INTEGRATING ICT-BASED CONTENT
IN TEACHING AND LEARNING

MATHEMATICS
Integrating ICT-Based Content in Teaching and Learning

MATHEMATICS
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Since the early 1970s, the Malaysian Government has introduced various initiatives to facilitate a wider adoption of ICT to boost capabilities in every field including education. The rapid development in the use of ICT for education especially in the late 1980s and early 1990s was partly a result of the tremendous decrease in the price of personal computers (PC). PCs were getting more affordable, affordable enough to be used in schools.

The government allocates a huge investment in equipping ICT infrastructure in schools. The investment is for purchase of hardware, software, and development of software and courseware for teaching and learning. Support and training for education has also received a big fraction of the allocation.

Smart Schools was adopted as one of the 7 flagship applications of the Multimedia Super Corridor, a strategy to meet the need for knowledge workers for the high-tech industries. A Smart School is an institution that prepares students for the information age, adapting an effective delivery system which encourages self-accessed, self-paced and self-directed learning.

The government’s pledge in accelerating the integration of ICT in education is explicitly stated in the Ninth Malaysia Plan 2006-2010. In the section on Mainstreaming ICT, the government warrants for a more extensive application of the Internet and courseware for teaching and learning.

During the Ninth Malaysia Plan period, the Smart School applications will be further strengthened to provide more comprehensive coverage. Towards this end, the deployment of web-enabled Smart School applications will be accelerated. This is to ensure continuous access to the latest online content and e-learning applications by teachers and students. The SchoolNet will provide a cost effective means of deploying widespread Smart School courseware.

However, studies and observations in schools provide consistent evidence that show minimal or inappropriate use of ICT applications in mathematics teaching and learning at all levels. As the technologies progress and become more prevalent, teachers will also need to be continually reconsidering the strategies in their teaching.
so that it meets every student’s potential, motivates learning and seeking of knowledge, creates the crave for learning beyond what is taught in the classrooms, and promotes creative and critical thinking. With resources that are readily available, teachers are responsible to seek a more effective teaching and learning strategy, one that integrate the use of ICT.

Believing that there is not enough time and that there is too much content to cover for examination require consideration on what really matters in teaching. As educators, we prepare our students for life and not just for tomorrow. This calls for a paradigm shift. Without a change in our mindset on what is the heart of education, barriers to the promises and possibilities of ICT integration and shifts in the practice of teaching mathematics in general, remain too substantial to overcome.

**Objectives of the Workshop**

Upon completion of the workshop, teachers are able to:

1. To help teachers understand the role of computer-assisted instruction (CAI) and computer-assisted learning (CAL) in mathematics pedagogy;
2. To expose teachers to the applications of ICT in the teaching and learning of mathematics;
3. To raise teachers’ awareness of various approaches to the integration of ICT in the teaching and learning of mathematics in the classroom and the computer laboratory;
4. To encourage the spirit of sharing best practices of ICT integration among Bestari school teachers; and
5. To help teachers develop mathematics lesson plans that incorporate the use of ICT, in particular, the use of courseware.

**Expected Learning Outcomes**

Upon completion of the workshop, teachers are able to:

1. explain the concept of courseware integration in hands-on teaching and learning situations;
2. make sound decisions about when, when not, and how to use courseware effectively in mathematics teaching;
3. evaluate the suitability of specific content in the courseware for classroom teaching;
4. develop lesson plans that effectively utilize the available courseware for the teaching and learning of mathematics;
5. justify the appropriateness of the segment/s of the courseware to be integrated in the teaching and learning of mathematics;
6. appreciate and support the nationwide efforts concerning the integration of ICT in mathematics teaching and learning; and
7. gain information on growing body of research on the effectiveness of ICT in mathematics teaching and learning.

Learning Strategy
In the workshop, participants are expected to:
1. actively listen to brief lectures on integration of courseware in the teaching and learning of mathematics;
2. actively participate in discussions and hands-on sessions;
3. review and categorize available mathematics courseware based on the Courseware Review guidelines suggested;
4. critique and discuss sample lesson plans for merits and limitations;
5. share ideas and best practices with workshop participants;
6. develop courseware integrated lesson plans in mathematics teaching and learning; and
7. reflect on the potential and limitations of the workshop content and activities and its applicability to the context of the mathematics classrooms and computer laboratory in schools.
ACTIVITY 1

Current Practices in Integrating Courseware for Teaching and Learning

Introduction

The workshop is conducted to provide a platform for teachers of Sekolah Bestari Perdana to share their experiences, views, understanding and current practices in integrating courseware for teaching and learning. As the Smart School project roll out to the next phase for real implementation, the pioneer teachers of the Smart School need to provide ideas for others to establish themselves as Smart School teachers.

Expected Learning Outcomes

Upon completion of this activity, teachers are able to identify the currents practices in integrating courseware for teaching and learning.

Instructions to Participants

1. Be ready to share your current practices in integrating courseware for teaching and learning. Do take note that in this workshop, the focus of discussion is just on courseware integration. You are given 10 minutes to state:
   (i) the level that you teach: primary, lower secondary or upper secondary;
   (ii) your self rating of integration based on the category low, medium, high;
   (iii) your self rating on the effectiveness of your courseware integrated teaching as not effective, moderate and very effective; and
   (iv) your method/s of integration. [30 mins]

2. Five minutes will be given for question and answer session for each representative selected. Be ready to answer any questions pertaining to the discussion. [15 mins]

3. The facilitator will conclude on current practices as reported by the selected participants. [5 mins]
ACTIVITY 2

ICT Integration in Mathematics Teaching and Learning: Strengthening the Use of Courseware

Introduction

This unit discusses six subtopics: (i) Effectiveness of ICT Integration in Mathematics Teaching and Learning, (ii) Integration of ICT in Mathematics Teaching and Learning, (iii) Classroom Organization of ICT Integrated Teaching, (iv) ICT Applications for Mathematics Teaching and Learning, (v) Teachers’ Competency in Integrating ICT for Instruction and (vi) Future Developments.

Expected Learning Outcomes

Upon completion of the workshop, teachers are able to:

1. make sound decisions about when, when not, and how to use courseware effectively in mathematics teaching;
2. appreciate and support the nationwide efforts concerning the integration of ICT in mathematics teaching and learning; and
3. gained information on growing body of research on the effectiveness of ICT mathematics teaching and learning.

Effectiveness of ICT Integration in Mathematics Teaching and Learning

Having the knowledge on the effectiveness of a technology would accelerate the adoption of the tool by the implementers, the teachers. Teachers need to believe that ICT is effective in helping students learn. The implementation would probably take more class time, therefore only teachers who believe in the technology would choose to adopt it.

Decision to deploy ICT in mathematics is a simple one: “Does it benefit the students’ effective learning of mathematics?”

Several questions can be used in determining the effectiveness of the ICT integrated lessons.

1. Did you meet the learning objectives?
2. Were the students actively engaged and were all abilities catered for?
3. Were the students confident?
4. Could students then transfer knowledge to other scenarios?
5. What mathematics did they use?
6. What progress did they make?
7. Can it be extended further?

ICT integrated lessons is a strategy that could cater the more mathematically abled students. Our normal classroom interactions could not really respond to the needs of these students. ICT integrated lessons would be able to help the abled students in the following ways:

1. **Acceleration.** Takes students into areas of the curriculum normally covered by older children often resulting in early entry to public examinations. This is sometimes achieved by moving students into higher year groups for all subjects or just the subject in which they excel. Alternatively, children can be accelerated within their own class working independently, often with some additional support.

2. **Extension.** Involves moving outside the syllabus and looking at aspects of mathematics not normally covered within the “normal” curriculum.

3. **Enrichment.** It is about extending students’ understanding of the mathematical ideas they have already met by applying them to other situations and problems, often requiring decisions on what area or areas of mathematics to employ. The aim is to develop higher level problem solving and communication skills. It extends the notion of using and applying. The aim is to produce a thinking mathematician who can look beyond the standard “test” type questions.

Evidence from research literature suggests that ICT has a powerful and significant impact on cognitive outcomes.

1. Logo programming, computer-assisted instruction (CAI), micro-worlds, algebra and geometry software were found to be effective in facilitating mathematics achievement (Hillel, Kieran and Gurtner, 1989; McCoy, 1996; Simmons and Cope, 1993).

2. Kulik (1994) reported that students who used computer-based instruction scored at the 64th percentile on tests of achievement compared to students in the control conditions without computers who scored at the 50th percentile.

3. Selinger (2004) claimed that ICT can improve the quality of education because multimedia content helps to illustrate and explain difficult concepts in ways that were previously inaccessible through traditional teaching resources and methodologies.
4. High-school students were found to retain mathematics skills longer after using commercially available mathematics software than did students in a control group receiving traditional classroom instruction. (http://www.education-world.com/a_admin/admin122.shtml).

5. Results of a meta-analysis on 42 studies that contained a combined sample of approximately 7,000 students showed that teaching and learning with technology has a small, positive and significant (p < .001) effect on student outcomes when compared to traditional instruction.

Integration of ICT in Mathematics Teaching and Learning

Various interpretations on what it means by integration have been used by teachers as a basis for their teaching. ICT is not a teaching approach. The use of ICT by itself does not ensure effective learning. It cannot be simply assumed that the integration of ICT into classrooms, whether in the form of courseware or other applications, will necessarily result in improved teaching practices and/or enhance students’ outcomes.

ICT could be abused and investments in ICT could be rendered ineffective if these technologies are assimilated into traditionally outdated pedagogies and modes of learning. The effectiveness of ICT could be maximized and their potentials realized by integrating ICT into teaching practices that are consistent with constructivist pedagogy, in which students are actively engaged in their own learning. When used appropriately, ICT allows students to:

1. access ideas and information from diverse sources through searching, locating, selecting, and authenticating material in a wide range of multimedia forms;
2. extend ideas and information through processing, manipulating, analyzing and publishing material in different multimedia forms;
3. transform ideas and information into new or different forms through synthesizing, modeling, simulating and creating material in many multimedia styles and formats; and
4. share ideas and information across local, national and international networks through interacting electronically with others in actual and/or delayed time.

Through these processes students express their creativity and imagination.

What does integration of ICT means? The ways to integrate varies with the learning outcomes to be achieved, the teaching approaches adopted, type of applications
used and the ICT infrastructure availability. It can be implemented in (i) a whole class or in laboratory settings, (ii) students-centered or teacher-centered approaches, and/or (iii) individualized, grouped or teacher-led discussion. This module focuses on how to integrate courseware in teaching and learning, by providing activities and lesson plans that leads to a clearer understanding of what integration means.

**Classroom Organization for ICT Integrated Teaching**

The arrangement of learning spaces has a significant impact on opportunities that can be provided for teaching and learning. ICT integrated mathematics teaching should not always adapt the whole class teaching approaches. In recent years, the trend is for individual access, or working in pairs, or working in groups. ICT resources for whole class work can be used in a number of ways including mental oral work, demonstration, interactive whole class teaching, and class discussion. This would allow teachers and students to make interactive use of ICT in a variety of ways, although students would only have limited opportunities for hands-on work.

1. Fully integrated classrooms promote maximum use of the computers at times when they are needed by individuals and/or groups of students. The computers are distributed around the classroom in ways that enable them to be used as readily-available tools for teaching and learning.

2. Computer labs give students access to computers within a set time-frame. It limits spontaneity of use and sometimes implies that the use of computer-based technologies is confined to one subject area or a limited number of areas.

3. Learning Resource Centers or school libraries. It allows for presentations with a projector networked to a computer.

4. Personal provision of laptops (notebooks) and/or palmtops in classroom setting.

In any particular setting, provisions should be made for the following:

1. A whole-class display visible to all students;

2. Scope for visual oral interaction between teacher and students in both one-to-one and whole class situations;

3. Space for students to work away from the computers; and

4. A range of software appropriate to the mathematics curriculum.
However, lack of infrastructure should not be dealt with as constraints. Teachers who believe in the potential of ICT in promoting learning would certainly be able to manage his/her teaching to integrate appropriate use of the technology.

**ICT Applications for Mathematics Teaching and Learning**

Many applications can be used as complement to mathematics teaching and learning. However, some of the applications require a more advanced competency in ICT, and some require infrastructures that are not readily available in our schools. The applications suggested here are basic enough to be readily applied in our school system.

**Courseware**

Courseware is educational material intended as kits for teachers or trainers or as tutorials for students, usually packaged for use with a computer. The CD-ROM is the most common means of delivering courseware that is not offered online. Courseware can include:

1. Material for instructor-led classes;
2. Material for self-directed computer-assisted instruction (CAI) or computer-based training (CBT); and/or
3. Websites that offer interactive tutorials.

Under the Ministry of Education (MoE), divisions such as the Educational Technology Division (BTP) and the Curriculum Development Centre (CDC), and Pusat Sumber Pendidikan Negeri PSPN has put in concerted efforts in developing coursewares for school. These coursewares are distributed free to all schools. The Telekom Smart School (TSS–TM Smart School Sdn. Bhd. http://www.tss.com.my/) was assigned to develop courseware for the Smart School projects. Classification of the coursewares include E-Bahan, PPSMI, Text Book CD-ROM, CDRI, Teacher Education (BPG) and PPSMI-BTP.

**Internet**

Vast resources of information are available on the Internet. Resources from the Internet (either ‘live’ or downloaded) can be accessed by teachers and students for teaching and learning. When used effectively the Internet extends the walls of classrooms. Students and teachers can identify and locate relevant information, select what is most useful for the task in hand and extract it. However, teachers and students need to determine validity and authenticity of information in the Internet.
Some criteria are needed when reviewing mathematics websites. The following criteria can be used in determining suitability of an Internet site for mathematics learning:
1. High relevance of content to school use;
2. A large body of interactive material available;
3. Emphasis of content over design; and
4. Ease of navigation around the site.

There are several advantages of the Internet over other softwares:
1. Browsers are free;
2. Pages are available at home as well as school and everywhere else;
3. Students’ work and teachers’ ideas can be shared worldwide;
4. Keen students can carry on working on their own using the resource; and
5. Web-generated interactive test pages give instant feedback to students and allow plenty of practice.

**Graph Plotters**

These are probably the most frequently used tools in mathematics teaching. There are several software packages whose primary function is to plot graphs. These include *Autograph*, *Coypu*, *Omnigraph* and *Winplot*. The built-in software in graphical calculators includes a graph-plotter. Other packages also include facilities to plot graphs. These include dynamic geometry such as *Geometer’s Sketchpad 4* (GSP), computer algebra systems such as *Derive* and integrated mathematics software such as *TI Interactive!* The Malaysian Ministry of Education has bought license for the GSP to be used by all educational bodies in Malaysia.

Common features of graph plotters include the ability to:
1. use a wide variety of mathematical functions (such as \(\sin(x)\), \(e^x\) etc.);
2. show several graphs on the same axes;
3. vary the colour, style and weight of graphs of functions;
4. label graphs, axes, points etc.;
5. rescale the axes easily, including zooming in and out;
6. control the way axes and grids are displayed;
7. mark points of interest, such as maxima or intersections; and
8. enter data and display statistical plots.
The *Geometer's Sketchpad* is a computer system for creating, exploring, and analyzing a wide range of mathematical concepts in algebra, geometry, trigonometry, calculus. *Geometer's Sketchpad* is a dynamic construction and exploration tool that adds a powerful dimension to the study of mathematics. Versatile and easy to use, *Sketchpad™* allows students to understand mathematics in ways that are not possible with traditional tools or with other software programs.

Students can construct objects, figures, and diagrams and explore their mathematical properties by dragging objects with the mouse. As shapes change, all mathematical relationships are preserved, allowing students to examine an entire set of similar cases in a matter of seconds. With its friendly user interface, *Sketchpad* is easy to use and lets students focus on the mathematics, not the software. It works with an overhead projector, with one or two classroom computers, or in a computer lab. One can quickly and easily generate teaching aids such as worksheets, tests, reports, and presentations by exporting *Sketchpad* files to word-processing programs and spreadsheets, other drawing programs, and the Internet.

**Java Mathematics Applets**

There is a rich and extensive source of student learning tools through the use of online, interactive java mathematics applets. An applet is a small Java program which is cross-platform compatible and can be embedded in the HTML of a webpage. Web browsers, which are usually equipped with Java virtual machines, can run the applets to perform interactive graphics, games, calculators, etc. “Applets” differ from “Java applications” in that they are more secure, they can’t access certain resources on the local computer, such as hard drives, modems, and printers; and they can only make an Internet connection to the computer from which the applet was sent.

The java applet should not be made the focus of the lesson. Instead, the applet’s function is merely as an effective interactive tool for enhancing student understanding of the concepts involved.
**Generic Tools for Learning – Spreadsheets**

As the name suggests, these were originally developed as accountancy tools and are very widely used in all aspects of finance as well as many other situations involving mathematical and/or statistical modeling. A key feature of a spreadsheet is that parts of the sheet (usually called ‘cells’) can be defined in terms of previous ones in such a way that any change to any cell automatically causes the values in every dependent cell to change instantly.

For mathematics we frequently want to be able to set up tables of data, which may use formulae to generate other data, and from which we can draw graphs. Useful aspects of spreadsheets in the teaching and learning of mathematics include:

1. A spreadsheet is instantly responsive to changed input values which enable exploration of the effect of variables within a process.
2. Replication of formulae enables the effortless generation of a large number of new calculated values across a chosen range of source values.
3. The spreadsheet as a content-free modeling space – used in this way the spreadsheet creates a model, some dynamic representation of the context under investigation, so that connections between the elements within that context can be considered.
4. As an interactive presentation environment.
5. On screen buttons enable incremental changes to cell values without using the keyboard.
6. Linked values are a defining feature of the spreadsheet. This capability to link and respond enables the spreadsheet to offer interactivity.
7. Value sensitive formatting allows the appearance of text, values, and background, to change according to the intentions of the designer, and so give high value feedback, or other information, to the user.

**Generic Tools for Learning – Database**

There are a number of packages designed to aid sorting and classifying data in a variety of ways, as well as their representation in graphs and charts. These are not specific to mathematics and can be used in any subject where classification according to different criteria is important. They differ from spreadsheets as they can be used to classify and represent non-numeric data. Databases linked to surveys can successfully form the focus of group work in mathematics lessons. Using a database for questionnaires and surveys will give students opportunities to consider appropriate ways of representing data.
Teachers’ Competency in Integrating ICT for Instruction

What could we expect from teachers? Teachers should be able to:
1. select computer-based technologies according to their appropriateness for particular areas of learning, capabilities, competencies and skills;
2. evaluate software in terms of the learning needs and preferences of individual students or groups of students;
3. use computer-based technologies to demonstrate concepts, access new information, individualize instruction, and create variety and challenge in the learning process;
4. become proficient in the use of generic software tools and content specific software relevant to their teaching;
5. use desktop publishing, graphics and multi-media applications to prepare learning materials for students and other teachers;
6. store material electronically and modify it for different classes and students;
7. use databases and other analytical tools to record students achievements and organize learning activities;
8. access CD-ROM material and databases in lesson planning and when working with students;
9. use the Internet as a personal resource and as a source of ideas and information for students;
10. vary teaching methodologies, software applications and learning tasks to facilitate successful learning for all students;
11. experiment with new and emerging technologies and adapt current practices to take advantage of them;
12. use electronic networks to research new teaching ideas and find new resources for use with students;
13. analyze the value of content derived from electronic sources against the needs of particular students and learning areas; and
14. identify, locate, select, authenticate, and evaluate material derived from electronic sources.

Future Developments

Hand-held technology such as graphical calculators, personal digital assistants (PDAs), palm top computers and mobile phones are all evolving rapidly. There is some convergence happening too – for example, all of these will soon be able to communicate wirelessly with other technology, including large scale displays and Internet servers. In a fairly short time this personal technology will be as common as the mobile phone.
**Instructions to Participants**

1. Listen to the presentation on *ICT Integration in Mathematics Teaching and Learning: Strengthening the Use of Courseware* by the facilitator. Feel free to ask questions and debate on the issues discussed. [1 hour]

2. Reflect on your current practices in the integration of courseware for teaching and learning. Discuss in groups of fours based on levels taught in schools (i) primary, (ii) lower secondary, and (iii) upper secondary. Fill up the following worksheet. Indicators of success can be in the form of students’ motivation, achievement, improved attitude, confidence, etc. Be ready to present your group discussion. [45 mins].

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ACTIVITY 3

Integrating Courseware for Teaching and Learning in Classroom Setting

Introduction

As was introduced in the previous section, courseware is an educational material intended as kits for teachers or trainers or as tutorials for students, usually packaged for use with a computer. Courseware for schools were developed by various divisions in the Ministry of Education and by companies assigned for the Smart School projects.

The Curriculum Development Centre developed Teaching Courseware comprising of hundreds of lessons for each level of schooling. Congruent to the emphases made in the curriculum, the lessons focus on concept building, problem solving, reasoning, and communication in mathematics. Moral values are also incorporated wherever it is appropriate.

Telekom Smart School coursewares are branded under the name “BestariEd”. The courseware comprises of learning contents from Year 1 to Form 5 of four subjects, namely Mathematics, Science, Bahasa Melayu and English Language. It has been deployed in 88 Smart Schools nationwide. The courseware serves as teaching and learning material that are suitable to be used for self-paced learning by students and teachers for teaching and learning in schools or at home.

Integration of courseware for teaching and learning in classroom settings seems less desirable to some teachers. It requires a lot more of setting up as compared to a regular class. Some teachers perceived it as a waste of time, troublesome and some feel apprehensive about the technology, expecting things to go wrong. Some feel that they can cover more content and able to make students understand better just by using the chalk and talk method. However, technology has become a tool in much part of our lives. The emergence of ICT has influenced much of our daily activities, and it should also in some ways, influence the way we teach, communicate and organizes our life.

The initial stage in adapting courseware for teaching is to analyze the courseware (i) to identify sections that are best used for teaching in a classroom setting and (ii) to identify sections that would complement class teaching because it helps explain concepts/algorithm or processes in mathematics.
This unit provides ideas on integrating courseware for teaching and learning in classroom setting, an effort to demonstrate effective ways of integrating courseware to enhance the teaching of mathematics.

**Expected Learning Outcomes**

Upon completion of this unit, participants are able to:

1. explain the concept of courseware integration in mathematics classroom teaching;
2. make sound decisions about when, when not, and how to use courseware effectively in teaching mathematics in classroom setting; and
3. evaluate the suitability of specific content in the courseware for teaching in the classroom.

**Pedagogical Concerns of Courseware Integration in Classroom Setting**

There are reports that a small number of teachers practicing courseware integrated teaching viewed the courseware as ‘a replacement for the teacher’. The teacher merely used an LCD projector to project the whole courseware and he/she interacted with the courseware and conducted a whole-class teaching throughout the entire class time. Although these are isolated cases, it created much concern on the effectiveness of the lessons and whether or not the teacher is optimizing the quality time with the students.

The philosophy underlying courseware integration in teaching and learning is constructivism. The basic tenet of constructivism is that students will build (or construct) knowledge and learning for themselves if teachers create the right learning environment. Constructivism takes the focus off “teaching” and places it on “learning”. It sometimes means teachers have to take their hands off the controls, let go a little, and realize that the best kind of learning happens when students work things out for themselves and not always when they get “taught”. Computers and communication technologies are amazing tools for moving the centre of power in a classroom over to the students. When teachers introduce technology into a classroom, they suddenly invite students to learn at different rates, about different ideas, catering to different interests and abilities. (http://ictpd.net).

**Guides on Integrating Courseware for Teaching in Classroom Setting**

In integrating courseware for teaching in the classroom, the teacher needs to go through the courseware and make certain decisions on which content matches the learning outcomes that he/she planned to achieve. For the purpose of integrating the courseware for teaching, only selected materials/segments should and could be used.
Integration of courseware in classroom setting is particularly effective in contexts whereby the ‘chalk and talk’ methods has its limitations in explaining a concept, which could be better explained using animation, simulation, exploration and experimentation. As an example, it has been found to be highly effective in the development of spatial visualization skills, enhancing students’ ability to visualize via technology (e.g. three-dimensional representations of angles between two planes).

The following are guides towards a more effective integration of courseware in classroom setting:

1. Select segments of the courseware that meet the learning outcomes students are to achieve. In the following example on the topic ‘Lines and Planes in Three Dimensions’, only the tutorial segment provided by Module 1 and 2 is suitable for class teaching.

2. In using the Teaching Courseware developed by Curriculum Development Centre, create your lesson for the day using the ‘My Lesson’ utility button built in the courseware.

   With this option, just click on ‘New’ button and choose the subtopics that you want to include in the lesson by clicking ‘Add’. Customize the content and the sequence of content according to your teaching plan. Preview lesson to make selection or to remove a selection. Click on save to ‘package’ your customized lesson.
3. Decide whether the identified segment of the courseware or your customized lesson is to be used as introduction (set induction), explanation or conclusion for the class teaching.

4. Practice constructivist teaching style. Although the teaching is more teacher-centered as compared to the laboratory setting, the teacher can still create learning environment that allow students to explore and experiment and to build conjectures, and hence construct knowledge for themselves. Teachers need to pose questions to create active learning environment. Asks divergent questions such as “Why is this so?”, “Can you predict what will happen if we change the value of y?”, or “What conjectures can we developed?”.

5. Do not let the courseware control your teaching. Use the ‘Pause’ and ‘Mute’ buttons whenever necessary to elaborate on the lesson.

6. Schedule mathematics class time for at least two periods at a time. This reduces the setting up time that you might need to take during every lesson. To reduce this problem, train students to help you with the set up, and assign students to pick up and return the laptop and the LCD projector.

7. Have enjoyment in improving your lessons year after year. Repeated use of the same methods not only bore the students but also bore the teachers. Take every innovations introduced as a challenge to improve yourself.

8. Develop Courseware Review Database. This has to be a collaborative effort among the Panitia members. Assign each teacher to go through several courseware and analyze each courseware from start to the end. For each courseware, the teacher needs to identify segments that are suitable for (i) teaching, (ii) learning with teachers’ guidance, (iii) independent learning, and (iv) enrichment. Build proper documentations of the database for all teachers to refer to whenever they need to use a courseware. The database has to be developed across different types of courseware. Therefore, if one is teaching on Cumulative Frequency and Ogive, they can just go through the database and gain information on what is available from all the courseware that covers that same topic.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Courseware</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Smart School</td>
</tr>
<tr>
<td><strong>Cumulative Frequency and Ogive</strong></td>
<td></td>
</tr>
</tbody>
</table>
**Instructions to Participants**

1. Participate in the discussion on integrating courseware for teaching and learning in classroom setting and sample lesson plan for integrating courseware in classroom setting. [1 hour]

2. Examine the courseware demonstrated by the facilitator. Identify its suitability as a tool to facilitate learning in a classroom setting. In the simplified Courseware Review sheet (Appendix 1), indicate:
   (i) courseware title/publisher;
   (ii) segment;
   (iii) how it can be used in teaching and/or learning with teachers’ guidance and/or independent learning, and/or enrichment; and
   (iv) whether it is suitable for classroom or laboratory. [30 mins]

Submit the Courseware Review to the facilitators at the end of the session.

<table>
<thead>
<tr>
<th>Courseware Title/Publisher</th>
<th>Segment</th>
<th>Suitability of Segments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<td>Classroom</td>
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<td></td>
<td></td>
<td>Classroom</td>
</tr>
</tbody>
</table>

3. Study the lesson plan given (Appendix 2). In groups of fours, discuss and debate on ways to improve the lesson plan for a more integrated solution of courseware integration in mathematics teaching. [30 mins]
ACTIVITY 4

Integrating Courseware for Teaching and Learning in Laboratory Setting

Introduction

Although laboratory classes are often connected to individualized learning, classes conducted in the laboratory should not be viewed as hands-on session with very little engagement by the teacher. Laboratory setting should be able to promote more of learner-centered learning, self-directed learning, exploration, experimentation and group work. The teacher sets the learning, facilitating and intervening at specific instances to clarify and to ensure that the learning objectives are achieved by the end of the session. Laboratory can also be used for teaching, if the teacher needs to demonstrate, and is later followed by hands-on activities.

This unit provides ideas on integrating courseware for teaching and learning in laboratory setting, an effort to demonstrate effective ways of integrating courseware to enhance learning. The discussion focuses on (i) evidences from research on effectiveness of ICT-based individualized learning, (ii) pedagogical concerns for teaching and learning in laboratory setting, (iii) guides on integrating courseware for independent learning in a laboratory setting.

Expected Learning Outcomes

Upon completion of this unit, participants are able to:

1. explain the concept of courseware integration in hands-on teaching and learning situations;

2. make sound decisions about when, when not, and how to use courseware effectively in teaching mathematics in a laboratory setting; and

3. evaluate the suitability of specific content in the courseware for teaching in the laboratory.
Evidences from Research on Effectiveness of ICT-based Individualized Learning

Empirical research as summarized by article Technology in the Schools: It Does Make a Difference! has shown a number of achievements related to the use of ICT in education (http://www.education-world.com/a_admin/admin122.shtml). The evidences that are listed here are much related to individualized learning, especially in the laboratory setting.

1. A study of elementary-aged students learning mathematics found that students who used multimedia computer software showed less math anxiety and more frequently perceived the subject as relevant to everyday life than students in a control group.

2. Students who tend to refuse to do class work were found to be more motivated and eager to work since they do not perceive computers as an “authority figure”.

3. Especially “at risk” students were found to improve attitude and confidence towards learning.

4. Computer use facilitates student collaboration on projects and thus team working abilities that are indispensable in the work place.

In Activity 1, the research findings discussed were evidences of cognitive gains in ICT integrated teaching and learning. The findings highlighted above clearly showed how ICT can help students especially those who are in the categories of “at risk” and/or “low achievers”. Changes in affective domains such as reduced anxiety towards mathematics, increase in motivation, attitude, and confidence, and increase students collaboration are desirable outcomes of any instruction.

Pedagogical Concerns for Teaching and Learning in Laboratory Setting

Conducting lessons that require students to use a courseware or make searches on the Internet in a laboratory setting may end up with fruitless efforts. A common misconception among teachers is that using the courseware or Internet as an instructional tool simply means assigning a topic for students to learn or search online without any guideline or supervision. They need to appreciate that “learning by doing” or encouraging the students to “explore” does not mean that activities should be unstructured. On the contrary, as the pedagogy shifts from being teacher-centered to being student-centered, there is greater need for teachers to structure the learning experience by providing a framework, formulating guide questions, recommending websites, facilitating discussions, and so on.

Laboratory works do not necessarily mean working alone. The teacher needs to consider when individuals benefit more by working independently and when group
work would be more effective. When students are working on their own or in groups, effective teaching involves teacher intervention to make sure that the objectives of the lesson are met and that students do not become distracted by the technology.

**Guides on Integrating Courseware for Independent Learning in a Laboratory Setting**

In integrating courseware for independent learning in a laboratory setting during class time, the teacher needs to go through the courseware and make certain decisions on which content matches the learning outcomes that she planned to achieve. The courseware developed for school use can be used independently by students or be used by teachers for teaching. For the purpose of independent learning, the entire content is suitable. However, for the purpose of integrating the courseware for teaching, only selected materials/segments should be used.

1. Select segments of the courseware that meet the learning outcomes students are to achieve. Planning effective use of the courseware for independent learning calls for classification of content as tutorial, drill and practice, test or enrichment. In the following example on the topic ‘Lines and Planes in Three Dimensions’, the tutorial segment is provided by Module 1 and 2, drill and practice is given in the Practice segment, Activities and Outdoor Activities segments are extension of class work or enrichment.

2. Decide whether students should use the courseware before, during or after the topic is taught.

3. Prepare supplementary worksheets. The worksheet may be completed by individuals or in groups. As an example, refer to the worksheet on page 26 to be used as supplementary material for the CD-ROM for Textbooks on the topic Set in Lesson Plan 2.

4. Practice constructivist teaching style. Create learning environment that allow students to explore and experiment and to build conjectures, and hence construct knowledge for themselves. Provide opportunity for students to construct mathematical knowledge through individual and group investigation using technology.

5. Make provisions for group discussions and group work.
### Sample Worksheet

<table>
<thead>
<tr>
<th>Group Name:</th>
<th>Names of Members:</th>
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<tr>
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<td>1.</td>
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<td>2.</td>
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<td>3.</td>
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</table>

**Courseware: Mathematics Form 4 CD-ROM for Textbooks**

**Instruction:**
1. Click on the topic on Set.
2. Go through the explanation in the Multimedia Library 1, 2, 3. You should be finished in less than 10 minutes.
3. Answer the following questions. (10 mins)

In your own words, describe the meaning of the following terms:

a) Sets:

b) Subset:

c) Intersection:

d) What does Venn Diagram represents?

e) What is the difference between a Venn Diagram with two circles and one with three circles?

f) What does overlapping of the circles mean?

g) Using the Venn Diagram, describe the students in your class. Exchange your work with another group. Be ready to present your work to the class.

h) Create a Venn Diagram using whatever subject you wish (Science, Geography, Islamic Studies, etc.).
6. Schedule time for independent use of MyCD. Arrange use of the laboratory during times when teacher is away attending seminars/courses/meetings or during the students’ free time after the mid-year or final year examinations. The Text Book CD-ROM (MyCD) complements the text book. Further explanation of the content in the text book are provided in the CD. Menus provided are e-glossary, e-journal, e-link, e-test and calculator. Although MyCD covers only certain content in the text book, the explanation provided would enhance students’ understanding of the specific mathematical content.

7. For the purpose of revision, or when teacher is away attending seminars/courses/meetings or during the students’ free time after the mid-year or final year examinations, arrange use of laboratory for sites such as eExam. eExam is specially designed for Year 4, 5 & 6 Malaysian students preparing for the UPSR. It's a friendly, online, interactive workbook, which covers four of the subjects in UPSR, i.e. Mathematics, Science, English and Bahasa Malaysia. eExam subscription rates are very reasonable. It's RM55 for six months and a special discounted rate of RM100 for 1-year. http://www.exam.com.my/siw4/default.asp

**Instructions to Participants**

1. Participate in the discussion on integrating courseware for teaching and learning in laboratory setting and sample lesson plan for integrating courseware in laboratory setting. [30 mins]

2. Work in groups of fours based on levels that you teach in school: primary, lower secondary or upper secondary. Examine the courseware that you have brought with you. Identify its suitability as a tool to facilitate learning in a laboratory setting. In the simplified Courseware Review sheet (Appendix 1), indicate:
   (i) courseware title/publisher;
   (ii) segment;
   (iii) how it can be used in teaching and/or learning with teachers’ guidance and/or independent learning, and/or enrichment; and
   (iv) whether it is suitable for classroom or laboratory instruction. [30 mins]
   Use this Courseware Review for the lesson plan that you will be developing in the next activity.

3. Study the Lesson Plan 2 given (Appendix 3). In the same groups of fours, discuss and debate on ways to improve the lesson plan for a more integrated solution of courseware integration in mathematics teaching in laboratory setting. [30 mins]
ACTIVITY 5
Development of Courseware Integrated Lesson Plans

Introduction
The main output of this workshop is to develop lesson plans that integrate effective use of courseware. The lesson plans would be a guide to other teachers in implementing effective courseware integration in their classroom or laboratory activities.

Expected Learning Outcomes
At the end of this activity, participants are able to develop lesson plans that effectively utilize the available courseware for the teaching and learning of mathematics.

Instructions to Participants
1. Work in the same groups of fours based on levels that you teach in school: primary, lower secondary or upper secondary. Using the references that you have brought with you and resources available in the Internet develop a lesson plan for a 2-periods lesson using the formats of the sample lesson plans provided in Appendix 2 and 3. You may add in other details as you see fit.
2. Use your laptop to write the lesson plan.
3. Be as innovative as possible. However, the lesson plan must be reflective of the current infrastructure and materials that are available in most smart schools.

[2 hours]
ACTIVITY 6

Presentation of Courseware Integrated Lesson Plans

Introduction

The power of sharing:

\[\text{Often, we are too slow to recognize how much and in what ways we can assist each other through sharing such experiences and knowledge.} \]

- Owen Arthur

Expected Learning Outcomes

At the end of this activity, participants are able to:

1. present the group's lesson plan; and
2. justify the appropriateness of the segment/s of the courseware to be integrated in the teaching and learning of mathematics.

Instructions to Participants

1. Be prepared to share your group's lesson plans with the others. Four groups working on upper secondary content, five groups on lower secondary and five groups on primary mathematics content will be randomly chosen to present their courseware integrated lesson plans. The group will also need to show the courseware segments that will be integrated in the teaching.
2. Each group will be given 15 minutes for their presentation and 5 minutes for comments and discussion.

[4 hrs 45 mins]
CLOSURE

Road Map for Courseware Integration in Teaching and Learning of Mathematics

As a follow up activity of this workshop, participants are expected to:

1. conduct similar workshops at school levels;

2. initiate development of Courseware Review Database of all available courseware in mathematics as a reference for all mathematics teachers in the region. This has to be a collaborative effort among all mathematics teachers in the school/district or state. The Courseware Review Database should be made available online; and

3. share ideas and best practices in conducting courseware integrated lessons by writing lesson plans which should be made available online. The website should allow uploading of materials by teachers.
## Appendix 1
### COURSEWARE REVIEW

<table>
<thead>
<tr>
<th>Courseware Title/Publisher</th>
<th>Segment</th>
<th>Suitability of Segments</th>
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<td></td>
<td>Laboratory</td>
</tr>
<tr>
<td>Courseware Title/Publisher</td>
<td>Segment</td>
<td>Suitability of Segments</td>
</tr>
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<td>Laboratory</td>
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</tbody>
</table>
Appendix 2
LESSON PLAN 1
Integration of Courseware in Classroom Setting

Subject : Mathematics  
Form : 2  
Number of Students : 36  
Time : 1 hr 20 mins  
Title of Lesson : Translation

Expected Learning Outcomes
By the end of the lesson, students are able to:
1. identify a translation.  
2. determine the image of an object under a given translation.  
3. describe a translation by stating the direction and distance of the movement.

Content
1. Concept of translation.  
2. Image of an object under a given translation.  

Students’ Prior Knowledge
1. Students encountered map reading in geography.  
2. Students have learned about the Cartesian coordinate plane.

Noble Values
1. Cooperativeness.  
2. Responsibility.
Materials/Resources

1. Mathematics Form 2 Teaching Courseware CD-7, Curriculum Development Centre.
2. Geometer’s Sketchpad.

Set Induction (5 mins)

The teacher writes the word ‘translation’ on the board. The teacher asks if anyone knows what the word means. The teacher explains that most of us refer to translation as a written communication in a second language having the same meaning as the written communication in a first language.

The teacher then asks a student to come to the front. Before the class starts, the teacher had already created an x and y axis grid on the floor using masking tape. She gets the students to focus on the location that he is standing. Then the teacher asks the student to walk diagonally to a location that the teacher determines on the grid floor. The teacher asks the students, “How can you describe your friend’s movement?” The teacher then asks the same student to walk to the side, alongside the x-axis, then move to the front, alongside the y-axis, to get to the same location, thus making an ‘L’ shape movement. The teacher asks students to consider the movement and the final destination. Based on the feedback by the students, the teacher wraps up the discussion by saying that the movement can be described using mathematics, and the new topic that will be learned is ‘Translation’.

Lesson Development

Note: The lesson should focus mainly on the integration of Smart School Courseware, e-Materials and PPSMI courseware. However, at the time the module was written, the author did not have access to these materials.

<table>
<thead>
<tr>
<th>Steps/Time</th>
<th>Content</th>
<th>Method/Activities</th>
<th>Teaching Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 (10 mins)</td>
<td>Identifying a translation. A translation is a process where all the points on a given plane are moved in the same direction and through the same distance. In a translation, the direction and distance moved always remain a constant.</td>
<td>Using the Mathematics Form 2 Teaching Courseware, the teacher shows Lesson 83 – Image and Object of Translation.</td>
<td>Mathematics Form 2 Teaching Courseware CD-7.</td>
</tr>
</tbody>
</table>
The teacher writes the definition of translation on the board. She/he further clarifies that a transformation is a 1-1 correspondence between points in a plane.

To translate an object means to move it without rotating or reflecting it. Every translation has a direction and a distance.

The teacher gives examples of translation and describe the movements involved:
1. movement of a car from a space in a parking lot to another space in the same parking lot.
2. rearrangement of furniture in a living room.

Students were then asked to provide other examples of translations in everyday contexts.
Image of an object under a given translation.

In a translation, every point in the object maps onto its corresponding point in the image.

The teacher further demonstrated the idea of translation using the software, Geometer's Sketchpad (GSP). Using a grid plane, the teacher shows translation of a point and object. The teacher further constructs different types of polygons and determines the translation by typing in the horizontal and vertical distances for the translation. For each translation demonstrated, the teacher focuses on the initial coordinate point of each point and the resulting coordinate point, referred to as the image.

The teacher gets three students in front of the class to try out other translations using GSP.

The teacher constructs a quadrilateral. Under the same translation, the teacher asks students to write the resulting image in a table on the white board. The teacher explains that in cases where the coordinate is not defined, e.g. \((x, y)\), the image is \((x', y')\) and image of point \(A\) is \(A'\).

<table>
<thead>
<tr>
<th>Point</th>
<th>Image</th>
</tr>
</thead>
<tbody>
<tr>
<td>((x, y))</td>
<td>((x', y'))</td>
</tr>
<tr>
<td>((3, 4))</td>
<td>?</td>
</tr>
<tr>
<td>((5, 7))</td>
<td>?</td>
</tr>
<tr>
<td>((1, 2))</td>
<td>?</td>
</tr>
<tr>
<td>((6, 6))</td>
<td>?</td>
</tr>
</tbody>
</table>

The teacher asks the students to look for the relationship between the point and its image.

Can the image be determined if the object and the translation is known?

Likewise, can the original position of the object be determined if the image and the translation is known?
Likewise, can the original position of the object be determined if the image and the translation is known?

The teacher provides the following examples. Students are asked to identify whether the given transformations represent translations.

(i)

(ii)

(iii)
### Conclusion (10 mins)

To conclude the lesson, the teacher uses the Mathematics Form 2 MyCD, Volume 2 by Arus Intelek. The teacher opens up the Multimedia Gallery of Chapter 11, Insight 1 and the Animation to determine image under a translation.

### Evaluation (15 mins)

The teacher asks the students to work on the practice questions given in printed worksheets. Students are called to the front to give their answers.

### Assignments

Page 166, Number 3 (a), (g), (h).
Page 167, Number 5, 7, 9(b)
Appendix 3

LESSON PLAN 2
Integration of Courseware in Laboratory Setting

Subject: Mathematics
Form: 4
Number of Students: 36
Time: 1hr 20 mins
Title of Lesson: Chapter 3: Subsets of a Set

Expected Learning Outcomes
By the end of the lesson, students are able to:
1. identify if a given set is a subset of a given set.
2. use the symbols $\subset$ and $\not\subset$ to represent subset and not a subset of a given set.
3. represent subsets using Venn diagram.
4. list possible subsets of a given set.

Content
1. Concept of subset of a given set.
2. Symbols for ‘subset of’ and ‘not a subset of’
3. Representation of subsets using Venn diagram.
4. Possible subsets of a given set.

Students’ Prior Knowledge
1. Students are familiar with the normal usage of the ‘sub’, such as subtopic.
2. Students have learned sets in the previous few lessons.

Noble Values
1. Cooperativeness.

Materials/Resources
2. PowerPoint Presentation.
3. Applet on Venn Diagrams.
4. Mathematics Form 4 Teaching Courseware.
Set Induction (3 mins)

The teacher asks the students to name some English words that begin with ‘sub’. Based on the list of words given, the teacher highlights ‘sub’ as part of a word as in subject and submarine to ‘sub’ that conveys meaning, such as subtopic and subcontractor. The teacher then asks the students if they are familiar with the meaning of the word ‘sub’ in subtopic. The teacher guide students in understanding meaning of ‘sub’ as ‘part of’. The teacher then introduces the word ‘subset’ by writing it on the board. The teacher asks the students to make a good guess on the relationship between set and subset.

The teacher reads out the content that will be covered in the lesson.

Lesson Development

Note: The lesson should focus mainly on the integration of Smart School Courseware, e-Materials and/or PPSMI courseware. However, at the time the module was written, the author did not have access to these materials.

<table>
<thead>
<tr>
<th>Steps/Time</th>
<th>Content</th>
<th>Method/Activities</th>
<th>Teaching Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 (20 mins)</td>
<td>Concept of subset of a given set. Symbol ⊆ is used to represent ‘a subset of’, while the symbol ⊄ is used to represent ‘not a subset of’.</td>
<td>The teacher shows Multimedia Gallery 2 using the CD-ROM for Textbooks Form 4 by Cerdik Publications. At the end of the segment, the teacher asks the students to explain the meaning of subset based on the multimedia presentation that they see. The teacher then gives the formal definition of subset using a PowerPoint presentation.</td>
<td>CD-ROM for Textbooks Form 4 by Cerdik Publications</td>
</tr>
</tbody>
</table>

The teacher emphasizes that a subset is a set that you can make by choosing none, some, or all of the elements of a set. The teacher gets students to notice the relationship between the given set and the subset.

The teacher then asks the students to give examples of sets and their subsets from events in daily life. The teacher then continues with the PowerPoint presentation that gives examples of sets and their subsets.
<table>
<thead>
<tr>
<th>Steps/Time</th>
<th>Content</th>
<th>Method/Activities</th>
<th>Teaching Materials</th>
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<tbody>
<tr>
<td></td>
<td>The teacher emphasizes on the use of the symbol $\subset$ to represent 'a subset of'.</td>
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<tr>
<td></td>
<td><em>Example 1:</em></td>
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<tr>
<td></td>
<td>Yuza, Izdihar, Zharif and Batrisyia are children of Mr. Zainal. Therefore, ${\text{Izdihar, Batrisyia}} \subset {\text{Yuza, Izdihar, Zharif, Batrisyia}}$. Likewise, ${\text{Izdihar, Batrisyia}} \subset {\text{Zainal's children}}$, and ${\text{Yuza, Batrisyia}} \subset {\text{Zainal's children}}$, and ${\text{Yuza, Zharif, Batrisyia}} \subset {\text{Zainal's children}}$.</td>
<td></td>
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<tr>
<td></td>
<td>The teacher also highlights that Izzati and Irrina are not children of Mr. Zainal. Therefore, the relationship can be represented using the symbol $\not\subset$ to represent 'not a subset of'.</td>
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<tr>
<td></td>
<td>${\text{Izzati}} \not\subset {\text{Zainal's children}}$, ${\text{Irrina}} \not\subset {\text{Zainal's children}}$, ${\text{Izzati, Irrina}} \not\subset {\text{Zainal's children}}$, and ${\text{Izzati, Irrina}} \not\subset {\text{Yuza, Izdihar, Zharif, Batrisyia}}$.</td>
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<tr>
<td></td>
<td><em>Example 2:</em></td>
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<td>${\text{violet, indigo}} \subset {\text{colours of the rainbow}}$.</td>
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<td>The teacher highlights that ${\text{violet}} \subset {\text{colours of the rainbow}}$, and ${\text{indigo}} \subset {\text{colours of the rainbow}}$. Also, ${\text{violet, indigo, blue, green, yellow, orange, red}} \subset {\text{colours of the rainbow}}$.</td>
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<td>The teacher then asks the students to indicate the truth of the following statement:</td>
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<tr>
<td></td>
<td>(i) ${\text{even numbers}} \subset {\text{whole numbers}}$</td>
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<td>(ii) ${\text{odd numbers}} \subset {\text{integers}}$</td>
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<td></td>
<td>The teacher concluded about subset using PowerPoint presentation.</td>
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<tr>
<td>Step 2</td>
<td>Representation of subsets using <strong>Venn Diagram</strong></td>
<td>Subset</td>
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<td>-------------------------------------------------</td>
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<td></td>
<td>The teacher explains the use of the applet to the students by showing them the first example on the page. The teacher asks if they know what the answer is. When a student responds correctly, the teacher clicks in the appropriate section of the diagram, the circles representing the sets will change colour.</td>
<td>If ( A = {a, i, d} ) and ( C = {a, i, d, z, h} ), then ( A \subseteq C ) because ( z \in C ) and ( h \in C ) but ( z \notin A ) and ( h \notin A ). The fact that ( A ) is not a subset of ( C ) is written as ( A \nsubseteq C ).</td>
<td></td>
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</tbody>
</table>

|         | The teacher opens the browser to **Venn Diagrams** in order to demonstrate the idea of set representation using Venn Diagrams. [http://www.shodor.org/interactivate/activities/VennDiagrams/](http://www.shodor.org/interactivate/activities/VennDiagrams/) | **Subset** |
|         | - If \( \mathbb{A} \subset \mathbb{B} \) and \( \mathbb{B} \subset \mathbb{A} \), it must be the case that \( \mathbb{A} = \mathbb{B} \). |
|         | - Every set is a subset of itself. |
|         | - The empty set is a subset of every other set. |
|         | - The set \( \mathbb{A} \) is called a **proper subset** of \( \mathbb{B} \), if \( \mathbb{A} \subset \mathbb{B} \) and \( \mathbb{A} \neq \mathbb{B} \). |
The teacher gets the students’ attention on the location of the “Check Answer” button and check the students’ answer.

The teacher asks the students to type in the URL for the applet and work in pairs to answer all the questions in the applet. The teacher wanders around the room to ensure that everyone is on task and understands how to use the applet.

Based on activity, the teacher guides the students to represent proper subset $A$ of set $B$ using a Venn diagram. Venn diagrams are pictures of sets. Venn diagrams were named for the mathematician John Venn.

A is a subset of B.

The teacher then shows Lesson 22 of the Mathematics Form 4 Teaching Courseware developed by Curriculum Development Centre to reinforce students’ understanding on Venn Diagrams.

Note: Although this applet focuses on the idea of intersection, it can also be used to introduce the idea of Venn diagrams. It can be regarded as a game that is motivating yet challenging.

Mathematics Form 4 Teaching Courseware

The teacher opens up the PowerPoint slides shown earlier on subsets of Mr. Zainal’s children. The teacher gets students to give all possible subsets.

The teachers asks the following questions: “Is the null set a subset of $\{10, 20, 30, 40\}$?”. The teachers ask “Why is that so?” if a student says yes, and “Why not?” if a student says no.

The teacher then guides the students in providing a systematic listing so as to be exhaustive, starting with subsets containing (i) only one element, (ii) only two elements, (iii) only three elements, (iv) all four elements, and not forgetting (v) the empty set. The students then count the number of possible subsets of the given set.
Steps/Time | Content | Method/Activities | Teaching Materials
---|---|---|---
| | Teacher gets students to work in groups of fours to fill up the following table. | | 

<table>
<thead>
<tr>
<th>Set</th>
<th>No. of elements in the set</th>
<th>Lists of sub-sets</th>
<th>No. of sub-sets</th>
</tr>
</thead>
<tbody>
<tr>
<td>A = {a}</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B = {a, b}</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C = {a, b, c}</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D = {a, b, c, d}</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

At the end of group session, the teacher guides the students to conclude the relationship between number of elements in a set to the number of possible subsets.

**Conclusion (5 mins)**

The teacher uses the *Mathematics Form 4 Teaching Courseware* developed by Curriculum Development Centre, on Lesson 21: Summary to conclude the lesson.

**Evaluation (10 mins)**

The teacher asks the students to work on the practice questions available in the CD. A printed worksheet is given to students as supplement to allow them to write the answers on paper for future reference. Students are asked to self check their answers.

**Assignments**

Page 23, Number 1 (a), (g), (h).
Page 25, Number 5, 7, 9(b).