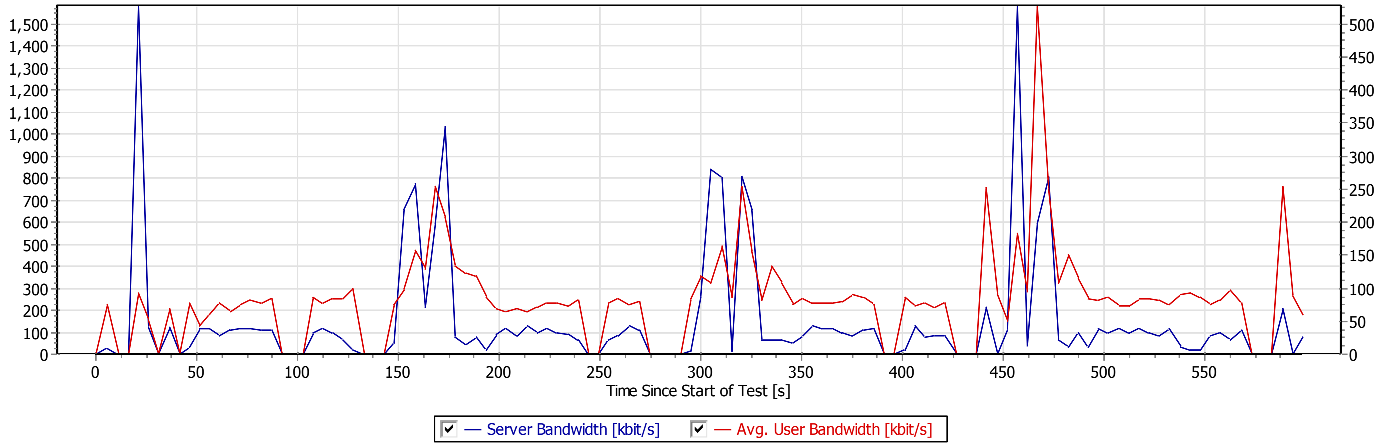

Fig. 4 Server and User Bandwidth

For exploring bandwidth that the server was able to deliver, the server and user bandwidth data were collected for the graph. In Fig. 4., the bandwidth information of server and user are displayed. Based upon Fig. 4., the server provide max bandwidth of 1,600 Kbit/s during the evaluation. User experiences max bandwidth of 520 Kbit/s during the evaluation.

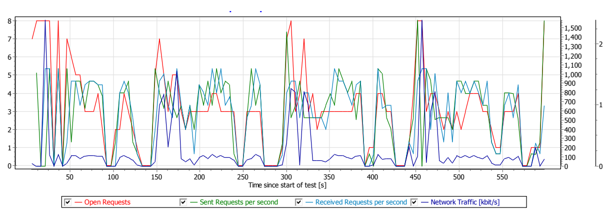

Fig. 5 Open requests and transferred data

For understanding requests upon network traffic, the number of open requests, of sent requests, of received requests, and network traffic were collected and drawn as Fig. 5. In the graph, it was summarized that the bandwidth used by simultaneous requests is less than 1.7Kbit/s. It was summarized that in a local area network with eight learners would use bandwidth of 1.7Kbits/s for this certain learning course.

For exploring the distribution of user wait time for each run in the test, click times were collected for drawing spectrum graph. In Fig. 6, there are three axis:

- Vertical: percentage of users
- Horizontal: user wait time
- Depth: Number of users

Most of users wait for around 2 seconds.

For exploring the hierarchy of each service requested, the page, image, frame, and failed request data were collect to draw the hierarchy graph. Since there is only black arrows for page request and without any red arrow in the Fig. 7., it was summarized that the page response time is quick short and with high efficiency .

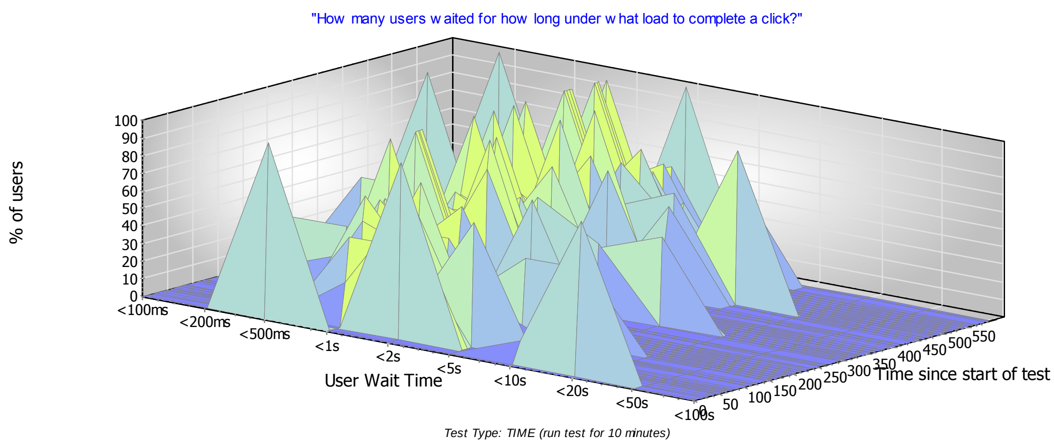

Fig. 6 Spectrum of click times

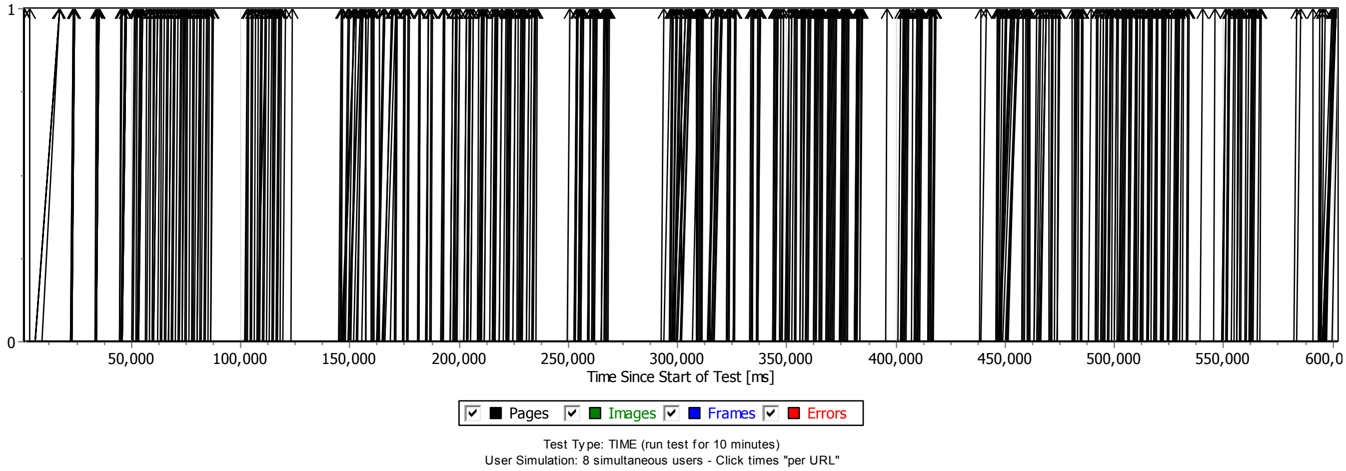

Fig. 7 Hierachy and times of all hits

For identifying the average time a user waited for his/her request to be processed, the hits per second and the users per clicks were collected and drawn. The max average click time is 10 seconds at 30 second in the evaluation procedure. The average click time is less than one.

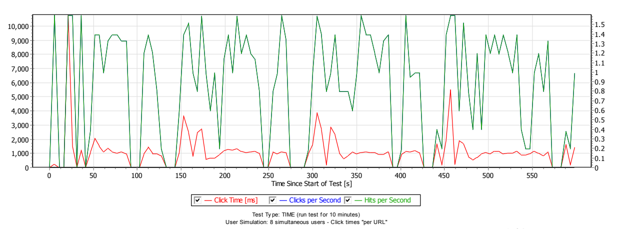

Fig. 8 Click time, hits/s, users/s for all URLs

The max average hits per second are 1.6. Based upon information from Fig. 8, it was summarized that the service quality is well in term of waiting for certain request. The course would not introduce high clicking interaction to users. The message brought by average hits would be too much for users.

For recognizing the time cost and the error of web service, the average times and error rate were collected and presented in the Fig. 9. The line of average response time for each URL is with different color. Most of lines are located under 2 seconds. Only the service of selecting sub-service page would took less than 10 second during the first 25 second of evaluation. After 25 second, the service response time decreases into 4 seconds. There exists no error during the evaluation. Base upon those information revealed from Fig. 9, it was summarized that The overall service is in high efficiency in terms of click response time and error rate.

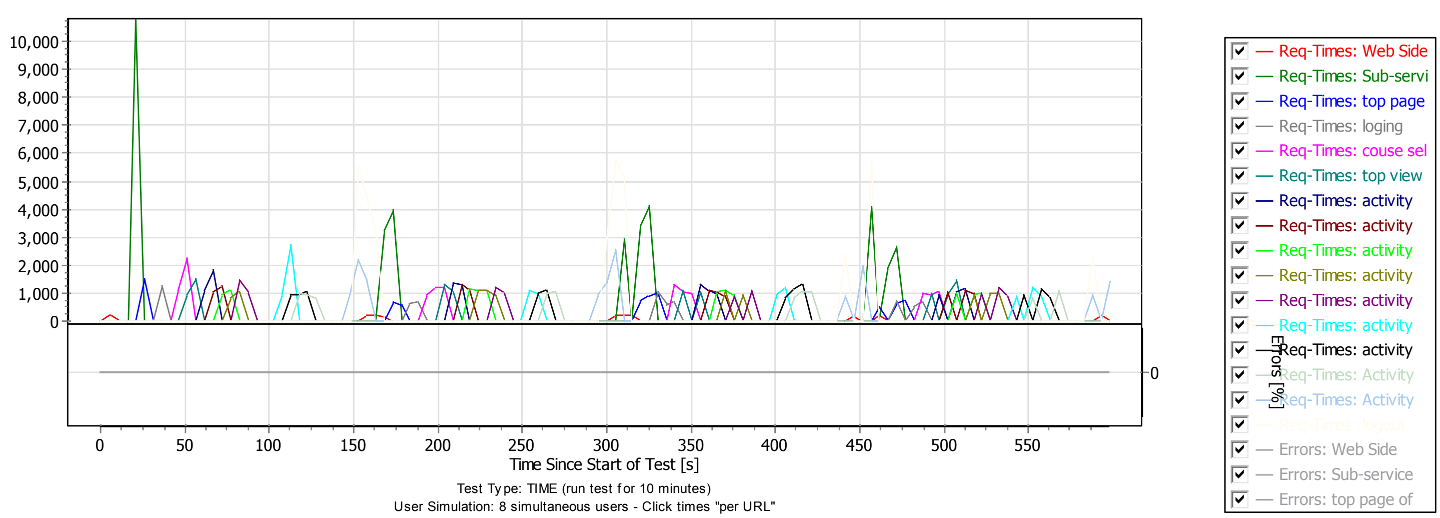

Fig. 9 Click times and errors

IV. CONCLUSION

The results of this study provide an concrete evidence for the feasibility of integrating cloud computing into senior high-school learning. Following the strict learning goal and principles of technology education, the content selecting and learning experience could be ideally organized for fitting into original curriculum.

The results of this study provide an concrete evidence for the feasibility of designing High-Scope technology web-based learning course. Following the strict web-based learning requirement, the content of cloud computing could be ideally organized for fitting into web-based learning environment.

As the finding shown, there are ten lessons in this course. Based upon definitions of green energy technology, this emerging technology become reality and could be further discussed and explained.

The purpose of this study was to design an online course of introducing cloud computing for high-school students in Taiwan. This course is part of formal high education for the technology Education subject. The digitizing course evaluation standard was applied to ensure the virtual learning quality. Based upon the evaluators' consistency, the reliability was reached 0.897. It is concluded that this web-based course is standard qualified.

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