USING TECHNOLOGY TO ENHANCE LEARNING OF DIGITAL VIDEO BROADCASTING (DVB)

Eva Rosdiana, Chua Beng Koon
Ngee Ann Polytechnic

ABSTRACT

To appreciate the technology behind the Digital Video Broadcast (DVB) system, its differences with the analogue system, and the additional features that can be supported, some level of understanding of the concepts and terminologies defined in the DVB standard is required. The challenge is that these concepts are typically very theoretical and dry. Students often find the concepts hard to visualize. Practical sessions were conducted using a real DVB system to demonstrate the process of preparing video and audio signals for broadcasting. However, as students listened (largely passively) and observed the instructors demonstrating the operation, the impact on their learning was limited. Many still could not answer the basic questions related to the DVB system posted at the end of the lesson.

In 2003, we launched a project to re-design the DVB practical lesson. The module development team set two main objectives for their task; to encourage active participation by providing students with hands-on experience, and to enhance students' understanding of the important concepts behind DVB technology. To achieve the objectives, all students needed to be involved in the whole process of digital video broadcast; from pre-broadcast processing which involves the preparation of the raw video and audio footage for transmission, to actual broadcast through sending the processed signal to a DVB transmitter, and finally tuning the receiver to verify if the broadcast is successful. Using an existing commercial DVB system would be too costly and impractical. The team therefore decided to leverage on NP's mobile e-learning platform and built two of the systems in-house; a Pre-Broadcast Signal Processing Software module, and Transport Stream Analyzer software. These software modules not only perform functions similar to commercial broadcast equipment, they also contain additional features that are designed specifically for learning purposes. The customized software modules could be installed on every student's notebook allowing them to perform their own pre-broadcast processing. Students were now able to work independently at their own pace, creating different programs and sending them for broadcast using the transmitter. In the process, students got to troubleshoot and solve problems, and as a result strengthen their understanding of the concepts behind DVB technology. To help students relate what they have learnt to real systems, the newly designed practical lesson also required students to record and analyze the engineering information carried within the programs broadcast by MediaCorp using the Transport Stream Analyzer. This encouraged students to explore beyond the scope of their curriculum. They showed greater enthusiasm and were motivated to find out more when discrepancies were found in the live broadcast from MediaCorp.

The re-designed practical lesson and the use of customized software had significant impact on students' learning. They were more active during practical sessions and had demonstrated deeper understanding of the concepts involved. This is evidenced by the fact that while the assessments have become more challenging, students have been able to demonstrate their competence.

KEYWORDS

Technology-enhanced learning, active learning, experiential learning.

INTRODUCTION

"Digital Audio Video Technology" (DAVT) is a 3rd year elective module offered by Ngee Ann Polytechnic's School of Engineering under the Diploma of Electronics and Computer Engineering. This module is applied in nature with an aim to provide students with the latest developments in Digital Audio and Video Technology namely, Digital Audio & Video Broadcast systems, data and transmission. One key learning outcome of this module is to develop students with the ability to apply their knowledge and skills to real engineering situations.

Like most traditional engineering modules, DAVT adopted a lecture-tutorial-practical approach with lesson designs that are essentially teacher and content-centered. But in recent years we have observed students lack in-depth knowledge in this topic. Many could recall definitions, facts and do computations very well, but lacked deeper understanding and the ability to apply the concepts into real engineering practice. A review of the lesson design showed that there is a gap in the teaching approach adopted and the learning preference of our youths today.

Research suggests that the current generation of students are kept visually and emotionally engaged by various sources such as internet gaming and digital media [1]. They are technologically-driven, and prefer experimental and structured learning [2]. Staying passive in class is a challenge for them. The teacher-centered approach adopted in DAVT lectures provided few opportunities for students to be actively involved. Due to constraints imposed by cost and complexity of the system, some practical sessions were also designed the same way with instructor demonstrations rather than student's hands-on practice. This mismatch saw students being less engaged and tending to adopt a surface approach to learning, memorizing content primarily to pass the examination.

This paper discusses the changes made in the teaching approaches and learning experiences of DAVT to encourage a deeper learning approach and an appreciation for the value of the knowledge as applied in the real world of broadcast.

THE MODULE

The syllabus of DAVT is categorised into two main sections; Digital Audio Technology and Digital Video Technology. The changes were made to the Digital Video Technology section of the module.

In this section on Digital Video, students are expected to be able to describe the fundamentals of analogue television technology, the digitization process of the video signal, the basics of video compression techniques and standards, the main features of the DVB system and DVB multiplexing and modulation techniques. In addition, they are also expected to be able to apply what they have learnt in real engineering situations.

KEY CHANGES NEEDED

The changes in the teaching and learning approaches have taken into consideration the learning styles of the current students – a generation that learns better when they are actively engaged in purposefully designed activities that are properly scaffold to guide the learning. The key changes identified addresses specific needs in the following areas:

1. Engage students through doing and exploration to stimulate their interest in the module.
2. Provide students with more experiential learning experiences to help deepen their understanding of the concepts.
3. Create an environment that encourages students to explore the topics at their own pace and time.
4. Include real life and concrete examples to help students understand the relevance and applications of the concepts.

THE DEVELOPMENT OF DVB LEARNING TOOL

To provide students with a more experiential learning experience, having a hands-on session with a real DVB broadcast system would be ideal. By working through the entire process from pre-broadcast processing which involves the preparation of the raw video and audio footage for transmission, to actual broadcast through sending the processed signal to a DVB transmitter, and finally tuning the receiver to verify if the broadcast is successful, allows students to appreciate DVB technology in greater dept. Unfortunately the equipment and computer software required are very costly and it is not practical to purchase a set for each student. Furthermore, these systems are real operational systems that are complex and are not suitable for teaching and learning purposes.

As a result, the module team collaborated with their partners from industry and developed with a learning tool that is used together with a commercial DVB system and a low-cost DVB receiver from the industry partner. The key development in this setup involves two software packages; a Pre-Broadcast Signal Processing software module and a Real-Time Transport Stream Analyzer software module.

The developed hardware and software packages are used extensively in the practical and lecture lessons as well as during the students' self-learning time at home. (The students' e-learning journey starts here!).

EXAMPLE OF CHANGES

This section details 3 key examples of the changes made.

Changes to the Practical Lessons

With the newly developed learning tool, the teaching plan of the practical lessons was modified with three new practical lessons being added to include the following features:

- A hands-on opportunity for every student during the practical hours (actively learning and using the various hardware and software modules with the given structured lab procedures)
- Tasks without specific instructions are included to encourage students to think and apply their knowledge to complete the task.

- Questions are included at the end of the lesson to help students reflect on what they have learnt.
- Discussions between the students and the lecturer on the topic are actively encouraged

Table 1 shows the original teaching plan which included only one hands-on session on Video Technology (Analogue TV Lab). The DVB equipment demonstration was done entirely by the instructor for a class of 20 students.

Table 1
DAVT-Video Section Teaching Plan **(OLD)**

Week No.	Lecture (2-hour) & Tutorial (1-hour)	Laboratory (2-hour)
8	Video Topic 1: Basics of Television Transmission and Reception	Audio Mini Project (for Digital Audio Section)
9	Video Topic 1: Basics of Television Transmission and Reception	Audio Mini Project (for Digital Audio Section)
10	Video Topic 2: Digitization of Video Signal Video Topic 3: Principles of Video Compression	Analogue TV Lab
11	Video Topic 3: Principles of Video Compression Video Topic 4: Video Compression Standards	Analogue TV Lab
12	Video Topic 4: Video Compression Standards	DVB Equipment Demonstration
13	Video Topic 5: Digital Video Broadcasting (DVB)	DVB Equipment Demonstration
14	Revision	Revision

Table 2 shows the re-designed teaching plan with three new practical sessions being developed. The DVB equipment demonstration session was re-designed to include not only the equipment demonstration but also time allocated for exploration. Students are free to explore the new equipment in groups to answer “What is Digital Television?”. This experience helps stimulate their interest in Digital Video and the subsequent practical session.

Table 2
DAVT-Video Section Teaching Plan **(NEW)**

Week No.	Lecture (2-hour) & Tutorial (1-hour)	Laboratory (2-hour)
8	Video Topic 1: Basics of Television Transmission and Reception	- Digital Video and DVB equipment demonstration and briefing - Free time for students’ self-exploration & discussion
9	Video Topic 1: Basics of Television Transmission and Reception	Analogue TV Lab
10	Video Topic 2: Digitization of Video Signal Video Topic 3: Principles of Video Compression	Analogue TV Lab
11	Video Topic 3: Principles of Video Compression Video Topic 4: Video Compression Standards	Digital Video Processing Lab
12	Video Topic 4: Video Compression Standards	Digital Video Processing Lab
13	Video Topic 5: Digital Video Broadcasting (DVB)	DVB Lab
14	Revision	DVB Lab

Note: The Teaching Plan for weeks 1 to 7 were left out from the teaching plan above as it relates to digital audio section which will not be discussed.

Figure 1 shows the hardware and software modules developed for the DVB lessons which have also been incorporated into a commercial system.

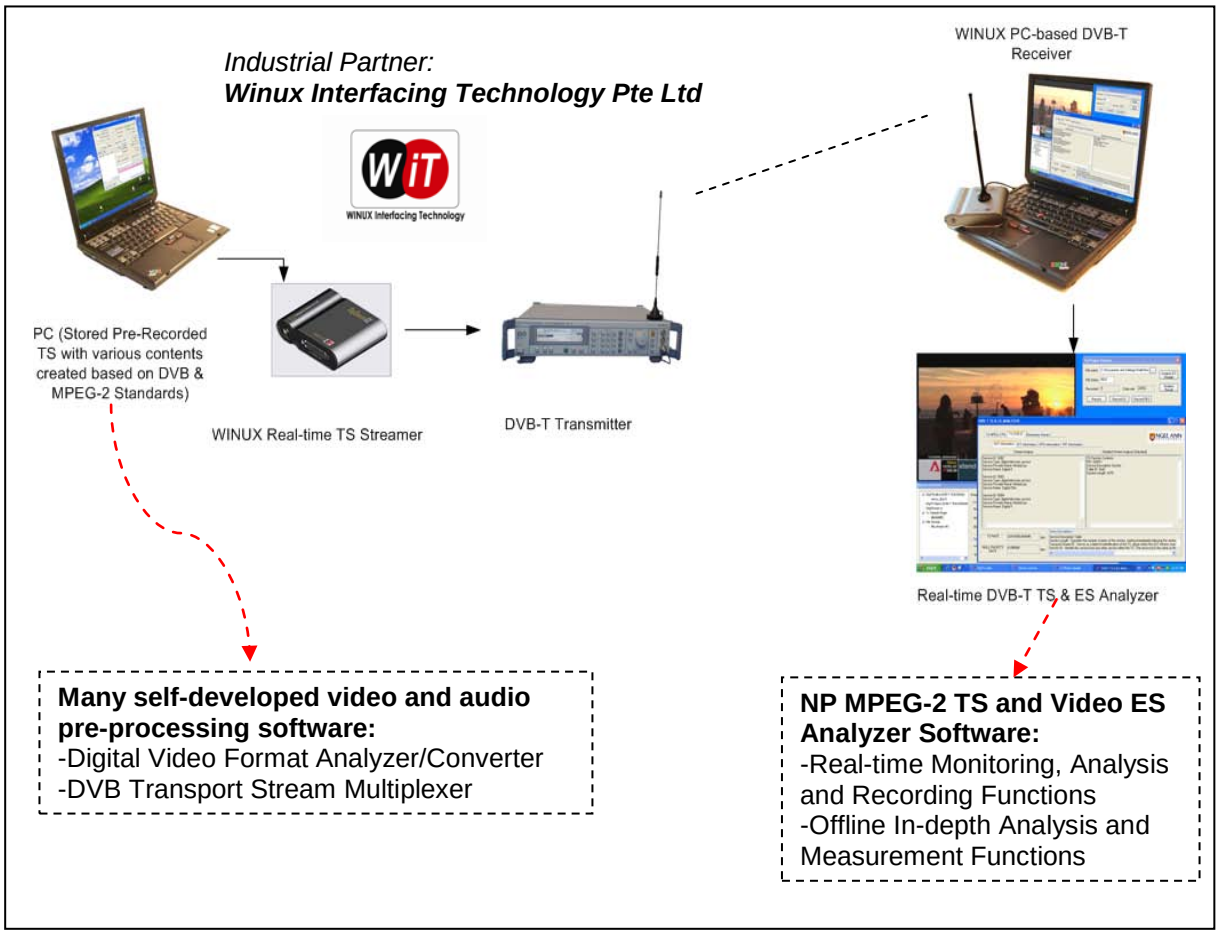


Figure 1. Portable Digital Video Broadcasting (DVB) System with Customised Learning Software Modules

The customized software modules can be installed on every student's notebook. This allows them to perform pre-broadcast processing and post-broadcast analysis. Students can now work independently at their own pace, creating different video programs and sending them for broadcast using the transmitter to see how the concepts and theories are being applied. In the process, students get to troubleshoot and solve problems which helps deepen their understanding of the concepts behind DVB technology.

To help students relate what they have learnt to real systems, the design of the new practical lessons incorporated a section where students record and analyze the engineering information carried within the programs broadcast by "MediaCorp TV" (Singapore's local Digital TV service provider) using the Transport Stream Analyzer. This encourages students to explore beyond the scope of their curriculum. They showed greater enthusiasm and are motivated to find out more when discrepancies such as the absence of some information in the live broadcast from MediaCorp TV.

The re-designed practical lessons and the use of the customized software have had significant impact on students' learning. They are more active during practical sessions and have demonstrated deeper understanding of the concepts and interest in the module as seen from a sampling of student's feedback extracts below.

> "This is a very interesting module. I now understand what goes behind the scene when we are watching televisions or listening to the radio."
>
> *by student A, Module Experience Survey, July 2008**

> "This module is best learned with the experiments.. and a lot of working is exactly very understandable and standard."
>
> *by student B, Module Experience Survey, July 2008**

(NB: *Names of students have been anonymised.)

Changes to Lecture Sessions

The lecture design also underwent some changes to include more concrete and real life examples to keep the students engaged. Specifically the two key improvements made to the design of the lecture are presented in the sections below.

Included more multimedia materials

More pictures and video streams (including those downloaded from YouTube) that are related to the video topics are used during lecture to help illustrate various concepts. With the use of real and concrete examples, students are more engaged and show greater interest in the topics covered.

Use of problems and questions during lecture to guide learning

The lecture hour has been divided into blocks of 15 to 20 minutes. At the end of each block, students are given simple questions to attempt. They have to work out the answers with their peers and present them during class. The questions are designed to be simple and straight forward so that most students would be able to work out the answer within a short timeframe.

The design also helps to encourage students to be more attentive during lectures as they need the knowledge to solve the questions. It also provides an opportunity for the students to discuss with their peers and lecturer which breaks the monotony of a one-way transmissionist lecture. Apart from a few students who prefer to learn more passively, the majority have commented that they learn more from this more active learning lecture design.

Self-directed Exploration via e-tools

As explained by Clark and Mayer [4], computer simulations and games are proven to stimulate learning and are good for e-learning and self-learning at home. The learning tool described above comprising a fully functional DVB (Digital TV) receiver and analyzer software is useful in that it allows students to explore the advanced features and functions of the new TV system which are not covered in the curriculum. Students are able to borrow the learning tool and explore the topics in greater depth at their own pace anywhere, anytime with the aid of their laptop.

EVALUATION

The module survey conducted in 2005 as shown in Appendix A indicated that only 79.17% percent of the student felt that the lecture, tutorial and practical sessions have increased their understanding of the module. This survey was conducted before the changes in teaching and

learning approaches were made. A focus group discussion was conducted and students' feedback indicated their preference for more hands-on sessions as seen from the focus group discussion report extract below.

> *"Students commented that they preferred more lab or practical work to help enhance their understanding of the module. The current plan has included lab works but there were some demonstrated lab sessions by staff due to lack of equipment."*

After the change as outlined in this paper, student feedback on the experience was obtained by conducting a module survey for the July 2008 semester. 36 students have rated their experience on seven dimensions as seen in Table 3 below.

Table 3
Student Rating on Learning Experience

Dimension	**Rating**
The module helped me develop useful skills and knowledge	89%
The module stretches my thinking.	89%
The teaching and learning approaches are appropriate for this module/project	94%
I received timely and useful feedback in a group/individually on my progress in this module	81%
The module materials including online resources were useful	83%
The module activities enhanced my overall learning	81%
Overall, this module provided a good learning experience	89%

Percentage rating indicates students who have selected "Agree somewhat", "Agree" and "Strongly Agree" in the rating scale

In general, student responses were strongly positive towards the changes in the module's learning design.

In addition, the change has allowed the module team to raise the standard of assessment on topics related to DVB technology. Prior to the change, the questions on DVB concepts were primarily recall-type, as shown in Appendix B. After implementing the change, the examination paper had more application and analytical type questions included. With an increased level of understanding, students have been able to attempt these questions and the passing rate of the module has not been affected.

CONCLUSION

The new learning design of our DVB module has been well received by the students. Greater interest was stimulated through the additional hands-on sessions. The learning tool encouraged students to explore beyond the curriculum, helping them to develop desirable attitudes such as self-directed learning. This e-learning design is currently being trialed by a small group of students. The module team intends to develop this further to help expand and extend its usage to benefit the greater community of students.

REFERENCES

[1] Ann Hodgkinson and Alisa Percy, "*Exploring Student Engagement for Generation Y: A Pilot in Environmental Economics*", Economics Working Paper Series 2008, http://www.uow.edu.au/commerce/econ/wpapers/UOW041801.html.

[2] Tracey Carver and Tina Cockburn, "*Making law more accessible: Designing collaborative learning environments for physically remote Generation Y students*", OLT 2006 Conference: Learning on the Move, 26 September 2006, Brisbane, Australia.

[3] B. Allen, A. Crosky, I. McAlpine, M. Hoffman and P. Munroe, "*A blended approach to collaborative learning: Can it make large group teaching more student-centred?*", Proceedings of the 23rd annual ASCILITE conference: Who's learning? Whose technology?, University of Sydney, pp. 33-42, 2006.

[4] Ruth C. Clark and Richard E. Mayer, "*E-learning and the Science of Instruction*", Pfeiffer Publication, Second Edition, 2008.

BIOGRAPHICAL INFORMATION

Eva Rosdiana is a lecturer in the division of Electronic and Computer Engineering at Ngee Ann Polytechnic (Singapore). She is the development team leader for the Digital Audio and Video Technology (DAVT) module. Her current interests focus on technical research and development in digital video processing and broadcasting areas.

Chua Beng Koon is a senior lecturer in the division of Electronic and Computer Engineering at Ngee Ann Polytechnic (Singapore). He is also the manager for the Digital Signal Processing Technical Centre. He is the development team member for the DAVT module. His current interests are in the areas of technical research and development in digital audio broadcasting area.

Corresponding author
Eva Rosdiana
Ngee Ann Polytechnic
School of Engineering
Electronic & Computer Engineering Division
535, Clementi Road, Singapore 599489
Telephone: +65-64608289
Email: rev@np.edu.sg

APPENDIX A – MODULE EVALUATION SURVEY 2005

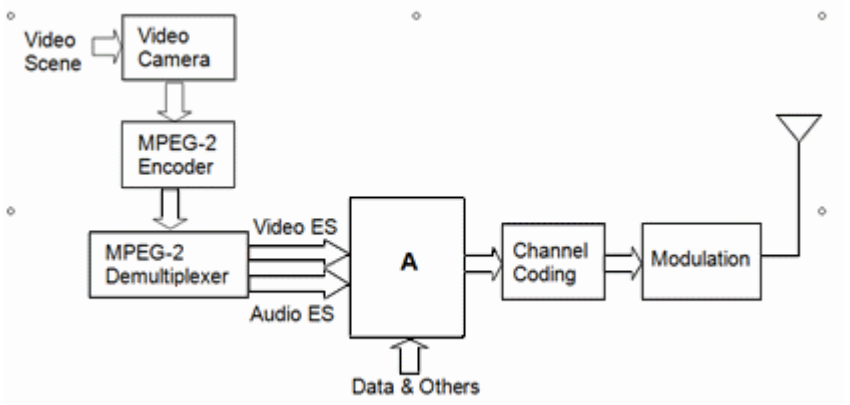
Survey conducted when the module was taught using the traditional approach.

	Module Design, Content & Organization	**Strongly Agree & Agree**	**Disagree & Strongly Disagree**
1	As a result of my learning experience in this module. I have greater confidence in my ability to explain the basic concept of the digital audio and video technology.	81.94	18.06
2	The relevance of the module (DAVT) to the whole course (Diploma of ECE/ETE) has been demonstrated.	91.67	8.33
3	The curriculum in the module is taught at a reasonable level of difficulty.	84.72	15.28
4	The sequencing of the topics in the module is appropriate and provides for students to build on previous knowledge.	81.94	18.06
	Teaching, Learning, Assessment	**Strongly Agree & Agree**	**Disagree & Strongly Disagree**
5	The module provides opportunities for active participation and learning.	83.33	16.67
6	The teaching methods used by lecturers to deliver lectures, tutorials and laboratory sessions are appropriate.	87.50	12.50
7	At the beginning of the semester I was informed about how I was to be assessed and examined in the module.	81.94	18.06
8	Overall, the learning sessions (tutorials, Laboratory sessions) have substantially increased my understanding of the module.	79.17	20.83

Question 8 of survey, “Overall the learning sessions (tutorials, laboratory sessions) have substantially increased my understandings of the module.” had only 79.17% of students responding with “agreed” and “strongly agree”.

APPENDIX B – EXAMINATION QUESTIONS

Table below shows examples of the type of questions set on topics related to DVB concept before and after implementing the change.

Year	Question	Question Category
AUG 2006 (old learning design)	In Digital Video Broadcasting (DVB), the data (audio and video) streams are packetized into PES (Packetized Elementary Stream) and then into TS (Transport Stream) packets based on MPEG-2 systems standard before transmission. State the two main differences between MPEG-2 Program Stream and MPEG-2 Transport Stream formats.	Recall
AUG 2007 (old learning design)	In DVB, MPEG-2 Transport Stream (TS) format is chosen as the data transmission format. State all the data information types that are found in TS and give any two factors that determine the total TS transmission bit rate.	Recall
AUG 2008 (after new learning design was implemented)	Figure 2 shows the process of broadcasting a video scene in European DVB-T (Digital Video Broadcasting – Terrestrial) standard.  Figure 2 (i) As shown in Figure 2, the output video signal captured by the video camera is passed to an “MPEG-2 Encoder”. State the name of the video signal at the output of the encoder and give two important data or information that is added to the video signal during the encoding process. (ii) Assuming that the MPEG-2 video ES at the output of the “MPEG -2 Demultiplexer” has a resolution of 704×576 pixels, chroma format of 4:2:2 and each sample is 8 bits long, calculate the number of macroblocks and blocks in one frame (include both luminance and chrominance samples). (iii) If the MPEG-2 video ES has an encoded rate of 3.8 Mbits/sec, calculate the average size of one MPEG-2 video frame in bytes and find the compression ratio. (iv) State the name of the block labelled with symbol “**A**”. What are the two compulsory tables that must be transmitted together with the video ES, audio ES and other information? (v) Calculate the number of data packets produced in 30 msec intervals at the output of block labelled with symbol “**A**” if the output net data rate is 16.58824 Mbits/sec.	Recall, Application and Analysis