

MW5200 MSC SCIENCE COMMUNICATION PROJECT
Project Report

Does the present usage of Web 2.0 Tools
aid in the communication of Secondary School Science?

Course: MSc (Science Communication)
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Abstract:

This report describes the findings from a project that sought to establish if the present usage of Web 2.0 Tools aid in the communication of secondary school science in Singapore. The project was conducted using surveys administered to teachers and students of secondary schools that conducted science lessons through the use of Web 2.0 Tools. The respondents reported a general trend that the use of these tools does allow for communication, not just between teachers and students, but also between students and students. The respondents also recognize that other 21st Century Skills such as collaboration and technological literacy are developed and sharpened, and hence advantageous in preparation for the students' future needs in the workplace. However, the potential of Web 2.0 Tools as a communication tools has not been fully tapped. Hence this report discusses some possibilities of what students and teachers could do to ease the integration of technology into the science curriculum, as well as to assess the teaching and learning of science and 21st Century Skills.

Introduction:

The MasterPlan for IT (Information Technology) in Education ...

In 1997, RADM Teo Chee Hean, the then Minister for Education and Second Minister for Defence launched The MasterPlan for IT (Information Technology) in Education.

“The underlying philosophy of the MasterPlan is that education should continually anticipate the future needs of society, and work towards fulfilling those needs. The skills required for the future will centre on thinking skills, learning skills and communication skills. IT-based teaching and learning strategies will facilitate the development of these skills in our young as well as open possibilities for designing new curricula and methods of assessment to meet our educational objectives. IT will also enhance the effectiveness of educational administration, and encourage schools to communicate and collaborate with other institutions, and the community at large.”

With the inception of the MasterPlan, students' learning was also to be more engaging through the integration of Information and Communication Technologies (ICT) in the curriculum.

In the past 10 years, there has been significant changes in social trends in which people access, use, and create information and knowledge, and this is “due to the ubiquitous availability of ICT” (Partners in Education Transformation, 2009). As mentioned in the paper by Partners in Education Transformation, (2009):

- The economy has shifted from manufacturing to information and knowledge.
- Information is widely shared - Decision-making is decentralized, work arrangements flexible, collaboration between individuals and across organization.
- Economic success highly is dependent on the ability to communicate effectively, respond flexibly, manage information, work in teams, use technology and produce new knowledge.
- People use the Internet to find jobs, stay in touch with friends and relatives, share photos and videos, do their shopping and manage their travel arrangements.

If education's aim is to anticipate future needs and work towards facilitating the development of essential skills, these trends have significant implications for education. The education system may use ICT ubiquitously for administrative purposes, but it has been slow to respond in terms of collaboration, communication and assessment, with many still mainly pen and paper.

To prepare our students for the future, an initial set of '21st Century Skills' that is aligned to the competencies and skills needed by the 21st century workplace and society, has been identified. Some of these skills are:

- Creativity and innovation
- Critical thinking
- Problem solving
- Communication
- Collaboration
- Information fluency
- Technological literacy

The successful implementation of phase one and two of the MasterPlan for IT in Education has provided Singapore schools with the essential ICT infrastructure and networking systems. To keep up with the changes in the workplace and society, the Ministry of Education has moved into the Third MasterPlan for ICT in Education (2009 – 2014). It is hoped that with this most recent third phrase of the MasterPlan (MOE, 2008),

“ICT will be more extensively integrated into the planning, design and implementation stages of the curriculum, assessment and pedagogy. There will be greater alignment of students’ learning outcomes in the syllabi, national examinations, and classroom experience to 21st century skills such as IT skills, and the ability to communicate persuasively and collaborate effectively. Students will be required to use ICT to look for information, synthesize reports, give feedback on each others’ work and collaborate with peers within and outside school.”

... Involving the use of Web 2.0 Tools ...

The introduction of Web 2.0 brought about the present economical and social trends. So what is Web 2.0? O'Reilly (2005) defines Web 2.0 as "the Web as platform" that enables, among other things, the "harnessing [of] collective intelligence," the "architecture of participation," "rich user experiences" and "remixable data source[s]".

According to Web2forDev (<http://2007.web2fordev.net/web2/glossary-of-web/en/>), Web 2.0:

- allows non-Web designers to put their own content (writing, audio, video, etc.) online easier than ever before.
- makes content more portable than ever and easier to remix, mash together or reuse in a different context.
- utilizes this user-generated content and the economy of scale/ network multiplier effect created to draw valuable connections between related users and content.
- makes the discovery of new content more automated and relevant than ever before.
- has the potential to exponentially increase the amount of information that any of us are able to access, store and recall.

In essence, Web 2.0 is a user-centred platform that has tools that allow more users to utilize as well as create content without the need for technical knowledge or skills (Wesch, 2007). “Web 2.0 is about users and content, instead of just surfing on the Internet. It is also about what the Internet can do for an active collaborator, rather than a passive viewer” (Scott, 2008).

Web 2.0 is supported by Web 2.0 Tools. These tools are applications or services that promote user participation, collaboration and sharing of ideas and information. Some examples of commonly used Web 2.0 Tools are

- Blogs
- Wikis
- Podcasting
- Tagging and Social Bookmarking
- Social Networking
- Multimedia Sharing

According to Anderson (2007), the characteristic of Web 2.0 Tools include:

<i>Categorisation (based on what they attempt to do)</i>	<i>Explanation and indicative links to the big ideas of Web 2.0</i>
Social Networking	Professional and social networking sites that facilitate meeting people, finding like minds, sharing content—uses ideas from harnessing the power of the crowd, network effect and individual production/user generated content.
Aggregation services	Gather information from diverse sources across the Web and publish in one place. Includes news and RSS feed aggregators and tools that create a single webpage with all your feeds and email in one place— uses ideas from individual production/user generated content. Collect and aggregate user data, user 'attention' (what you look at) and intentions—uses ideas from the architecture of participation, data on epic scale and power of the crowd.
Data 'mash-ups'	Web services that pull together data from different sources to create a new service (i.e. aggregation and recombination). Uses, for example, ideas from data on epic scale and openness of data.
Tracking and filtering content	Services that keep track of, filter, analyse and allow search of the growing amounts of Web 2.0 content from blogs, multimedia-sharing services etc. Uses ideas from e.g. data on epic scale.
Collaborating	Collaborative reference works (like Wikipedia) that are built using wiki-like software tools. Uses ideas from harnessing the power of the crowd. Collaborative, Web-based project and work group productivity tools. Uses architecture of participation.
Replicate office-style software in the browser	Web-based desktop application/document tools. Replicate desktop applications. Based on technological developments.
Source ideas or work from the crowd	Seek ideas, solutions to problems or get tasks completed by out- sourcing to users of the Web. Uses the idea of power of the crowd.

Extracted from Anderson, P. Feb. 2007, What is Web 2.0? Ideas, technologies and implications for education, *JISC Technology and Standards Watch*

Web 2.0 technology allows the opportunity of creation of content and self-publication to large audiences to millions of people, enhances the rate and scope at which these content and publications reach audiences, and boosts the prospects for collaboration. Wesch (2007) also noted “the ease of creation and dissemination creates more material for collaboration which feeds back into the loop of creation and dissemination.”

Leveraging on Web 2.0 Tools not only encompasses the usage 21st Century Skills, it also provides an authentic environment for teaching and learning. This is because students are acculturated to digital and cyber technologies and have been accustomed to the habits of seeking and retrieving information from the Internet (Barnes et al, 2007).

... To develop communication skills

“Communication is an overt phenomenon. It occurs, publicly or privately, ...
...between people and whatever has significance to them. It is a dynamic

activity, which means that it changes and evolves as it unfolds. Because it occurs 'between', and is entirely dependent on the 'between' relationship, it cannot be reduced to its components. Thus there is no such things as a message on its own, now such thing as a communicator on his own, no such thing as an audience on its own."

Extracted from Sless, D. and Shrensky, R., *Conversations in a landscape of science and magic: thinking about science communication*

Science communication, be it between scientists and the public, between science teachers and students or even between students studying science, has to be a two-way flow (Gross, 1994). The infusion of Web 2.0 Tools into the science curriculum will not only eliminate the uni-directional approach of traditional classroom teaching, it will encourage feedback from teachers and students, and the focus of science communication will naturally shift to "engagement" (Kim, 2007). With regular feedback, not only will teachers be able to evaluate and assess students' learning, it will also permit teachers to gain feedback in terms of the clarity of their delivery of the lesson.

Method:

The survey

Two separate surveys were carried out:

- A quantitative-qualitative survey of teachers on their pedagogical practices using Web 2.0 Tools and their experiences;
- A quantitative survey of students on their learning experiences using Web 2.0 Tools.

The surveys included structured (fixed responses and scale) and open-ended questions and were developed to find out:

- the respondents' (teachers' and students') usage and proficiency of Web 2.0 Tools;
- the respondents' (teachers') usage of Web 2.0 Tools in their science teaching;
- the respondents' (teachers' and students') experience of using Web 2.0 Tools with respect to 21st Century Skills;
- the respondents' (teachers' and students') experience of using computer-based lessons as compared to traditional classroom lessons;
- the respondents' (teachers') mode of evaluation of learning in their science teaching;
- the respondents' (teachers' and students') attitude towards 21st Century Skills;

Correspondence with the schools was via email, and schools that consented were provided web links to the survey. All participants responded to the survey electronically.

The sample

The samples of teachers and students were from 3 Singapore secondary schools. The selection of the participants was based on the following:

- Comparable schools in terms of academic achievement and were selected using MOE's Achievement Banding of Secondary Schools 2009;
- Co-educational schools;
- Schools that have incorporated Web 2.0 Tools as part of their science curriculum.

Results:

The sample

A total of 175 students and 10 teachers took part in the surveys. Of the 175 students, 51% were females and 49% males, 69% were upper Secondary and 31% lower Secondary. All, but one student, have Internet access from home. Fifty percent of the teachers were female, 80% were aged 40 and below, and 70% had less than 10 years of teaching experience.

Table 1: Demographics of Students

Gender	Female		Male	
	No.	%	No.	%
	90	51	85	49
Present level of studies	Upper Secondary		Lower Secondary	
	No.	%	No.	%
	121	69	54	31
Internet access from home	Yes		No	
	No.	%	No.	%
	174	99	1	1

Table 2: Demographics of Teachers

Gender	Female				Male					
	No.		%		No.		%			
	5		50		5		50			
Age	21 – 30		31 – 40		41 – 50		Above 50			
	No.	%	No.	%	No.	%	No.	%		
	3	30	5	50	1	10	1	10		
Years of teaching	0 – 3		4 – 6		7 – 10		11 – 15		Above 15	
	No.	%	No.	%	No.	%	No.	%	No.	%
	3	30	1	10	3	30	1	10	2	20

Familiarity and Usage of Web 2.0 Tools

General Usage and Proficiency of Web 2.0 Tools

The survey contained questions concerning the familiarity of various Web 2.0 Tools and their usage, and if respondents have uploaded or edited material using these tools. The selection of Web 2.0 Tools represents a range of more commonly used tools by teachers and students.

Table 3: Current status of students in terms of knowledge and usage of Web 2.0 Tools

Students who	have heard of		have used		have uploaded or edited material on	
	No.	%	No.	%	No.	%
Blogs	152	87	108	62	94	54
Wiki	131	75	107	61	48	27
Flickr	103	59	31	18	11	6
YouTube	152	87	143	82	49	28
Google Apps	131	75	105	60	57	33
At least one of the above	161	92	156	89	124	71

Web 2.0 Tools have been around for more than five years, yet knowledge of their existence is not all-pervading. In addition, students lack the technological skills to share information and knowledge as 71% students have uploaded or edited any material using Web 2.0 Tools. This is consistent with Oblinger and Oblinger (2005), that students today are frequent users of the Internet. In addition, students of today also lack information and technical literacy and thinking skills (Branes et al, 2007).

Table 4: Current status of teachers in terms of knowledge and usage of Web 2.0 Tools

Teachers who	are familiar with		have uploaded or edited material on	
	No.	%	No.	%
Blogs	7	70	4	40
Wiki	7	70	5	50
Flickr	4	40	2	20
YouTube	10	100	6	60
Google Apps	5	50	6	60
At least one of the above	10	100	8	80

When respondents were asked to rate their proficiency of the various tools, their confidence is encouraging. The respondents rated the variables on a 5-point scale where 1 denoted 'I'm an expert' and 5 denoted 'I know nothing' to the survey statement.

Table 5: Students' self-rated proficiency of Web 2.0 Tools

	Blogs		Wiki		Flickr		YouTube		Google Apps	
	No.	%	No.	%	No.	%	No.	%	No.	%
1 I'm an expert	15	9	17	10	5	3	34	19	12	7
2	74	42	65	37	24	14	77	44	66	38
3	33	19	38	22	28	16	22	13	36	21
4	12	7	15	9	17	10	14	8	16	9
5 I know nothing	41	23	38	22	92	53	28	16	40	23
Total	175	100	173	99	166	95	175	100	170	97
Mean	2.9		2.9		4.0		2.6		3.0	

Table 6: Teachers' self-rated proficiency of Web 2.0 Tools

	Blogs		Wiki		Flickr		YouTube		Google Apps	
	No.	%	No.	%	No.	%	No.	%	No.	%
1 I'm an expert	1	10	0	0	1	1	2	20	2	20
2	5	50	7	70	3	30	5	50	3	30
3	1	10	2	20	2	20	3	30	3	30
4	2	20	0	0	0	0	0	0	1	10
5 I know nothing	1	10	1	10	2	20	0	0	1	10
Total	10	100	10	100	8	80	10	100	10	100
Mean	2.7		2.5		2.8		2.1		2.6	

Table 7: Teachers' usage of Web 2.0 Tools for science curriculum

Teachers who	have used for science lessons	
	No.	%
Blogs	2	20
Wiki	3	30
Flickr	0	0
YouTube	6	60
Google Apps	2	20

Other Web 2.0 Tools that teachers have used are Moodle, Slideshare and Photobucket.

Teachers are more familiar with Web 2.0 Tools, with 100% teachers familiar with at least one tools compared to 92% of students who have heard of at least one tool. Teachers also have a higher frequency of uploading and editing material on at least one of the tools (students' percentage = 71% compared with teachers' percentage = 80%). In addition, teachers generally rate their proficiency of Web 2.0 Tools better than their students (students' mean = 3.06 compared with teachers' mean = 2.54). However, the teachers very seldom incorporate the use of Web tools in their science lessons.

Many people learn about Web 2.0 Tools in a social context, for keeping in touch with family and friends (social networking sites), to archive or share information about their lives (blogs or multimedia sharing sites), to fuel a hobby (tagging or social bookmarking) or even entertainment (multimedia sharing). Few, however, think of Web 2.0 Tools as a medium for work or study. Like many, teachers may only think of Web 2.0 Tools as a social networking tool and have employed these tools for personal use, rather than a professional working tool.

Another possibility of the low usage of Web 2.0 Tools in science lessons is teachers' misconception of ICT in schools is to have specific software programmes that are specially written for the curriculum. And when in reality these software programmes are hard to come by or requires technical and programming expertise to be involved, teachers simply put off using ICT in their lessons altogether.

Finally, the integration of Web 2.0 Tools into school curriculum is still in its infancy. Teachers have been slow to respond to ICT assimilation as they have had in the last 10 years, been grappling with learning to use the computer for teaching (Microsoft Word and PowerPoint) and administration (Microsoft Excel). And just as they have mastered and feel proficient enough to tackle one application, they now must brave another wave of changes. Teachers have to tweak their mindset, move out of their comfort zone and courageously face another painful step to make changes.

How and Why Web 2.0 Tools were used in Science lessons

Question: For the Web 2.0 Tools you have used, briefly describe how you incorporated the tools in your lesson.

The following are some of the responses from the teachers for the question:

"I used to have a blog where students discuss about the concepts learnt in class."

"Relevant videos on topics in chemistry to be used as introduction to a lesson or for lesson building."

"Embed YouTube videos in PowerPoint slides or website. Show these videos to engage students and to arouse interest in the topic."

"I show the movie clip related to certain concept in science."

"Basic uploading of PowerPoint slides, answers as well as an avenue for students to upload work."

"Useful videos related to chemistry concepts were shown during lessons."

"The students used blogs, wiki and photo sharing websites to obtain, share, store edit and/or submit information for their assignment or project work."

"Mainly video incorporated in lesson teaching, wiki for information."

Some teachers do use Web 2.0 Tools as a platform for communication and collaboration with students through blogs and wikis. However, many of these responses also show that teachers use YouTube for unidirectional purpose and that Web 2.0 Tools were mainly used as replacement medium rather than creative pedagogical use of technology

Students are not required to comment online on the video they watched, but be aroused by the content of the video. The full potential of using Web 2.0 Tools to communicate, in terms of providing information as well as receiving feedback, is not reached.

Teachers, being new to the terminology, describe using "wiki for information". Wiki is a social platform, a group of web pages, that allows users to add content, but also allows others to edit content. It is used to build and exchange information through collaborative effort. So in this instance, Wikipedia could have been what she was referring to.

Question: Why did you decide to use Web 2.0 Tools?

The following are some of the responses from the teachers for the question:

"Ease of sharing information."

"For more collaboration and self-directed learning. Allowing the students to have a 'voice', to build confidence in their learning."

"Easy to use, students like them."

"Some of the demonstrations are too dangerous and cannot be carried out in school."

"Convenient and reach most students (those who have Internet access at home)"

"I think I teach less and students learn more (skills on top of content). Students are also trained to be thinkers ..."

"For ease of dissemination and retrieval of information and graphics. Common database is easily accessible by Internet by every student. [Web tools] enable permanent record of work, contributions of individual students in a group to be indentified, the group dynamics and work attitude to be tracked e.g. consistent / last minute, and students' progress and growth over time e.g. wiki history page."

Teachers do recognize and appreciate the ease at which information is made accessible through the Internet, especially when most of the students have Internet access from home. However, teachers are simply using Web 2.0 Tools for dissemination. Teachers have not utilized the full potential of Web 2.0 Tools, as one respondent noted, in which "contributions of individual students in a group [can] be indentified, the group dynamics and work attitude

[can] be tracked e.g. consistent / last minute and students' progress and growth [can be monitored] over time e.g. wiki history page.”

Using Web 2.0 Tools to develop 21st Century Skills

The perceptions of the use of Web 2.0 Tools by both teachers and students are optimistic. Students generally view the use of Web 2.0 Tools as being advantageous in promoting creativity, communication, collaboration and technology literacy.

When respondents were asked if the various web tools developed their skills, their reaction is generally positive. The respondents rated the variables on a 5-point scale where 1 denoted 'Strongly Agree' and 5 denoted 'Strongly Disagree' to the survey statement.

Creativity and Innovation

Both teachers and students equally believe that creativity and innovation can be developed with the use of Web 2.0 Tools.

Table 8: Students' View of Web 2.0 Tools for Developing Creativity and Innovation

Using Web 2.0 Tools for my Science lessons have allowed me to

	display creativity	
	No.	%
1 strongly agree	20	11
2	79	45
3	61	35
4	8	5
5 strongly disagree	6	3
Total	174	99
Mean	2.4	

Table 9: Teachers' View of Web 2.0 Tools for Developing Creativity and Innovation

Using Web 2.0 Tools for my Science lessons allowed my students to

	display creativity	
	No.	%
1 strongly agree	0	0
2	6	60
3	3	30
4	0	0
5 strongly disagree	0	0
Total	9	90
Mean	2.3	

Communication

Both teachers and students believe that there is communication with the use of Web 2.0 Tools, especially in discussion beyond the classroom. However, they do not feel that Web 2.0 Tools used have allowed for them to handle disputes with classmates.

An interesting view that surfaced is how none of the teachers disagreed that usage of Web 2.0 Tools increased students' communication with teachers or eased clarification of doubts. However, there was a significant number of students (12% and 13%), felt that the use of Web 2.0 Tools did not improve students' communication with teachers or eased clarification of doubts.

The difference may be due to the perception teachers get from interacting with a handful of students. It is often a difficult task for teachers to individually communicate and assess each and every student in a class. More often than not, teachers obtain feedback through a sampling of students and these students may be the one who are naturally more outspoken and tend to question and clarify doubts using their initiative. As such, teachers' evaluation may just be based on a significant minority who have responded, and may not be the view of the quieter majority.

Table 10: Students' View of Web 2.0 Tools for Communication

Using Web 2.0 Tools for my Science lessons allowed me to

	handle disputes with classmates		communicate more with classmates		communicate more with teachers		air views with ease	
	No.	%	No.	%	No.	%	No.	%
1 strongly agree	15	9	29	17	22	13	22	13
2	64	37	85	49	82	47	68	39
3	71	41	46	26	50	29	74	42
4	15	9	5	3	10	6	4	2
5 strongly disagree	9	5	9	5	10	6	5	3
Total	174	99	174	99	174	99	173	99
Mean	2.6		2.3		2.4		2.4	

	communicate in a way that others understand		participate in discussions beyond the classroom		clarify doubts with ease	
	No.	%	No.	%	No.	%
1 strongly agree	26	15	31	18	25	14
2	86	49	90	51	75	43
3	50	29	40	23	51	29
4	6	3	5	3	17	10
5 strongly disagree	5	3	6	3	6	3
Total	173	99	172	98	174	99
Mean	2.3		2.2		2.4	

Table 11: Teachers' View of Web 2.0 Tools for Communication

Using Web 2.0 Tools for my Science lessons allowed my students to

	handle disputes with classmates		communicate more with classmates		communicate more with teachers		air views with ease	
	No.	%	No.	%	No.	%	No.	%
1 strongly agree	1	10	2	20	1	10	0	0
2	2	20	5	50	6	60	5	50
3	5	50	1	10	2	20	4	40
4	1	10	1	10	0	0	0	0
5 strongly disagree	0	0	0	0	0	0	0	0
Total	9	90	9	90	9	90	9	90
Mean	2.7		2.1		2.1		2.4	

	communicate in a way that others understand		participate in discussions beyond the classroom		clarify doubts with ease	
	No.	%	No.	%	No.	%
1 strongly agree	0	0	3	30	1	10
2	4	40	5	50	6	60
3	5	50	1	10	2	20
4	0	0	0	0	0	0
5 strongly disagree	0	0	0	0	0	0
Total	9	90	9	90	9	90
Mean	2.6		1.8		2.1	

Collaboration

Web 2.0 Tools enhance collaborative opportunities, which in turn amplify the opportunities for communication. At the same time, collaboration skills, like showing respect for ideas and opinions of others, appreciate the importance of teamwork and being aware of the progress of the team, are developed through the use of Web 2.0 Tools. Most importantly, it surfaced to the students the importance of taking responsibility of one's own share of work.

Table 12: Students' View of Web 2.0 Tools for Collaboration

Using Web 2.0 Tools for my Science lessons allowed me to

	collaborate with classmates		show respect for ideas and opinions of others		appreciate the importance of teamwork		be aware of the progress of the team		be aware of the contributions of team members	
	No.	%	No.	%	No.	%	No.	%	No.	%
1 strongly agree	28	16	30	17	37	21	38	22	41	23
2	89	51	86	49	84	48	82	47	74	42
3	47	27	50	29	38	22	46	26	50	29
4	4	2	1	1	9	5	2	1	2	1
5 strongly disagree	6	3	6	3	6	3	6	3	6	3
Total	174	99	173	99	174	99	174	99	173	99
Mean	2.3		2.2		2.2		2.2		2.2	

	take responsibility for my own share of work		learn from teachers		learn from peers		learn beyond the classroom	
	No.	%	No.	%	No.	%	No.	%
1 strongly agree	38	22	26	15	32	18	36	21
2	90	51	89	51	86	49	92	53
3	39	22	50	29	45	26	39	22
4	1	1	3	2	5	2	2	1
5 strongly disagree	6	3	5	2	6	3	5	2
Total	174	99	173	99	174	99	174	99
Mean	2.1		2.3		2.2		2.1	

Table 13: Teachers' View of Web 2.0 Tools for Collaboration

Using Web 2.0 Tools for my Science lessons allowed my students to

	collaborate with classmates		show respect for ideas and opinions of others		appreciate the importance of teamwork		be aware of the progress of the team		be aware of the contributions of team members	
	No.	%	No.	%	No.	%	No.	%	No.	%
1 strongly agree	2	20	0	0	1	10	1	10	2	20
2	6	60	5	50	4	40	3	30	1	10
3	0	0	4	40	4	40	5	50	5	50
4	1	10	0	0	0	0	0	0	0	0
5 strongly disagree	0	0	0	0	0	0	0	0	0	0
Total	9	90	9	90	9	90	9	90	8	80
Mean	2.0		2.4		2.3		2.4		2.4	

	take responsibility for their own share of work		learn from teachers		learn from peers		learn beyond the classroom	
	No.	%	No.	%	No.	%	No.	%
1 strongly agree	2	20	0	0	0	0	3	30
2	3	30	6	60	6	60	5	50
3	4	40	3	30	3	30	1	10
4	0	0	0	0	0	0	0	0
5 strongly disagree	0	0	0	0	0	0	0	0
Total	9	90	9	90	9	90	9	90
Mean	2.2		2.3		2.3		1.8	

Technological Literacy

According to Hayden (1989),

“Technological literacy is having knowledge and ability to select, properly apply, then monitor and evaluate appropriate technology given the context.”

As discussed earlier, both teachers and students have sufficient technological literacy in the social context as many have heard and used a variety of Web 2.0 Tools. These skills will allow them to communicate effectively and efficiently as global citizen who are not restricted

by where they are. However, their skills are limited to end-user skills of viewing, seldom uploading or editing.

The usage of Web 2.0 Tools in science lessons has not only increased teachers' and students' repertoire of information technology skills, but also improved existing one. However, responses show a difference in perception between teachers and students. What do students consider IT skills? What is the expectation of improvement? These two questions may not yield similar answers from teachers and students. Teachers have to know what their students are capable of and the variance in terms of IT competency to more accurately evaluate the degree of learning their students have achieved.

Table 14: Students' View of Web 2.0 Tools for Technological Literacy

Using Web 2.0 Tools for my Science lessons allowed me to

	pick up more IT skills		hone IT skills	
	No.	%	No.	%
1 strongly agree	41	23	33	19
2	77	44	79	45
3	47	27	53	30
4	2	1	2	1
5 strongly disagree	6	3	6	3
Total	173	99	173	99
Mean	2.2		2.2	

Table 15: Teachers' View of Web 2.0 Tools for Technological Literacy

Using Web 2.0 Tools for my Science lessons allowed my students to

	pick up more IT skills		hone IT skills	
	No.	%	No.	%
1 strongly agree	3	30	2	20
2	5	50	6	60
3	1	10	1	10
4	0	0	0	0
5 strongly disagree	0	0	0	0
Total	9	90	9	90
Mean	1.8		1.9	

Engagement in learning

Effective communication will result in engagement. Because communication is a two-way process, engagement comes naturally when there is constant reflection and feedback. This in turn will result in students being more inquisitive and yearning to find out more.

Worthy of note is that all the teachers surveyed felt that students learn science better, learn more science than required and want to learn more science using Web 2.0 Tools. However, students do not feel that the use of Web 2.0 Tools have engaged them sufficiently, as only slightly more than half felt that they learn science better (60%), learn more science than required (59%) or want to learn more science (57%). In addition to this, a slight difference in view point between teachers and students is that teachers believe that students have the tendency to learn beyond the classroom, while students do not perceive so.

The difference in perception could be a result of teachers' mistaken belief of students' affinity to the computer and the Internet. This could, in turn, be a result of mass media's overrating the 'IT-savviness' of today's students. Students do not learn just because the computer or

the Internet is used, they still have to be interested or enticed to learn by the contextualizing of content so that they value the relevance of their world.

Students often do not realize how much is enough in terms of the content in the syllabus. Students will assume that as long as the teacher covers a set of content in class, they are expected to learn and thus regard everything taught or mentioned as within expectation of the syllabus. They are often not aware of the boundaries of the syllabus. Teachers, on the other hand, have a very clear idea of how much information students are required to know. In teaching a scientific concept, teachers often use an assortment of examples to help students appreciate the relevance of the concept. These examples would include situations found in everyday life or the industry. These examples, to teachers, would constitute to learning beyond the classroom, but to students, any content learnt in class will not be considered learning beyond the classroom. Hence, the difference in response may simply be due to the lack of awareness or communication of expectation by the teachers to the students.

To reduce this ambiguity, some form of calibration of expectation needed between teachers and students. This could be done by creating awareness to the degree of understanding or the extent of appreciation students are required to have contextually.

Table 16: Students' View of Web 2.0 Tools for Engagement in Learning

Using Web 2.0 Tools for my Science lessons allowed me to

	learn science better		learn more science than required		want to learn more science		understand how science is related to everyday life		be more independent	
	No.	%	No.	%	No.	%	No.	%	No.	%
1 strongly agree	28	16	32	18	34	19	30	17	39	22
2	77	44	71	41	66	38	82	47	85	49
3	57	33	54	31	58	33	52	30	42	24
4	4	2	8	5	10	6	3	2	1	1
5 strongly disagree	8	5	9	5	6	3	7	4	5	3
Total	174	99	174	99	174	99	174	99	172	98
Mean	2.4		2.4		2.4		2.3		2.1	

	learn beyond the classroom	
	No.	%
1 strongly agree	36	21
2	92	53
3	39	22
4	2	1
5 strongly disagree	5	2
Total	174	99
Mean	2.1	

Table 17: Teachers' View of Web 2.0 Tools for Engagement in Learning

Using Web 2.0 Tools for my Science lessons allowed my students to

	learn science better		learn more science than required		want to learn more science		understand how science is related to everyday life		be more independent	
	No.	%	No.	%	No.	%	No.	%	No.	%
1 strongly agree	0	0	4	40	1	10	2	20	1	10
2	9	90	5	50	8	80	5	50	8	80
3	0	0	0	0	0	0	2	20	0	0
4	0	0	0	0	0	0	0	0	0	0
5 strongly disagree	0	0	0	0	0	0	0	0	0	0
Total	9	90	9	90	9	90	9	90	9	90
Mean	2.0		1.6		1.9		2.0		1.9	

	learn beyond the classroom	
	No.	%
1 strongly agree	3	30
2	5	50
3	1	10
4	0	0
5 strongly disagree	0	0
Total	9	90
Mean	1.8	

Evaluation of effectiveness of Web 2.0 Tools used

Question: How do you evaluate the effectiveness of the use of Web 2.0 Tools?

The following are some of the responses from the teachers for the question:

“By assessing the number of correct answers to questions based on the videos.”

“Attempts on quizzes, scores, chats / forums.”

“It’s how you use it, how you plan your lesson around it. Can be extremely effective.”

“On a scale of 1 to 10, I will give it a score of 7.”

“We have conducted a survey / questionnaire and responses were good.”

Teachers readily endorse the effectiveness of Web 2.0 Tools, however these tools are rarely formally or directly evaluated. Teachers’ evaluation was relatively vague and they did not manage to provide concrete evidence or examples to show its efficacy. Evaluation was likely done indirectly and informally through the teachers’ professional judgement after lessons or during classroom discussions.

Furthermore, the teachers’ responses reflect solely the use of Web 2.0 Tools in aiding the acquisition of content or measuring academic achievements. Responses for the evaluation of acquisition or competence of intrinsic skills such as 21st Century Skills of communication, collaboration or even technological literacy, however, were not evident. This may be the

result of the strong emphasis of academic achievement for subject content, but not intrinsic competencies or skills needed for the 21st century workplace or society.

Evaluation of learning with use of Web 2.0 Tools

Question: How do you evaluate if learning has taken place with the use of Web 2.0 Tools?

The following are some of the responses from the teachers for the question:

“By assessing the number of correct answers to questions based on the videos.”

“Through short quizzes, and write-ups. Make [the students] do comparisons, analogies, probe deeper thinking that is beyond the usual questions outlined in the syllabus.”

“By looking at the quality of discussion made by students..”

“Pen and paper assessment, exercises, oral questioning.”

“Work submission or quiz”

“Give new context / problem, is students can show transfer of learning, then students have understood, become better thinkers and have picked up skills involved in problem-solving.”

It is evident from the comments of the teachers that content knowledge is the foundation of assessment and is still very much reliant on traditional pen and paper methods. In other words, assessment of learning is the predominant form. Although there is evidence of problem solving and critical thinking skills being assessed, it is regrettable that none of the teachers verified if their students picked up creativity, communication, or collaboration skills

Computer-based Lessons versus Traditional Classroom Lessons

There is also misconception amongst the teachers surveyed that computer-based lessons are more effective in helping students understand science concepts. In fact, only 64% of the students felt that computer-based lessons aid students' understanding science concepts. This again would probably stem from the false impression of students learning better with computer and the Internet as discussed earlier.

In spite of this, only 50% of teachers feel that students learn from teachers more effectively in computer-based lessons compared to 59% of students feel that they learn from teachers more effectively. Teachers still feel that they are essential for learning to take place. Teachers also feel that traditional lessons are better in allowing students to apply science concepts. This may be because traditional lessons are more efficient in providing a variety of examples to contextualize or apply concepts learnt in new situations in a short time frame. Traditional lessons would also provide the opportunity for immediate dialogue between teachers and students to discuss different possibilities.

Additionally, a high percentage of teachers (80%) and students (63%) felt that learning from peers through computer-based lessons were more effective than traditional lessons. This is possible as Web 2.0 Tools allows for asynchronous online learning where participants have the luxury of contributing and learning at their convenience because information provided by other are archived and readily available, even if the creator of the content is not online.

Table 18: Students' views on computer-based lessons compared to traditional classroom lessons

I feel computer-based lessons are more effective than traditional lessons in

	earning science concepts		understanding science concepts		applying science concepts		learning from teachers		earning from peers	
	No.	%	No.	%	No.	%	No.	%	No.	%
1 strongly agree	38	22	36	21	35	20	26	15	34	19
2	72	41	75	43	67	38	77	44	77	44
3	53	30	48	27	56	32	55	31	49	28
4	10	6	11	6	13	7	12	7	9	5
5 strongly disagree	2	1	5	3	4	2	5	3	5	3
Total	175	100	175	100	175	100	175	100	174	99
Mean	2.2		2.3		2.3		2.4		2.3	

Table 19: Teachers' views on computer-based lessons compared to traditional classroom lessons

I feel computer-based lessons are more effective than traditional lessons in

	earning science concepts		understanding science concepts		applying science concepts		learning from teachers		earning from peers	
	No.	%	No.	%	No.	%	No.	%	No.	%
1 strongly agree	1	10	1	10	0	0	1	10	1	10
2	7	70	9	90	5	50	4	40	7	70
3	2	20	0	0	3	30	5	50	1	10
4	0	0	0	0	1	10	0	0	1	10
5 strongly disagree	0	0	0	0	0	0	0	0	0	0
Total	10	100	10	100	9	90	10	100	10	100
Mean	2.1		1.9		2.6		2.4		2.2	

Skills needed by students for their future

Teachers and students recognize that 21st Century Skills such as communication, collaboration and technological literacy are equally important for the future. However, the difference in extent of importance between teachers and students is not significant.

Table 20: Students' views on skills needed by students for their future

	IT skills are essential for students today for their future.		The ability to communicate and collaborate effectively are essential for students today for their future.	
	No.	%	No.	%
1 strongly agree	72	41	77	44
2	44	25	37	21
3	25	14	29	17
4	16	9	21	12
5 strongly disagree	18	10	10	6
Total	175	100	174	99
Mean	2.2		2.1	

Table 21: Teachers' views on skills needed by students for their future

	IT skills are essential for students today for their future.		The ability to communicate and collaborate effectively are essential for students today for their future.	
	No.	%	No.	%
1 strongly agree	4	40	6	60
2	3	30	2	20
3	0	0	0	0
4	0	0	1	10
5 strongly disagree	1	10	1	10
Total	8	80	10	100
Mean	1.9		1.9	

Limitations:

The most significant limitation is the teacher's expectation of the extent in which Web 2.0 Tools were used. The extent of students' involvement and participation is dependent on the teachers' instruction for the lesson. In other words, the teacher may simply require students to post a blog but does not require students to comment on fellow classmates' blog. This would reduce the channels for communication.

Another limitation is that measures used in this study are self-reported data. The baseline on which comparison is made depends on the openness of the respondents. In this aspect, the perceptions of students and teachers may differ due to the students' and teachers' individual expectation.

Finally, the learning community environment, in terms of the school environment and culture, also influences the level of engagement, participation, learning and personal development of the student respondents.

What needs to be done:

Students must appreciate the importance of 21st Century Skills

Students have to recognise that technological fluency, communication and collaboration are essential skills, not just in the 21st century workplace, but for social interaction as well. With the industrial transformation from technology-intensive in the 1990s to knowledge-intensive in the 2000s, we are now moving forward into one that is innovation-intense.

“Many educators believe that specific knowledge will not be as important to tomorrow’s workers and citizens as the ability to learn and make sense of new information.” ~ D. Gough, Educator, 1991

As such, students must cultivate essential life skills that allow for them to deal with a rapidly changing world. Skills like technological literacy will facilitate students in being critical in deciding and selecting appropriate information and technology, to communicate effectively or accomplish a task.

Students ought to know their potential, and it is essential for them to know where and how far they need to go, and consequently they can decide how best they can get there. This is ‘Assessment AS Learning’. Education has a role in preparing our students in knowing what future employers expect of them and in turn, allow students to take responsibility of their learning. Teachers can facilitate this learning by monitoring their students’ progress, even getting the students’ to track their own progress, when using Web 2.0 Tools for discussions, assignments and project work. Checklists could be used in this instance to guide the tracking and monitoring process.

Teachers’ attitude and beliefs must change

According to Hennessy (1985),

“Beliefs are anything that the individual thinks is, might be, or ought to be. Individual’s beliefs are mostly descriptive or pragmatic. Attitudes are tendencies to respond to objects in predisposed ways. They are organized because they are based on patterned beliefs, and have their origin in what has experienced or have been taught. And in the presences of appropriate stimuli they lead to action unless other attitudes or inhibitory forces intervene.”

Sandholtz, Ringstaff, and Dwyer (1997) agreed that teachers demonstrated change in instruction and beliefs when they had exposure to “alternative belief systems and experience positive consequences of those alternatives”.

These positive experiences can be brought about formally through professional development courses or informally teachers’ sharing. However, whether formally or informally, these experiences have to be content-based and subject specific (Hughes, 2005). Hughes believed that teachers who learn about technology from a content perspective might be more likely to use it to support content learning, whereas teachers who learn it as a skill may have greater difficulty using the technology for educative purposes. This has implications to how future teacher professional development courses and sharing of best practices should be organized.

Contrary to popular belief, teachers with more teaching experience have an added advantage in the integration of technology into the curriculum as they in a better position to use their knowledge of the subject content, curriculum to quickly assess or decide how

technology can best support pedagogy. However, it is this group of teachers, that were not born into the 'Net Generation' that is most likely to resist change.

Seeing computers and the Internet as part of the classroom furniture, as we have seen books and whiteboards, is a normalization process that teachers have to go through. Only with this normalization, will teachers stop viewing technology as extras and use it like how we have used textbooks (Motteram and Sharma, 2009).

If education were to prepare students for the future, the demands of society in terms of social and technological norms cannot be ignored. Schools need to emulate society and students have to be equipped with technological skills, not only for future professional practice, but also for personal use and social interaction.

Changes to Pedagogy

Teachers traditionally depend very much on textbooks that are written according to the curriculum syllabus. This relieves the teacher of the selection process needed with internet-based lessons. Crafting of new performance task that incorporates the use of the internet and Web 2.0 Tools requires teachers to rely on their knowledge of the syllabus to sieve through numerous available websites to select relevant ones for classroom used, and knowledge of their students, to choose a theme that enables a project that encompasses enough content to allow the project to last a significant duration for collaboration and creativity to surface (Wallace, 2004).

Teachers have to overcome the fear of working outside their comfort zone, in terms of broader and sometimes unfamiliar context and content, to incorporate content-based technological pedagogy. As Wallace (2004) aptly describes,

“The very things that make the internet desirable, also lead to routine encounters with unfamiliar content: it is up-to-date, responsive to change, wide-ranging, and at the same time, it is unreliable, unpredictable and changing. For the teacher, this could mean dealing with new content at unexpected times and in expected ways.”

In this light, teachers have to be provided with ample opportunities for subject-specific content-based professional development and sharing to learn from others, or to discuss with colleagues on how to best tackle these unfamiliarity. They also require the support of school administration to facilitate in scheduling these sharing sessions, in addition to the availability of technical support.

Integration of Web 2.0 Tools should be technology functioning as transformation, rather than simply replacement or amplification (Hughes, 2005). Hughes explained that using technology replacing is just a different means to the same instructional end and technology as amplification is technology's ability to complete task more efficiently and effectively. Using technology as replacement and amplification is not what Web 2.0 advocates intended. Instead, Web 2.0 Tools should be technology functioning as transformation, “to change students' learning routines to include problem solving, or teachers' instructional practices and roles in the classroom” (Hughes, 2005). It does not need a complete overhaul of the curriculum, it can simply be infusing a small segment that includes using a video or photo found on a Web 2.0 webpage, and getting the students to make use of their understanding of their science concept learnt to comment or explain what they observe within the 'Comments' box on the webpage.

Web 2.0 Tools enables innovative technology pedagogy, which can be demonstrated through blended learning (Motteram and Sharma, 2009). This means lessons are crafted to

combine of a range of web tools, from text (e.g. Google Docs, blogs, wiki) to visual (e.g. YouTube, Skype) and even aural (e.g. podcast), or be a combination of traditional face-to-face with technology.

Web 2.0 advocates promote its use because

- Technology connects the classroom to the real world (Motteram and Sharma, 2009). Students have to be engaged in authentic and genuine activities and material to appreciate the content that they learn. This allows contextualization so that students understand the value of the knowledge they acquire.
- Communication, via online learning, encourages reflection and higher-order thinking. It is because online learning essentially requires written communication, a process that requires interpreting and constructing meaning, in addition to putting across clear and concise comments and responses.
- Asynchronous online learning has the “ability to provide collaborative learning experiences at the conveniences of the individual” (Garrison, 2003). It is the connectivity of being online that offers the opportunity of collaboration, which in turn supports the formation of learning communities.
- Learning communities can facilitate students’ engagement in educationally purposeful activities inside and outside of the classroom. According to Zhao and Kuh (2004), students will have “greater gains in intellectual and social development, higher persistence rates, and take more responsibility for their own learning instead of being a passive receiver of information.”

Technological integration also provides opportunities for teachers to teach intrinsic ICT literacy skills such as safety and security, privacy and confidentiality, intellectual property and copyright policies, in addition to the social responsibility of respecting social and cultural differences in the virtual world in the face of globalization and internationalization (Moll and Krug, 2008).

Assessment of 21st Century Skills

With the science lessons that were carried out, many teachers fell back on traditional methods: the testing of content with pen and paper assessments. This however, does not make full use of the potential of Web 2.0 Tools that allow online interactions.

This may be due to the fact that beyond classroom learning, all other major assessments that contribute to the advancement of students from one level to the next is based on content knowledge and is on paper.

This should not be the case, as noted by Herman and Knuth (1991),

“Assessment data effects students advancement, placements, and grades, as well as decisions about instruction strategies and curriculum.”

Assessment of students’ knowledge and skills in communication, collaboration and other 21st Century Skills cannot be done with traditional forms of assessment. Presently, the most common form of assessing presently is through feedback and surveys that are self-perception and self-reported data. This hopefully will change in the future as studies have

started on how 21st Century Skills have and can be assessed accurately. This is definitely a challenge for education professionals to tackle.

There are different forms of assessment. As mentioned earlier, with technology, 'Assessment AS Learning' could be one way. Having a desired outcome as target, students track the advancements of skills the students make through monitoring, for example, online participation, quality of comments and responses or even, proficiency of technological literacy. This method of assessment places the responsibility of learning on the students to decide the route and rate at which they want to achieve their target.

Teachers, on the other hand, should practise 'Assessment FOR Learning', where teaching and learning is expected to be interactive and for teachers to be reflective practitioners. For teaching and learning to be interactive, there must be a two-way communication, and Web 2.0 Tools provide a range of different ways of interaction to suit students' preferred mode of learning. With interaction, teachers would be able to assess students' learning and adapt their teachings to meet the needs of the students.

There are also different modes of assessment. This includes ways that could be conducted via Web 2.0 Tools, like discussions and reflective writing. There are also traditional forms of classroom assessment like observation or written evaluation. It is also important to note that changes must be made to the present individualized modes of assessment so that collaboration can be assessed. The vast range of assessment methods through the use of Web 2.0 Tools allow teachers to decide to best way of collecting evidence for students' learning, not just in content but also for essential 21st Century Skills.

Conclusion:

The Ministry of Education recognized that for Singaporeans to move confidently into the 21st Century, schools have to prepare our students to embrace globalization. Globalization encompasses linking people through communication and collaboration, and communication and collaboration channels and tools like Web 2.0 make possible its realization. Web 2.0 and its tools not only permits communication of the masses, it allows students to contextualize and understand their role as global citizens.

Teachers and students are significantly proficient in their knowledge of various forms of Web 2.0 Tools and are regularly using these tools in the social context. However in the education arena, the present use of Web 2.0 Tools is restricted to the use of technology as replacement of past practices. It is used as a dissemination tool and the present use does not promote communication. These underutilizations of the potential of Web 2.0 Tools may be a consequence of not appreciating the connotation of communication and not understanding the capabilities of the tools.

One issue to tackle is the difference in perception between teachers and students. In order for a more accurate measurement of how teachers and students rate the usefulness of Web 2.0 Tools, there must be calibration of standards to ensure equal basis of comparisons. Various methods of assessments with standard rubrics should be developed to help teachers not only to measure students' competencies of 21 Century Skills accurately, but also to reflect the situation correctly.

To produce a transformation that policy makers and researchers advocate, teachers have to recognize that changes in mindset and culture of the classroom are inevitable, and should hence, adopt a learning stance towards the integration of technology. School administration can provide assistance through technical support and scheduling sessions for teachers to share or discuss how different approaches can be used to bring out the potential of using Web 2.0 Tools effectively and efficiently. Teachers and students must also recognise that 21st Century culture is about linking people electronically, both professionally and socially, and this involves collaboration, that requires communication to result in engagement. In addition, a responsible global citizen has to be aware and accountable for social and cultural aspects, and moral and ethical issues regarding the use of information and communication technology.

Using Neil Armstrong's first words, as he became the first man on the moon, "One small step for man, one giant leap for mankind." Teachers must take that one small step to initialize the changes needed to educate our students to be global citizens, to be equipped with skills that not only help them deal with the present, but skills that will see them through their lifetimes.

"The illiterate of the 21st century will not be those who cannot read and write, but those who cannot learn, unlearn, and relearn." ~Alvin Toffler

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