AN ANALYSIS OF BOOK RESOURCES FOR PRIMARY SCIENCE: Implications for Improving the Use of Textbooks in Indonesia

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CONTENTS

Appendices

List of Tables

ABSTRACT

In Indonesia, textbooks are very important, and the teaching of science is not making maximum use of these resources so as to help children's understanding of science concepts. Because of this failure, teachers find it very difficult to explain concepts in a manner children can understand. In this study I focus on ways of improving this situation by identifying how teachers can take advantage of the abundant resource material so as to involve children's ideas and everyday experience and encourage the use of process skills in coordinating children's conceptual and procedural understanding. Central to my analysis is the benefit of book resources to the Indonesian child in understanding science concepts and in relating these to everyday life problems.

In addressing these central issues, my report includes the following: chapter I provides an introduction to the study; chapter II deals with research on children's learning in science and the importance of book resources in learning and teaching in order to develop criteria for evaluating book resources in science; chapter III outlines the methodology; chapter IV provides a detailed analysis of the schemes and chapter V discusses the findings and makes suggestions about the structure of supplementary resource material that could be used with the Indonesian textbooks. The strengths of the UK science schemes were used in giving recommendations concerning the structure of science books and their use in helping children to understand science.

The results show that the Indonesian textbook does not take into account children's ideas so as to help children to develop their own ideas and ways of thinking. Second, background information for teachers, and activities which promote children's process skills and procedural understanding, are also limited. Such information and activities encourage children's creativity and also help teachers to raise their confidence in teaching science. Third, questions provided are generally unproductive and so do not help teachers to assess and promote childrens' scientific ability.

In conclusion, it is possible to adapt some of the elements in UK book resources for use in the Indonesian context. The ideas and structures recommended and methods of implementation suggested might help teachers in improving teaching and learning in science and promoting childrens' process skills and procedural understanding.

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CHAPTER I

AN ANALYSIS OF THE INDONESIAN PRIMARY SCIENCE TEXTBOOK

BACKGROUND

In Indonesia, the textbook is still seen as the staple diet in the classroom. It is regarded as an essential, indeed the main teaching aid. The Indonesian science textbook is structured in such a manner that skills, such as investigating, analysing, interpreting and communicating are given little attention, and generally children are encouraged simply to remember facts. The materials are didactic and compel the teacher to follow traditional teaching styles which emphasise rote learning. Almost all the published materials start with instructions as well as questions, so hardly ever do we find materials directed to practical investigations and developing children's curiosity through raising their own questions. Because of this, my analysis focuses on ways of improving the teaching and learning of science in primary education through the use of good resource materials.

In considering both appropriate materials and ways of using them, I will draw on examples from textbooks from the education system in the UK which tend to give greater emphasis to children's active involvement in learning. Also to be included in my study is the way in which resources can encourage the development of process skills, which are used in coordinating children's conceptual and procedural understanding in investigations, and can take account of children's ideas in science. Central to my analysis is the benefits which good resource books can provide to the Indonesian child in understanding

science concepts and procedures and in relating these to the solution of everyday life problems.

A very important part of the job of a teacher is to guide the child towards tasks where he or she will be able objectively to do well but not too easily, not without difficulties to be mastered and creative solutions to be found. A teacher in Indonesia finds it difficult to achieve this goal because the resource materials (textbooks) do not give the required platform in terms of subject content structure. Based on the National Assessment, taken in 1985/1985, the average achievement of children in science is only 5.39 (the maximum score is 10) (Jiyono, 1992). The lack of focus on the development of children's process skills may contribute to this, in particular in relation to the open-ended questions used in the assessment. Children are not given a firm basis for developing their investigative and analytic thinking processes.

As teaching and learning in Indonesia depends heavily on book resources, it is important that good resource material should be created to provide both teachers and children with background knowledge and indicate starting points for practical investigative science. Suggestions for the development of children's understanding need to be flexible enough to be incorporated into teachers' own topic plans.

In view of this, I am interested in developing criteria for identifying good teaching material in science, analysing existing material and recommending changes in both content and use of current material. Indonesia is moving towards being a more scientific and technological society and therefore needs to develop

children's investigative and analytic skills and abilities to use these in different situations. All recommendations made will be in line with the educational reforms which were made by the government in 1994. These stated that the functions of the science curriculum are to provide information about the natural environment, develop skills, widen horizons, and increase technological awareness in relation to the use of science in daily life (P&K, 1993). In suggesting resource materials which are suitable for the development of children's process skills and relevant to the Indonesian context, I am going to consider the following questions:

1. What are the criteria for identifying good primary science resources materials?
2. What are the strengths and weaknesses of Indonesian primary science material?
3. What are the strength and weaknesses of some common resource materials used in the UK?
4. Can the UK schemes offer any useful suggestions or ideas?
5. What supplementary materials and activities could be used to improve on Indonesian textbooks?

The report will consist of the following chapters:

Chapter II. Literature review and development of criteria for evaluating book resources in science

Chapter III. Methodology

Chapter IV. Analysis of the schemes

Chapter V. Discussion and conclusion

CHAPTER II

LITERATURE REVIEW AND DEVELOPMENT OF CRITERIA FOR EVALUATION BOOK RESOURCES IN SCIENCE

Use of textbooks in Indonesia is still a common practice in schools, and teachers use textbooks closely to support the teaching and learning process. However, in considering the use of textbooks more widely, it is important to recognise that it is difficult to write as if there were one international role for book resource material, since discussion needs to relate to the context of the educational system in each country. For example: in Indonesia, textbooks offer a way of introducing teachers and children everywhere in the country to common socialising experiences, and therefore the books form a vital integrative function. In contrast, in the UK, there is no national textbook; teachers are exposed to a variety of book resources and do not rely on one form of text. In the UK, the book resources to support teaching at primary level are often referred to as 'teaching schemes' which provide a structure for the learning experiences that children should have during their time in school. Schemes are often sufficiently structured to ensure coverage of the national curriculum programmes of study in an appropriate way (DFE, 1995). However, they also need to be flexible, to allow teachers to respond the needs and interests of their children (Holland, 1996). Most teaching scheme material in the UK consists of teachers' guides and children's books provided separately. Teacher resources tend to give guidance on how to develop children's scientific knowledge, understanding, skills, strategies and attitudes, alongside offering suggestions for the content and sequencing of activities, whereas the children's book resources often present a variety of scientific activities and further background information related to the

topic. They can be read by children themselves or shared with an adult, providing the opportunity for adult and children to find out about science together (Howe, 1989). Harlen (1993) has argued that books need to be a source of interest and delight, challenge and stimulation, and should be structured to encourage the development of process skills and an active approach to learning.

Despite these differences in approach there are common needs to be met. Lakin (1994) wrote, 'A great many teachers rely heavily on textbooks to shape their science programmes because their varying backgrounds and lack of experience make the teacher feel alienated from the given ideas and concepts of science'. With this in mind, teachers think that book resources in science should help them to provide carefully structured activity-based programmes which develop scientific knowledge and understanding, the skills and strategies of investigations and scientific attitudes, and to make links with the requirements of the local curriculum. Book resources, therefore, should be concerned with the important notions of grading and sequencing, integrating and planning of divisions of content, where the writer should focus on the users (i.e. teacher and children) and on their needs (Gopinathan, 1983). Howe (1989) argued that it is in this way that class teacher can be confident in teaching science, because children are being guided through an appropriate range of scientific activities where their informal knowledge is built on, with relevant questions being asked and children's ideas being fostered.

Materials should help teachers in explaining science in the classroom and provide guidance in using resources for the teaching of science. Books of

enduring quality are those that withstand multiple readings and those that offer the potential for interpretation at a variety of levels, and can thus be revisited with renewed interest (Davies, 1984). In an equally significant way, through book resources, the curriculum is made explicit. Thus in many countries they play a very important function in educational assessment; e.g. In Indonesia, the assessment of children's work is mostly based on the content of the science textbook.

Books should not conflict with the demands of school curricula, syllabi, assessment procedures and what works best in the classroom. However, I also believe that good book resources can help teachers make significant changes in their approaches and practices in teaching science. This will involve changes in values, attitudes and belief about the teaching and learning of science. Based on research carried out by Science Process and Concept Exploration Project (SPACE) (Black, 1990), the Nuffield science scheme in the UK is a good example of this. The project sought both to find out about children's ideas in key areas of science and to explore strategies for developing those ideas. The SPACE Project tried to answer these questions through (1) a research phase, in which it investigated the nature of children's ideas about the world around them and how they came to form these ideas, and (2) a curriculum development phase, in which it developed classroom materials and trialled these with teachers. The Nuffield Scheme is the outcome of the curriculum development phase. These materials are now used widely in schools in the UK and support teachers in changing their practice to take more account of children's ideas.

After considering the role and the importance of book resources in learning and teaching, I am going to consider the criteria which good book resources should meet if they are to promote effective learning in science.

Based on recent research findings, there are several important aspects which should be considered in selecting good book resources for science.

A. Criteria Related to Effective Learning in Science.

1. Does the material take into account children's ideas and their everyday experience of science?

Children use existing ideas in attempting to make sense of new experience, and when their ideas change as a result of this, the learning depends on the way in which children process information, how they select, gather and use it (Harlen, 1993). Children's everyday experience and ideas therefore have an important influence on learning, as they do on the rest of people's lives. Children learn from experience. They take information from many sources and use it to try to explain their experiences. It is not always possible to predict what children will make of an event, partly because they are building on a different 'raft' of ideas from those of the adult. It is difficult to separate the different sources of experience that influence the development of children's ideas.

Recent research in the area of children's ideas has focused on the issue of helping children to change their ideas. The SPACE project (Russell, 1992) was

set up not only to discover children's ideas, but also to work with teachers in attempting to find ways of helping children towards more useful ideas. In this project, the child has the key, because, she or he has the opportunity to develop her or his own ideas and ways of thinking. The SPACE Project developed materials which teachers needed in order to help them with their background knowledge, information about children's ideas found from research and ways of finding out ideas. It provided teachers with starting points for practical investigative science to challenge thinking, and enabled them to plan for the development of children's understanding (Russell, 1992).

This work suggests that the importance of children's ideas and their everyday experience of science should be taken into account in evaluating and choosing good book resources. To enable teachers to work from children's ideas, teachers' book resources need to include: (1) activities which help the teacher to know what the children's ideas are and provide a basis for changing those ideas, (2) proposed activities specific to the topic concerned, with descriptions of common ideas exhibited by children arising from these activities, (3) a collection of ideas for challenging and extending children's thinking, using a range of classroom activities which have been tried and found both practical and effective (Bentley, 1988). Teachers can use these activities to guide their teaching; meanwhile children will be encouraged to develop their ideas.

Children's interest is aroused when the learning starts from the things they already know; children will use this experience in exploring and investigating new ideas. Attitudes that a child may have about the content play a central role in the

ways the ideas are developed. It is therefore useful if each topic starts from an exploration of children's everyday experiences. It is important that children's ideas are invited in all units and that book resources should be flexible enough to reflect children's specific interests. Book resources in science should set up the expectation that all ideas have to be tested, because children learn from experience, take information from many resources and use it to explain their experiences. Children need experiences that allow them to see that their idea or conception is inappropriate, which is far more powerful than telling them that it is wrong.

Book resources should combine the purposes of providing information, extending experience through activities in and out of school, enabling children to gain ideas and make interpretations and offering explanations about what they do, see and feel. The immediate environment of the school can provide an abundant source of opportunities for considering the applications of science in everyday life. This can help them understand new ideas, for example, What happens when the sun comes and hits your bodies? Why does your shadow change in direction? Children have opportunities to make sense of their own experience rather than just recalling knowledge.

Recently the Centre for Research in Primary Science and Technology in Liverpool (CRIPSAT) (Russell, 1992) was centrally involved in the development of distance-learning materials, aimed at helping teachers in developing their background of knowledge and understanding in science. The centre developed textual materials in order to support teachers' understanding consistent with a

constructivist approach. The issues raised in this project were: firstly, adults can be assumed to share many characteristics of learning through a constructivist approach; secondly, even textual forms can adopt an interactive approach which encourages the reader to reflect on direct experience, carry out activities, etc. This material was also designed to include a 'fast-track' for those who wanted only a rapid review of the science content. From my point of view, good resource materials should engage teachers' thinking and encourage them to reflect on their own understanding, alongside children's understandings. It should promote an approach to science teaching which takes account of children's current level of understanding and enables teachers to identify how children's thinking might progress.

Based on the discussion above, the following considerations in relation to children's ideas and childrens' everyday experience are important in choosing appropriate book resources:

1. Does the book take account of children's ideas?
2. Does the book relate to childrens' everyday experience?
3. Does the book give opportunities to consider applications of ideas introduced both in and out of the school?
4. Does the book help teachers to develop their background of knowledge and understanding of science?

2. Does the material encourage the development of scientific process skills and procedural understanding?

The view that ' book resources need to encourage the development of scientific process skills and attitudes, as well as concepts of science...', is a question which should be taken into account when recommending book resources. This emphasised in both the Indonesian Primary Science Curriculum 1994 (DP&K, 1993) and the National Curriculum of England and Wales (DFE, 1995). It is important in science to encourage the development of scientific process skills.

Process skills and procedural understanding, according to Woolnough (1991), refer to observing, hypothesising, predicting, investigating, drawing conclusions and communicating. Science is about solving problems in everyday and scientific situations. The APU (1988) refers to problems as tasks in which children cannot immediately see an answer or recall a routine method for finding it. To investigate and solve a problem, children need not only to use process skills. The successful usage of the process skills can only be achieved if the interdependence of conceptual understanding, processes and procedural understanding is made explicit to teachers (Foulds & Maschiter, 1991). Processes are the various 'ways of thinking' that are needed to coordinate the childrens' conceptual (subject knowledge) and procedural understanding (concepts of evidence) into an overall plan for the task. As the task develops, they will use and develop concepts (such as gravity) while utilising and refining the procedural element of the task, deciding what to vary, measure and control and how to do it effectively to give valid and reliable results (Woolnough, 1991).

Book resources should give higher profiles to these different aspects and the links between them in investigations. Tobin, in Woolnough (1991), suggests that the vast majority of children are able to derive some satisfaction from the positive outcomes of investigations in science. If book resources give opportunities for carrying out investigations (at a range of levels appropriate with the ability of the learner) in the real contexts of everyday situations, then the understanding not only of concepts but also of scientific procedures by children will be improved.

There is a little reward for changing teaching strategies and classroom organisation to emphasize high-level cognitive learning and process skills if book resources continue to present material in a way that emphasises the recall of facts. If book resources just provide information and encourage only theoretical work, there is little encouragement for children to take risks and think divergently. Thus, one essential characteristic of good book resources is that they provide practical activities which develop process skills as well as conceptual and procedural understanding in science.

In my opinion, the application of ideas and process skills is influenced by attitudes; for example the expression of childrens' curiosity is stimulated by reading a book or watching intently. Attitudes have an important influence on learning through determining reactions to people, to objects and events. Giddings in Woolnough (1991) classified different attitudes associated with the learning of science in the following way: ... attitudes to science and scientists; attitudes to inquiry; the adoption of scientific attitudes like curiosity and open-mindedness; the enjoyment of science learning experiences; interest in science

apart from learning experiences; and interest in a career in science. Book resources should provide coverage of each of these distinct categories because they have the potential to enhance constructive social relationships as well as positive attitudes and cognitive growth. If, for example, the resources are geared towards the development of open-mindeness then questions which encourage this aspect need to be a common feature in the books.

In order to encourage positive attitudes, it is important that book resources should incorporate the following aspects. Science learnt should be useful in everyday life and for the future, and related to the real world. If book resources enable existing knowledge and understanding to be applied in the pursuit of solutions to real life problems, children will tend to like science and engage in more challenging activities. Investigations have a motivating influence on children; the challenge of responding to a problem which they see as relevant to the everyday demands of modern society makes them feel committed and it is these aspects which book resources should foster. Making demands at a level commensurate with children's understanding is also important in ensuring positive attitudes in learners.

Howe (1996) defines a concept in science education as referring to such constructs as energy, molecule, density and solar system, to name but a few chosen from a vast list that forms the core of a science curriculum at all levels. Children often lack the conceptual background to learn difficult and unfamiliar topics in science. One effective way to clarifies is for the teacher to provide a bridge between the unfamiliar concept and the knowledge which children have;

this bridge can be provided by making links with children's prior knowledge and experience and suggesting practical activities, enabling those who do not readily think in abstract terms to develop a better understanding of the concepts to support the teacher. It is important that key concepts involved are well identified.

The role of the textbook is important in the context of education for an increasingly technological society. Therefore, all the listed attributes above should be of paramount importance in a good textbook. Thus, the book must allow the development of process skills, concepts and attitudes so as to bring about an individual who can use science in his or her everyday life.

These considerations support the following the main ideas related to the development of scientific process skills and attitudes, as well as concepts of science, through book resources:

5. Does the book encourage the development of scientific process skills and procedural understanding?
6. Which concepts of science are involved? Are the key concepts clearly identified for the teacher and the child?
7. Does the material give guidance about teaching approaches? (starting points, progression, sequence of events, planning and assessment)
8. Does the book help a teachers to create activities which provide opportunities for children to work together and promote positive attitudes, e.g. respect for evidence, sensitivity to the living and non-living environment?

3. Does the material encourage a variety of practical work?

Children learn best when they are able to relate what they are doing to their own experience, and learn most successfully when the learning involves practical work. It must be borne in mind that practicals give first hand experience-hence the emphasis on them in resource materials. Playing with items is one of the most interesting parts of a child's learning. For example: Sulistiorini (1996) found that children developed their ideas about shadows through experiment with a torch, a ball and a box screen. She wrote that first hand experience gave the children meaningful evidence to expand their understanding, and so comprehension of the ideas about shadows was developed. Through practical work children can also develop scientific skills, processes and an understanding of scientific procedures.

Since practical work has such a motivating influence on children, book resources should give a variety of these activities so that children can be gainfully employed in the activities. If book resources help children to make accurate observations, arousing and maintaining interest, promoting logical reasoning and methods of thought, making phenomena more real through experience and enabling comprehension and carrying out instructions, children are motivated to learn and thus to increase exploration and understanding of the subject matter and to develop process skills and positive attitudes.

In the past, there has been a belief that skills will somehow develop automatically in the processes of doing practical work and that children will

'discover' scientific concepts. However skills have a distinct knowledge base which is connected directly and necessarily with the understanding of scientific evidence. There is now a recognition that there are different kinds of practical work in science, and each of them encourages development in different ways.

> 'Practical activities can be grouped into four basic types: (1) basic skills; this activity is commonly used to develop skills or techniques they may need to use their investigation, e.g. children should know how to use a stopwatch before measuring force (2) observations: this activity can encourage children to observe in a scientific way, i.e. children might examine the rubbish they collected in the park and sort it into different groups; (3) illustrations: the purpose of this activity is to illustrate a concept so that children gain first-hand experience of it. Illustrative work is using accompanied by detailed instructions that tell the children what to do, what apparatus to use, what to measure, how many measurement to take; (4) investigations: the activity gives children opportunities to carry out their own investigations, to help them apply and develop their existing understanding of scientific concepts and procedures (Glauert, 1996; p.28)

Whenever practical work is used, book resources should make links with conceptual understanding. However, as Foulds and Gott (1992) argued, children need not only to know certain ideas of science, but also why and how scientists have come to know this, and they need to have sufficient knowledge and confidence to be able to engage in these procedures for themselves. It should be remembered that the understanding of scientific evidence and the way in which it is assembled does not simply emerge from 'doing practical work' but has to be taught.

In order to promote children's skills and understanding in practical investigations, the following aspects should be noted. Simple skills, such as the use of a thermometer, can be taught using any practical activity ranging from a specifically designed task, perhaps as part of a skills circus, to its use as a tool

in a whole project. The understanding of concepts of evidence requires a higher level of understanding than skills because they require an appreciation of the task as a whole. The idea of 'appropriate accuracy', for instance, relates to the consideration of patterns in the resulting data. The accuracy must be such that the pattern can be unambiguously interpreted. It follows that book resources should be designed to teach the understanding and application of concepts of evidence, and there is a need to engage children with a sense of the whole task. Experience suggests that synthesis of skills and concepts of evidence is difficult to target in any other way than by involving the children in open-ended practical tasks where they are in control of the activity. The subsequent data collected are then owned by the children. They can be encouraged to think critically about the validity and reliability of their evidence. This ability to synthesise all these ideas into a workable strategy to solve a practically based problem is a key ingredient of scientific literacy (Gott & Duggan, 1996). So, different types of practical work can be used to develop the skills and understanding needed in investigation.

I also agree with Gott and Duggan (1992) when they emphasize that by presenting investigative work in schools, children will gain both an accurate grasp of procedural understanding and an opportunity to use and refine their conceptual understanding in practical contexts. Open-ended investigations have a particular advantage because they allow children to carry out a whole task, freely putting into practice their own understanding and applying their own ideas during the gathering of evidence. In contrast, other types of practical work, such as illustrative tasks which use recipes or detailed instructional worksheets, severely limit the decisions that children can take with regard to design,

measurement and data handling. These are a common feature of many textbooks.

The discussion above suggests that it is important to take into account the following in choosing appropriate book resources:

9. Does the book give opportunity for practical work?
10. Is there a balance of types of practical work? (Basic skills, observations, illustrative work and investigation)
11. Are there opportunities for investigations?
12. Do children have any choice in selecting materials and equipment? Does the practical work involve the use of simple and safe equipment and materials?

These questions are particularly useful in analysing teachers' book resources.

B. Physical Format and Content

Children learn best when the book provides them a good layout and includes pictures or stories. Yuill (1991) found that both visual and verbal organisers can facilitate children's understanding of the text. Comprehension during reading is an elaborate process dependent on variables within and outside the printed text. When children read or listen, they rely on previous knowledge to guide their comprehension. Harrison, in James (1991), has shown that reading ability acquired from class readers does not automatically transfer to that required for understanding textbooks. Science book resources may be written in standard language, but children may be apprehensive about their science experience.

At this point I will analyse the relationship between various aspects of book format and the readability of the text. Science book resources contain symbolic language, illustrations, numerical features, concepts, specialized vocabulary, repetition of key words, and scientific style. Thus, in order to help teachers in choosing good resource material to use in a classroom situation, I will focus my analysis on the physical format of the text, i.e. layout/picture/ illustrations and the readability of the text.

1. Does the layout and presentation assist childrens' learning (e.g. encourage interest, attention, retention, support less able readers)?

Teachers and publishers of educational materials need to select books with good and appropriate illustrations, but they often lack the basis on which to make choices when dealing with this aspect. Good illustrations can be powerful aids in learning new material; thus Constable (1988) argues that illustrations are still valued in teaching. The use of pictures as components of teaching and learning packages can be justified for two reasons. Illustrations assist learning, because illustrations are good for conveying concrete images, e.g. pictures of living and non-living things may be "worth a thousand words" and thus they are good for supporting words and providing support material when teaching a concept. Learning to use illustrations is a valuable educational aim in itself. There are other important roles for illustrations in a classroom; (1) an affective role, in enhancing interest and motivation (2) an attentional role, in attracting and directing attention (3) a didactic role, in facilitating learning by showing rather than telling and providing additional information (4) a supportive role, in

enhancing the learning of less able readers (5) a retention role, facilitating long term recall (Hartley, 1985, p.21).

Newton (1983) in a small study of primary children's science texts, found that the presence of illustrations can substantially improve children's ability to comprehend these texts. However, Harris, in Newton (1983) pointed out how difficult the use of illustrations can be. He suggests that young children are not used to lifting their eyes and then re-finding their place in the text, so they find the integration of text and illustrations difficult. They believe that the competent reader can cope with illustrations and text alongside each other, but the beginning reader may need help. Thus, appropriate integration and proportions of illustration and text should be taken into account in choosing good book resources.

The effect of text and illustration on the learning of a school science topic was measured by Reid (1986). He studied the effects of pictures in two different modes of presentation. He compared two modes of presentation, microcomputer and worksheet presentation and picture presentations. The results indicate that there is no general motivational effect of pictures on the learning of text, but that with higher ability levels the effect of specific pictures is beneficial, while with less able children they distract. In addition, there is some evidence to indicate that when material is presented in traditional worksheet mode, children might learn it more efficiently than the same materials presented in microcomputer mode.

The statement that children make the same sense of the illustrations as do

teachers needs to be challenged. This has implications for the use of such illustrations in science teaching. The first implication is that there is need for an increased awareness in science teachers of the difficulties which certain illustrations may pose for children. Furthermore, it must be recognised that if an illustration is intended to support the introduction of new ideas then this will be effective only as long as children have a sufficient understanding of whatever conventions are used in the illustration. More importantly, if children do not understand the conventions, they may use a dimly understood view of what the object may be, to decipher the conventions. One way to overcome this may be to teach explicitly about conventions in relation to viewing illustrations. The science teacher may be a source of information and ideas here, especially if there is a large symbolic content.

Elkind, in Constable (1988), confirms this view in a general sense, noting that in viewing complex pictures children's ability to describe the whole object increased with age. Older children are more organised and systematic in scanning the objects (pictures) than younger children. This then implies that in teaching using illustrations there is need to take account of the age of the children and consider carefully the structure of each page, for example: the size and style of illustration, the balance of text and illustration. All these lines of enquiry would lead to the possibility of a more informed use of illustrations as an aid to children's learning.

Based on the discussion of the importance of layout and illustrations in book resources, some considerations in choosing appropriate book resources are:

1. Do the layout and presentation assist childrens' learning (e.g. encourage interest, attention, retention, support less able readers)?
2. What sorts of illustrations are involved? Are they clear? Do they assist children's learning?
3. Is there an appropriate balance of text and illustration?

2. Are the book resources readable by children at key stage two (7 to 11 years olds)?

Readability is an assessment of the features of a text that make one text easier to read than another. There are many features of a text than affect the ease with which it is read, i.e. features of vocabulary frequency, word length and sentences length. Texts with a high readability are more difficult than those with a low readability.

Newton (1983) further suggests that the primary science material can be made more readable, that is, children will be able to comprehend it better, if it is accompanied by illustrations. Since comprehension is one aspect of readability, it is suggested that illustrations can improve the readability of such material. However, while the effect of illustrations was found to improve comprehension, this effect was not uniform. It would seem, therefore, that the presence of illustrations is not always adequate for improvement of the comprehension of textual material.

The importance of assessing the readability of books is realized when one

recognizes the relationship between comprehension of science book resources and the reading level of the materials. For example: Corey, in James (1991), has shown that biological articles rewritten to a lower level of reading difficulty by simplification of style and vocabulary and amplification of technical words helped children to increase their comprehension.

Cohen and Steinberg (1983) analysed three popular science textbook series for grade four, five and six and found that the passages on biological science were difficult because of a low standard frequency index (SFI) of all word categories, low repetition of non-technical words and the inclusion of unfamiliar words (especially technical words) and long sentences.

The implications of this would appear to be that science book resources should match the children's general reading ability. Thus, the main questions that can be asked in relation to the readability of science book resources are:

4. How readable is the book for children at key stage two (7 to 11 year-olds) in term of the length of sentences and use of technical vocabulary?

3. Are the types of questions provided in the book resources appropriate?

Questions provided in book resources can contribute positively to children's learning in science (Woodward, 1992). However, children may be interested in solving problems that are beyond their scope, either because the necessary equipment is inadequate or because the required experimentation is simply too

difficult or complicated. When children ask, they indicate that they want to know, and when they want to know, they are interested. Asking questions is an activity which can be investigated and also helps teachers to assess childrens' scientific ability. A clever teacher also recognises that, where questions arise and interest is present, functional literacy shows its worth. Children will not only be led to good books, but also look for and find answers to problems given (Harlen, 1985).

Harlen (1985) identifies two types of questions, productive and unproductive. She suggested that productive questions can be of the following kinds;
(1) attention-focusing questions-meant to fix attention on some significant detail which might be easily be overlooked; i.e. Have you noticed that all the cars do not go the same distance? or What do you think is inside the car that makes it move? (2) measuring and counting questions-these are questions such as how many, how long, how often, and children can use these questions in order to check their answers themselves; i.e.How far does this car go? or Does the slope make any difference? (3) Comparison-making questions-these questions bring about sharper observation; i.e. Do you mean that all the cars go the same distance? or What have we found out about how this car moves? (4) Action-provoking questions-these are the 'the what happens if ... ' questions which can always be truthfully answered. They entail simple experimentations and never fail to provide a result; i.e. What happens if you hold your magnet near a match? or What happens if you put your twig upside-down? (5) Problem solving questions-these questions will always set up a real problem-solving situation to which the children enthusiastically respond; i.e. Can you think how you can make this car go further? or Is there a relationship between the size of the car

and the distance it travels?

Unproductive questions are those to which a child either knows the answer (for example: where did you find it? or, if not (for example: What's it called?), the answer can be obtained from secondary sources, the teacher or reference books. Furthermore, recent research indicates that the use of productive questions encourages higher order cognitive skills (Allerton, 1993). This may be because in responding to an productive questions, the child has to form an internal representation of the response before actually giving it. In contrast, unproductive questions demand only one kind of response, the nature of which is already encoded in the questions.

The nature and types of questions asked in book resources are important, especially if these questions focus attention on eliciting understanding rather than recalling. For example: the question, 'What is the temperature now?' may provoke a response which is simply recall. Asking questions is a powerful way of attracting a response from someone. Children ask questions in class in order to expand their knowledge, as well as for other reasons; teachers ask questions of children to provoke their thinking, to check up on learning and also for other purposes such as to control behaviour and to monitor and regulate activities. Good questions in teaching resources can encourage class room activities, arouse interest, and widen the childrens' horizon of learning and knowledge of science.

The ability to allow children to express and challenge their own thinking is

fundamental in encouraging conceptual change. It is against this background that questions asked by the teacher and in book resources are very important in promoting children's scientific investigation. Success depends not only on the children's mental capacity to manipulate the variables but also on the ability of the writer/teacher to identify questions within a task in the first place. This is why Harlen (1985) argued that any question already has within it the kind of answer that can be given, even before it is spoken. The types of questions I have highlighted in my previous paragraphs have varying effects on children's thinking.

If these guidelines are taken into account by both teachers and writers, then the questions they provide will be useful for encouraging activity and discussion, or prompting children to carry out research using book resources to acquire more information.

Based on the discussion above, the following are important considerations in examining the types of questions provided in book resources:

5. What types of questions are provided in the book? How 'productive' are the questions given? Are they open-ended? Do they promote children's activity and reasoning?
6. Does the book provide questions for practical work?
7. Does the book clearly explain what the children are to do?
8. Does the book stimulate childrens' curiosity through the ways the activities are presented? Would the book motivate children to learn?

These questions are useful for examining children's books.

CHAPTER III

METHODOLOGY

A. Research Design

The design of this research is in the form of an evaluation study, as my main attention is on improving the teaching and learning of science in primary education in Indonesia through the use of book resources. In recommending new methods or approaches, I make use of examples from textbooks from the UK education system which tend to adopt approaches where children's involvement in learning is emphasised more than in Indonesia. Central to my analysis is the benefits the resource books can provide to the Indonesian child in understanding science concepts and in relating these to the solution of everyday life problems. Educational products, textbooks, play a major role in classroom instruction, therefore the effectiveness of these products is a matter of some concern to the researcher.

Borg (1989, p.742) called education evaluation a process of making judgements about the merit, value or worth of educational programs. This design is of interest because evaluation research yields important data about the benefits and problems of various program alternatives, which are then reviewed by persons with decision-making authority. Gay (1987) identified educational evaluation as the systematic process of collecting and analysing data in order to make decisions, whereas Worthen&Sanders (1987) says that evaluation in education is the determination of the quality, effectiveness, or value of a

program, product, process, objective or curriculum. In addition, according to Borg (1989, p.766-767), there are specific emphases in an evaluation of educational products-i.e. textbooks; assessment devices, comprehensibility, individualization, learner characteristics, management systems, motivational properties, prerequisites, readability, role of the children and role of the teacher.

B. Sampling

It was necessary to select particular schemes for evaluation and choose a particular area of the curriculum as an example. I used the following criteria in determining books to be used as a sample (1) the books are widely available in the schools (2) the schemes were recent and produced by a major publisher (3) the books are available in the library of the Institute of Education, University of London.

The topic of "light" was chosen as an example, because it is included in both curricula in Indonesia and England and Wales, and indeed the concepts addressed are similar. Materials for children at key stage two were selected, because in the Indonesian curriculum the topic of light is taught in year five.

Further details of the schemes used and a detailed comparison of the curricula in Indonesia and England and Wales are given in the sections that follow.

C. Background Information

There are two important areas of background information which should be considered in analysing the book resources selected.

1. A comparison of the content of the Indonesian Syllabus with the National Curriculum in England and Wales and in relation to the topic of 'Light'. This was used to check that light was a suitable example for use in comparing the schemes.
2. Descriptions of the teachers' schemes and childrens' books selected.

I. A comparison of the content of the Indonesian Syllabus with the UK National Curriculum in relation to the topic of 'Light'.

This analysis examines the content of the science curriculum in Indonesia and in England and Wales in order to identify the differences and similarities between them in relation to the topic of 'Light' at key stage two (for 7 to 11 -year-olds). This topic 'light' is addressed in primary science classes both in Indonesia and in England and Wales. In the Indonesian curriculum, the topic is considered important because it relates to the development of skills and technology awareness and is useful in daily life (GBPP, 1994). In the England and Wales Curriculum reasons for its inclusion are not clearly mentioned.

An Analysis of the Indonesian Science Curriculum

I am going to outline the Indonesian Science Curriculum from the 1994

Curriculum for Basic Education. In the 1994 Curriculum, the Ministry of Education and Culture declared that there was a great deterioration in primary educational standards, mainly in the science curriculum. In view of the relationship between science and technology, the government has developed a policy of promoting a science minded society at all levels in education (P&K, 1993). The curriculum for basic education is organized so that children can reach the national education objectives with due regard to their stage of development, taking into account a concern for the environment, national development demands, and the development of science and technology and the arts.

In 1994 the government introduced a new education system replacing the old curriculum. Basic education was to be on a nine-year cycle, meaning that children from the age of 7 to 12 years can enroll in a six-year course in primary school and children from the age of 13 to 15 years can enroll in an upper primary school for a three-year course.

In Indonesia, the functions of the science curriculum are to provide information about the natural environment, develop skills, widen horizons, and increase technological awareness in relation to the use of science in daily life (P&K, 1993). At the primary level, science is started in the third grade, whereas children in year one and two learn about science through science vocabulary introduced in the Indonesian Language course. Science in years three to six is approached through making observations of the natural as well as man-made environment. Children in the upper primary school are introduced to basic scientific understandings such as the relationship between cause and effect, and

observation procedures using equipment which goes beyond human senses. Furthermore, in the upper primary school, simple technological activities are also introduced to develop creativity in applying scientific ideas and making use of available natural resources.

As science is introduced in year three, this means that children from the ages of 9 to 15 years study science in more formal ways (science to be taught separately as an entity). The time allowed for science to be taught in classrooms depends on the particular year in the course;

* year three children have three hours per week (consisting of 30 minutes/hour sessions)
* year four to year six children have six hours per week (consisting of 40 minutes/hour sessions)
* year one to year three upper primary school children have six hours per week (consisting of 45 minutes/hour sessions)

This system requires primary teachers to improve their scientific knowledge and understanding as well as their competence in teaching science. In order to meet the requirements of the topics and the timetable, teachers often focus more on didactic approaches and rote learning so as to cover the syllabus rather than seeking to help children in understanding the subject. Teachers may also have limited understanding of the nature of science process skills and of the importance of helping children to develop these skills as well as scientific concepts and attitudes.

In the Indonesian syllabus, the topic of "light" is studied by children in year five. It is suggested that children conduct experiments about the properties of light, explore the relationship between light and vision, communicate and discuss the result of their experiments and apply their knowledge to their daily life. There are seven major topics listed relating to light and seeing:

1. Light travels in a straight line.
2. Light comes through a clear object.
3. Reflection.
4. Light is reflected at the boundary between two different materials.
5. White light can be split up into a range of colours.
6. There is a relationship between light and seeing.
7. Optical equipments help us to see the objects.

Furthermore, in the upper primary school the topic is continued through topics related to the concept of waves and the idea that light can be refracted and diffracted.

An Analysis of the National Curriculum in England and Wales

The National Curriculum in England and Wales is based on the reforms of the Education Reform Act of 1988. Compulsory school age in England and Wales begins at the start of the term in which a child is five years old, and the minimum leaving age is sixteen. The act requires that all publicly provided schools, within the years of compulsory schooling, address the requirements of the national curriculum and its associated assessment arrangements.

Teachers are required to teach three core subjects, the foundation subjects and religious education. The core subjects are Mathematics, English and Science. The foundation subjects are art, geography, history, music, physical education, design and technology and informal technology.

Before the National Curriculum was introduced, schools and class teachers exercised considerable autonomy in curriculum planning, with no set timetable for individual subjects, except typically for activities taking place outside the classroom (e.g. physical education or music, and school assembly). The National Curriculum applies to children of compulsory school age. It is organised on the basis of four key stages:

	childrens' age	year group
Key stage one	5-7	1-2
Key stage two	7-11	3-6
Key stage three	11-14	7-9
Key stage four	14-16	10-11

The Introduction of the National curriculum has increased the need to develop teachers' subject knowledge in science. The challenge for teachers of the national curriculum is to provide access to science for all children and to translate the science curriculum into appropriate learning experiences, taking account of children's needs (Feasey, 1994). In the classroom situation, the teacher should take cognisance of the three aspects of scientific knowledge and understanding, scientific skills and scientific processes.

1. Knowledge and understanding of science encompasses the different content areas. It is organized in terms of biology, chemistry and physics.
2. Scientific skills revolve around the development through practice of children's skills in using measuring instruments of various kinds, recording in tables, displaying results in

graphs.

3. Scientific processes are learned through testing ideas by scientific methods, such as observing, predicting, hypothesizing, interpreting and inferring (Feasey, 1994; p.75).

In line with the National Curriculum (DFE, 1995), the topics of "light and sound" are addressed at key stage one. The programme of study references to light indicate that children should consider the properties of light as well as behaviour of light as it meets different materials.

1. Key stage one: the topics of Light and Dark
   - that light comes from a variety of souces, including the sun;
   - that darkness is the absence of light;
2. Key stage two:

   Everyday effects of light;
   - that light travels from a source;
   - that light travels cannot pass through some materials, and that this leads to the formation of shadows;
   - that light is reflected from surfaces, e.g. mirrors, polished metals;

   Seeing:
   - that we see light sources, e.g. light bulbs, candles, because light from them enters our eyes.

The differences and similarities between the two curricula

My analysis of the two science curricula shows that there are some similarities and differences. I am going to give the similarities first.

Similarities:

1. Topics related to light travelling, reflections, and light sources, are taught in both education systems. In England and Wales, younger children in key stage one are introduced to different light sources and idea that darkness is absence of light.
2. The initial developmental stages, in helping children to develop their ideas, are well structured in the two education systems, for example in the topics of light travels and reflection.
3. The topic of light was chosen as an example, because it is included in both curricula, and the concepts addressed are similar. Materials for children at key stage two were selected because in the Indonesian curriculum, the topic of light is taught in year five.

Differences:

1. The content of the Indonesian curriculum is demanding for the age group, and not in line with the cognitive development of children, whereas the curriculum in England and Wales is less demanding.
2. Most books following the National Curriculum in England and Wales discuss colour, even though it is not mentioned in the curriculum, whereas the Indonesian textbook relates absolutely to the curriculum.

2. Descriptions of teachers' schemes and childrens' books selected for analysis

After giving pictures of both national curricula, I am going to give a description of the teachers' resoures and children's books which I chose as a sample to

indicate key characteristics and what they include. I will start by outlining the teachers' materials and then consider the children's books for each different scheme.

1. Oxford Primary Science

a. Teachers' materials

This course consists of a series of books covering the curriculum and structure of each book (see appendix 1). Each book is divided into themes; for each theme, objectives, key ideas, why is it important, relevant statements of attainment, linked childrens' materials, core activities and assessment pointers are indicated.

The teacher is guided on activities to follow. Scene-setting activities and follow-up activities are provided, with questions which help teachers in preparing the content to be presented to children. The organisation of activities to be carried out by children is prescribed. Suggestions for the time-span of activities are made in the teacher's guide. Pointers for assessing the success of the activities are provided. Guidelines in choosing resource materials for activities are provided, so as to help the teacher in organising activities, for example a design for shadow masks and screen.

b. Children's books

There is one book for each topic, and no clear explanation is given about how they are to be used. Pictures are the main feature in these books. Illustrations are used to introduce and explain key ideas and vocabulary. Questions are used to encourage children to use and apply new concepts and vocabulary, for example children are asked to identify transparent objects and materials in a

picture. No other practical activities are suggested in the children's books. They are intended to encourage discussion. Objects or materials used during illustrations are those normally found in children's homes.

2. Star Primary Science

a. Teachers' materials

Material for each topic in the Star Primary Science course material includes teachers' notes, a starter book for children and a series of activity cards. The scheme is organized so that concepts are introduced in concept chains, and each concept is introduced by six activity cards. The cards are organised in a sequence; card 1 introduces the concept, card 2 and 3 give the children opportunities to demonstrate it, card 4 shows children ways of applying it and card 5 and 6 are extension cards, which give children further opportunities in applying the concept and extending their knowledge (see. Appendix 2).

The purpose of the teacher's notes is to give the teacher information on the purpose of each activity and provide background information and ideas on questions to be asked. The scheme encourages the teacher to develop his or her own alternative ways of planning and teaching, using the cards.

The starter books introduce children to key concepts which are presented through the use of double-page spreads. Each spread is associated with a particular concept and six suggested activities. In illustrating the concept, the book uses pictures as a way of motivating children to learn the required concept.

Each card is used to explain the same concept and theme; however all of them

consist of activities ranked according to ability levels. For example, in the light theme, the first concept is ' Giving out light'. Children are asked to draw some things at school which give out light, and this concept is introduced on page 2-3 in the starter book. Concepts are broken into units which are explained via the use of the cards, and on each card instructions for practical activities are given. The questions given which suggest practical activities are open-ended and require children to offer opinions.

3. Nuffield Primary Science

a. Teachers' materials

This scheme is based on the work of the SPACE Project (1990). It consists of a teacher's book and childrens' books for all areas of the science curriculum. Each teacher's guide consists of suggestions for (1) orientation: activities and questions for eliciting children's ideas; (2) planning with children's ideas in mind through key ideas and investigations; restructuring of ideas, application of ideas and review of change in ideas; and (3) assessment: of skills and of children's understanding. This approach provides possible ways in which children's ideas can be followed up (see. Appendix 3). Besides, Nuffield Primary science also suggests a range of methods that can be used for finding out ideas, including open questioning, asking children to draw and annotate their drawing, encouraging children to write about and talk about their ideas. There is a chapter of the book containing the basic knowledge of the topic discussed which helps teachers to plan and present it.

b. Childrens' books

There are two children's books for each topic. Each book has a contents page

where topics included in the book are listed. When introducing particular concepts or ideas, the book makes wide use of illustrations, for example pictures on the uses of light, diagrams about cycling clothes, or pictures which show the important role of colour in expressing feelings. Stories are also an important feature in the books, for example: a story about the famous French artist Georges Seurat. Some story-telling in the form of cartoons is used, for example about signalling. Questions are used to encourage children's thinking, e.g. How did the photographer manage to take this picture? Clear links are made between one concept and another. There are too few suggestions for practical activities in the children's books, these are often in the form of questions. For example: which colour would you use to create a; spooky scene or a warm feeling. At the end a glossary is given, explaining key scientific vocabulary.

4. Collins Primary Science

The books in this scheme are intended to be used by both teachers and children. This scheme is very different from Nuffield primary science. Very little guidance is given about teaching approaches. Teachers needs to decide the possible outcome for an activity given and build up their own ideas for planning and assessment (see. Appendix 4).

Each book consists of a series of activities linked to a cross curricular topic. Activities suggested in these books provide instructions to guide children in carrying out the activities. After each practical activity, questions are given to ask children about their findings. In some cases, pictures are used to illustrate points, for example: in the blindfold game, the picture shows how the game

should be played. The activities given provide opportunities for children to investigate scientific ideas, e.g. whether plants need light to grow. Pictures and diagrams are also used to show possible ways of recording or experimental arrangements. Equipment to be used consists mainly of items commonly found in children's homes or in the classroom, for example mirror, torches and baby oil. Children are asked to record their findings in their note books. Group work activities are also common, for example when children are asked to find out why footballers at night have more than one shadow.

5. Tiga Serangkai

Tiga Serangkai is presented as one example of the Indonesian science textbooks. This material consists of a book for each age group. Each book is structured so that teachers and children can use the same book. Each chapter coves a different theme (see. Appendix 5). Long explanations of particular aspects of the theme are a common feature of these books. Diagrams are used to illustrate concepts and show apparatus used, for example about light travelling and reflections. Pictures are rarely used. Results and explanations for practical activities are explained in theory and then children are asked to perform these practically in the classroom. At the end of each topic questions are given for the children to answer. Materials to be used during the activities are recommended.

D. Analysis

There were several processes in the analysis of the book resources. First,

each book or scheme was analysed based on the criteria developed in chapter II. It was read section by section to see what it included. Second, each section was then judged as to whether it met the criteria. This process also helped to determine the judgement based on evidence. Third, illustrations and examples were selected to justify the decision.

E. Strengths and weaknesses of the book resources

The strengths and weaknesses of the book resources following each national curriculum were identified in order to put forward suggestions for developing supplementary material for use with the Indonesian book resources.

CHAPTER IV

ANALYSIS OF SCHEMES

Table 1. Analysis of Oxford Primary Science for the topic of Light

Analysis of Teachers' book resources

Categories	Decision	Justification/Evidence
1. Does the book take account children's ideas?	Yes, implicitly	Some activities encourage children to offer their ideas, e.g. identification of colours in the classroom. Other examples are when (1) children are taken outside the classroom and asked to list objects of different colours (2) children make a collection of magazine photographs of various sources of light (p.203, 206, 207,211,...)
2. Does the book relate to childrens' everyday experience?	Yes	Activities are based on familiar materials or events., e.g. dark places, Christmas tree, use of torch in providing light, sun, and moon, how children see shadows (p.215), ..
3. Does the book give opportunities to consider applications of ideas introduced both in and out of school?	Yes	e.g. In some experiments such as identification of colours, children are taken outside in the school grounds (colours of leaves, flowers, signs and decorations (p.203). Children are asked to observe and describe sources of light outside during the day and night time, streetlights, lights on cars, etc.

Categories	Decision	Justification/Evidence
4. Does the book help teachers to develop their background knowledge and understanding of science?	Yes, partly	To some extent. Aspects like the children not looking straight at the sun are not fully explained to the teacher. However, some elements are fully explained and teachers are able to develop their background knowledge, e.g. on reflection and transparency.
5. Does the book encourage the development of scientific process skills and procedural understanding?	Yes, implicitly	The development of 'core activities' provided in the book implicitly helps children and teachers to develop their scientific process skills. e.g. p.218. What happens when light from the torch hits a mirror? This question is successful in developing knowledge about light rays and processes of involved in scientific investigations. (see also, p 202, 210, 214, 218 ....)
6. Which concepts of science are involved? Are the key concepts clearly identified for the teacher and child?	Yes	Key ideas are explained in every theme (e.g. p. 201). Objects and light sources may be of various visible colours, the colour of an object can be seen only if light shines onto it. (see also p.205,209, 213, 217, etc.). The linking of objectives, key ideas and why they are important is well developed so that teachers can easily understand and apply them in a classroom setting.
7. Does the book give guidance about teaching approaches? (starting points, progression, sequence of events, planning and assessment)	Yes,	In each theme, the book starts with a sequence of questions and activities which the teacher can use, e.g. objectives, planning (time, place and resources) and assessment pointers. Also, at each stage, children are introduced to a concept through story, rhyme and songs. (see. Core activity..., p 202, 206, 210, 214, 218 ....)

Categories	Decision	Justification/Evidence
8. Does the book help a teacher to create activities which provide opportunities for children to work together and promote positive attitudes, e.g. respect for evidence ..?	Yes	The experiments provided offer opportunities for working as a team or group and also as an individual. e.g. when children are taken outside the classroom to observe objects. There is no particular activity that promotes positive attitudes.
9. Does the book give opportunity for practical work?	Yes	Throughout the teachers' guide, children are asked to carry out experiments. See.. 'Follow up activities' (p. 203, 207, 211, 215, 219) This provides activities that children can do with the teachers' asistance. Also, some activities provide diagrams and instructions for making apparatus.
10. Is there a balance of types of practical work? (Basic skills, observations, illustrative work, investigation)	No	This book concentrates on observations and investigative work. These are clearly introduced through questions provided in the core activity and follow-up activities provided. For example: ' What happens when light from the torch hits a mirror?' This question asks children to investigate. 'Look round the classroom. Can you see anything this colour?' is the type of question which asks children to observe around the classroom.
11. Are there opportunities for investigations?	Yes	The book suggests questions to investigate, e.g. How does light go from this torch to this target? (p. 214). In each theme at least 4-7 questions are provided for children to carry out investigations.
12. Do children have any choice in selecting materials and equipment? Does the practical work involve the use of simple and safe equipment and materials?	Yes, partly	The book gives a list of resources required for every activity. Most of the resources required are simple and everyday. The safety of the materials is not really mentioned in this book.

Analysis of childrens' book resources

Categories	Decision	Justification/Evidence
1. Does the lay-out and presentation assist childrens' learning (e.g. encourage interest, attention, retention, support less able readers)	Yes, partly	Pictures or illustrations used help retention or comprehension of text. Even though they are just pictures, children can use them to explain the use of colour (p.2-3), the use of light (p.4, 8)... Some parts of the book would need teacher input, e.g.the picture of when the boy is sleeping, his mother opens the door and light comes in to the dark room. The 'focus' section helps children in focusing on or linking with the concepts or key ideas explained on each page.
2. What sorts of illustrations are involved? Are they clear? Do they assist children's learning?	Yes, few	Some pictures some do help, like those of transparent objects, however most of them do not help. e.g. on p.2-3 the messages do not help in explaining the world as full of colours
3. Is there an appropriate balance of text and illustration in the book?	No	See p.2-3, 4, 6, 8, 10, 12, 14, 16, .. Some of pages just give illustrations and it is very rare to find text which explains the purpose of the pictures.

Categories	Decision	Justification/Evidence
4. How readable is the book for children at key stage two (7 to 11 year-olds) in term of the length of sentences and use of technical vocabulary) ?	Yes, partly	The book can be read by this age group with no difficulty and the presentation is suitable for them. All concepts are explained in simple language which children are used to in their home. For example: The sun gives us light in the daytime. A candle can give us light. A torch can help you to see in the dark. Light bouncing off something shiny makes a reflection, ...
5. What types of questions are provided in the book? How 'productive' are the questions given? Are they open ended? Do they promote children's activity and reasoning?	No	The questions are mostly recall, and need one word to answer, they do not promote reasoning. E.g. What colours can you see? Do you have a favourite colour? (p. 18) Do you see 15 and 17 in the big cycle?...
6. Does the book provide questions for practical work?	No	No practical work is involved. Everything is theory and explanation from the book. Children are just asked to answer simple questions, such as Do you have a favourite colour? Can you see shades of blue?
7. Does the book clearly explain what the children are to do?	No	There is no description of any kind of activity to be carried out by the children.
8. Does the book stimulate childrens' curiosity through the ways the activities are presented? Would the book motivate children to learn?	No	Not at all. Children are only encouraged to be passive learners and take in what the book gives. On its own, the book would not motivate children as they are only asked to absorb information.

Table 2. Analysis of Star Science for the topic of Light

Analysis of teachers' book resources

Categories	Decision	Justification/Evidence
1. Does the book take account children's ideas?	Yes, implicitly	Activities provided encourage children to offer ideas , e.g. (1) encourage the children to observe a sparkler or a candle burning (2) activity on 'hide and seek' game (on card 1, concept 2), which explains the ideas of light and dark, concepts that children can develop through ordinary play with this game (3) on object-source of light-many items are common in children's vocabulary (4) use of mirror in dealing with reflection
2. Does the book relate to childrens' everyday experience?	Yes	Activities and explanations are related to children's everyday experiences, e.g. use of torches in darkness as way of explaining the uses of light, use of mirrors in explaining reflection, light in traffic lights which helps children to develop the ideas of warning lights, hide and seek game in explaining darkness and daytime.
3. Does the book give opportunities to consider applications of ideas introduced both in and out of school?	Yes, partly	Applications of ideas related to childrens' experience at home, e.g. adventure in the dark. Children are asked to imagine there is no street lighting and they have to find a way to get home. Children are not encouraged to explore light outside the school, for example: relating light to plant growth, explaining the importance of light for humans' health.

Categories	Decision	Justification/Evidence
4. Does the book help teachers to develop their background knowledge and understanding of science?	No	The book does not provide information which helps teacher to develop their background knowledge and understanding of science. Thus, teachers need to use other books if they need more information about the concept of light.
5. Does the book encourage the development of scientific process skills and procedural understanding?	Yes,	A questioning technique is used to encourage children to find answers for themselves and relate ideas to their everyday experiences, for example: Does light from the torch always travel in straight lines? Try out your ideas.
6. Which concepts of science are involved? Are the key concepts clearly identified for the teacher and child?	Yes	The concepts of light are well developed. Children are made to see the importance of light and its uses. Some things give out light, we need light to see. It is dark when there is no light, some things block light and light does not bend around things. Children are made to realise that light does travel in straight lines. Concepts like transparency and opacily are emphasized.
7. Does the book give guidance about teaching approaches? (starting points, progression, sequence of events, planning and assessment)	Yes	The book guides the teacher in planning his or her teaching activities, however there are some restriction as teachers would tend not to explore other related areas. The usage of cards, helps teacher in organising his/her class, e.g. by giving one card to one groups of children for activities and lead them to communicate their findings to others. Assessment is clarified by offering of a range of assessment approaches relating to teaching styles provided in the book.

Categories	Decision	Justification/Evidence
8. Does the book help a teacher to create activities which provide opportunities for children to work together and promote positive attitudes, e.g. respect for evidence, sensitivity to living and non living environment...?	No,	There is no sensitivity about light in the environment, light linked to lighting of homes and preserving it for future use - no mention of this in the book. This material provides opportunities for children to work together through hide and seek games, blindfolded lego, make a box theatre, .. However this book is suitable for a combination of individual, paired, small group and whole class teaching.
9. Does the book give opportunity for practical work?	Yes	Hide and seek activities , blindfold lego, light and dark box and making a box theatre
10. Is there a balance of types of practical work? (Basic skills, observations, illustrative work, investigation)	Yes,	In the activity on giving out light-basic skills are emphasized-naming of items which give light, using a hand lens to observe a small bulb; Observations include effect of reflections, light travelling Illustrative activities; shadows and light Investigations include hide and seek, the idea of transparency and opacity and seeing in the dark.
11. Are there opportunities for investigations?	Yes,	Some activities encourage children to carry out investigations, e.g. Investigations on seeing in the dark, light beams, shadows on the ceiling.
12. Do children have any choice in selecting materials and equipment? Does the practical work involve the use of simple and safe equipment and materials?	Yes,	This book does not suggest alternatives for children to choose, but, the teacher could modify the equipment provided. The practical activities use simple and safe equipment, and the book gives safety advice.

Analysis of childrens' book resources

Categories	Decision	Justification/Evidence
1. Does the lay-out and presentation assist children learning (e.g. encourage interest, attention, retention, support less able reader)?	Yes	The illustrations are well developed: for example; the illustration of granny's peephole. It explains clearly that light travels in a straight lines. The concept explained is related to childrens' everyday knowledge.
2. What sorts of illustrations are involved? Are they clear? Do they assist children learning?	Yes	Most of the illustrations are in the form of pictures. The pictures both in the book and on cards may help children to develop their understanding, for example the silly inventions. The explanation on the words would help children appreciate properties of light. Most of pictures encourage children to become involved in practical activity.
3. Is there an appropriate balance of text and illustration in the book?	Yes	There is a good balance between the text and illustrations.
4. How readable is the book for children at key stage two (7 to 11 year-olds) in term of the length sentences and use of technical vocabulary)?	Yes	The language used will help children to make links with the concepts being introduced (some things give out light when they get very hot. These sparklers are burning. They are very hot. They are giving out light.). At the same time children are introduced to the picture of sparklers. It is very rare to find words children would have difficulty in understanding. The language is suitable as children use it in everyday activities. The choice of vocabulary is good; no difficult words or ideas are found.

Categories	Decision	Justification/Evidence
5. What types of questions are provided in the book? How 'productive' are the questions given? Are they open ended? Do they promote children's activity and reasoning?	Yes	Attention-focusing and action-provoking questions are mostly provided in the book, e.g. seeing in the dark. What does it do? How does it work? What did you find out? Try your ideas. All of the cards are provided with questions. They stimulate children's active involvement.
6. Does the book provide questions for practical work?	Yes	Each card has questions that children could tackle through practical work. E.g. using a light and dark box; children are provided with activities which ask them to investigate when they can see the light most.
7. Does the book clearly explain what the children are to do?	Yes	Each card provides guidance on key ideas of science and childrens' experience. Instructions, equipment and the questions to be used are clearly shown.
8. Does the book stimulate childrens' curiosity through ways the activities are presented? Would the book motivate children to learn?	Yes	Practical activities are fun. e.g. in the activities 'silly inventions' on card 3, target game on card 5, blindfolded lego on card 5. Children can be interested through playing a game (hide and seek, granny's peephole, paint spraying shadows, target game, ...) and making up a story (amazing story).

Table 3. Analysis of Nuffield Primary Science for the topic of Light

Analysis of teachers' book resources

Categories	Decision	Justification/Evidence
1. Does the book take account children's ideas?	Yes, explicitly	In sources of light (p.36) , children are asked to list the things they see or use at home which give light. Starting from p.36-90 (chap.3), the teacher is given some guidance on how to find out children's ideas about light by asking children to draw and to do a range of activities, e.g. light a candle. Through this activity, the children are given the opportunity to explain their ideas by asking them to draw and write down their explanations of what happens to the light from the candle. Also. in chap 3, teacher are given information about 'what children's ideas are about light' based on research findings and also 'how to help children to develop their ideas' . This chapter is helpful as a starting point for teachers in planning and teaching about 'light'.
2. Does the book relate to childrens' everyday experience?	Yes	Activities and explanations relate to children's everyday experiences, e.g. on light travelling (p.30) traffic lights and lights at pedestrian crossing are used as examples in explaining the idea that light travels in a straight line; experiments on light travelling and on reflections use torches. The context of how children see a book is used to explore ideas about vision.

Categories	Decision	Justification/Evidence
2. Does the book relate to childrens' everyday experience? (continued)	Yes	In teaching about reflection (p.52) mirrors, torches, light bulbs are used to explain the idea of reflection, reflectors and shadows. In work on colour (p.80) children are asked to look at the colours of minibeasts, and of flowering plants in order to make comparisons between colours found in different places.
3. Does the book give opportunities to consider applications of ideas introduced both in and out of school?	Yes	Materials encourage children to consider the use of reflectors (e.g. cycling) and when explaining safety systems (traffic light) (p.44), the use of light in sending messages (p.64) , make shadows by using primary and secondary sources of light (p.68-p.77), explore natural habitats and the types of living things to see the range of colours found.
4. Does the book help teachers to develop their background knowledge and understanding of science?	Yes	In chap.3 teachers are given background knowledge and understanding in relation to light linked to teaching and learning in the classroom. Various types of questions are provided which help teachers to raise children's understanding.
5. Does the book encourage the development of scientific process skills and procedural understanding?	Yes	Activities provided (Why, How, what happened ..) encourage children to solve problems on their own. On the other hand, teacher are encouraged to help children to develop or revise their ideas by using them to make predictions, testing their ideas, e.g. p.34. The question 'How do you see a book'. This asks the children to draw a picture to explain how he/she can see a book, then asks them to talk and write about their drawing and see how their ideas work in practice.

Categories	Decision	Justification/Evidence
6. Which concepts of science are involved? Are the key concepts clearly identified for the teacher and child?	Yes	Concepts related to light sources and vision, reflections and shadows and colour are involved. The concepts are well developed for both teacher and children (e.g. see p.27). Key ideas are listed at the start of each section.
7. Does the book give guidance about teaching approaches? (starting points, progression, sequence of events, planning and assessment)	Yes	In each section, the book starts with useful strategies to find out children's ideas through talking and open questions, annotated drawings, sorting and classifying, writing down ideas, letting children develop them, getting children to communicate them, etc. Also, the book provides guidance about strategies for using the Nuffield children's books. Assessment of skills and children's understanding is well developed in chap.4.
8. Does the book help a teacher to create activities which provide opportunities for children to work together and promote positive attitudes, e.g. respect for evidence, sensitivity to living and non living environment...?	Yes	Through (1) activities provided; e.g. finding out about reflected light and vision, the position of shadows, sending messages round corners with mirrors (p. 64), are activities which require children to work together; (2) sharing the responses with in the rest of the class; (3) discussion. In relation to attitudes, children are introduced to (1) the uses of light and colour in different religions and cultures (2) the awareness of how light is used in everyday situations; (3) the relation between colour and emotion.

Categories	Decision	Justification/Evidence
9. Does the book give opportunity for practical work?	Yes	Teachers are given guidance about kinds of practical work that can be used to help children try out and develop their ideas (see. chap.3), for example: the ideas for choosing which materials and shapes make the best reflectors (p.63), testing ideas about whether we can change the shape of our shadow (p.70), etc.
10. Is there a balance of types of practical work? (Basic skills, observations, illustrative work, investigation)	No	This book provides chiefly opportunities for observations and investigations. This clearly emerges in the questions provided. For example: 'Is your shadow always in the same place? If not, why not?. The question asks children to observe during the day and ' What would you need to do to make your shadow larger/smaller?" is the type of question which asks children to investigate.
11. Are there opportunities for investigations?	Yes	For example, in the topic concerning light sources, children are provided with questions such as, What creatures can you think of which are more active at night? Do you think that they are able to see in the dark? If so, how do you think they are able to see in the dark? They are asked to discuss and do the investigations. Also, see. 44, 49, 53, 65, ...
12. Do children have any choice in selecting materials and equipment? Does the practical work involve the use of simple and safe equipment and materials?	Yes	The book indicates materials which teachers and children can use, but children can decide on objects and equipment to use in practical work. Issues related to the safety of materials and procedures used in the investigations are indicated by a warning sign which highlights the need for particular care during investigations.

Analysis of childrens' book resources

Categories	Decision	Justification/Evidence
1. Does the lay-out and presentations assist children learning (e.g. encourage interest, attention, retention, support less able reader)	Yes	The illustrations link very well with children's everyday knowledge, hence retention is enhanced. E.g. (1) a link to art and design is provided to introduce the representation of light (p.16-17) (2) a colour to introduce the concept of light and reflection (3) a colour, for effects of coloured light.
2. What sorts of illustrations are involved? Are they clear? Do they assist children's learning?	Yes	Most are pictures. They assist children's learning as they are able to build the concepts around the picture-e.g. when explaining reflection. Many different reflections are shown from different objects. Children are able to question why these reflections occur when using different objects.
3. Is there an appropriate balance of the text and illustration in the book?	Yes	There is quite a good balance; however pages 14-15 show only pictures, not linked with printed text.
4. How readable is the book for children at key stage 2 (7 to 11year-olds) in term of the length sentences and use of technical vocabulary?	Yes	The language is simple and linked to everyday objects. Children are used to it in their everyday life. Words not common in children's vocabulary are printed in 'bold' to emphasise them. These are followed by definitions in a glossary. Objects (pictures) are also shown to help children understand or comprehend the text.

Categories	Decision	Justification/Evidence
5. *What types of questions are provided in the book? How 'productive' are the questions given? Are they open ended? Do they promote children's activity and reasoning?*	Yes	A mixture including comparison-making questions which encourage sharper observation by children and ask for explanation, e.g. in reflections (p. 6), the question 'what confusion did the orange street lights cause Pamela? (Pamela was confused by the different colours made by the orange light on the car the burglar was using.) The question 'Where are the clouds in this picture?' is an example of an unproductive question.
6. Does the book provide questions for practical work?	Yes	For example, simple observations (e.g. find three colours and try to invent your own names for them; how does the cartoonist show light in this drawing?), Illustrative work (e.g. making children own coloured expressions and making moving pictures)
7. Does the book clearly explain what the children are to do?	Yes	Children are told what to do, for example 'Can you think of some words to describe the way light looks in the pictures on these pages?. See also pp.4, 6, 7, ..)
8. Does the book stimulate children's' curiosity through the ways the activities are presented? Would the book motivate children to learn?	Yes	Children will be interested in reading about comics (p.10-11), poems (p. 5) and " look and listen" (p.20-21). Certain attitudes and skills will be developed, e.g. giving signals reflection as SOS (p.10-11), minding out for traffic when cycling to school (p.14-15), attitudes toward colour and how it is used out of school.

Table 4. Analysis of Collins Primary Science for the topic of Light

Analysis of teachers' book resources

Categories	Decision	Justification/Evidence
1. Does the book take account children's ideas?	Yes, implicitly	Some activities encourage children to offer ideas, e.g. on changing light, the use of light in the ambulance, traffic lights, decorative lamps, etc.
2. Does the book relate to childrens' everyday experience?	Yes	Activities and explanations are related to children's everyday experience, e.g. the concept that seeds need light to grow; what happens when we have too much sun on our skin? What do you think it would be like to live in the dark all of the time?
3. Does the book give opportunities to consider applications of ideas introduced both in and out school?	Yes	In the activities on light from the sun, on judging how the pupils' of the eye function in light and dark places. In the blindfold games, children are asked to try them in different places, such as: a dark cupboard and a bright room
4. Does the book help teachers to develop their background knowledge and understanding of science?	No	This book does not help teachers in developing their background understanding about light. Each concept is not explained.

Categories	Decision	Justification/Evidence
5. Does the book encourage the development of scientific process skills and procedural understanding?	Yes, partly	The book promotes the development of scientific process skills through activities provided. Questions in the activities allow children's views. Children are asked to create their own procedures for activities-hence the development of science process skills is involved.
6. Which concepts of science are involved? Are the key concepts clearly identified for the teacher and child?	Yes, partly	Changing light, light from the sun, our eyes, seeing things and exploring light, shadows. Some of the concepts are well developed for both teacher and children, e.g. light from the sun and our eyes.
7. Does the book give guidance about teaching approaches? (starting points, progression, sequence of events, planning and assessment)	No	This book does not provide guidance on planning and assessment. Teacher have to do all this by themselves. The sequence of each topic is not well developed. Work on the same topic is provided in different books. Thus, teachers have to link each concept by themselves.
8. Does the book help a teacher to create activities which provide opportunities for children to work together and promote positive attitudes, e.g. respect for evidence, sensitivity to living and non living environment...?	Yes, partly	Through activities provided, e.g. the experiment of using the torches with sieves, colanders, and other things with holes in to make light patterns, exploring light and blindfold. Besides, such activities can be done by working together, e.g. our eyes and seeing things. A positive attitude towards science is not developed in this book.

Categories	Decision	Justification/Evidence
9. Does the book give opportunity for practical work?	Yes	The 'activity' section helps children to try out ideas and provides the opportunity for practical work. Also, some starting points ask children to do activities, e.g. What do you think it would be like to live in the dark all the time?
10. Is there a balance of types of practical work? (Basic skills, observations, illustrative work, investigation)	Yes	Illustrative skills, e.g. activity on how important are our eyes (p.37), activity on seeing things (38), etc Observation skills, e.g. blindfold games, growth of plant seeds in trays- the effect of light from the sun, etc Investigative skills, e.g. shine the torch onto a wall. Does the light go straight to the wall? How can you find out? Can you find out if light always travels in straight lines?
11. Are there opportunities for investigations?	Yes	The activities on 'how does light travel' encourage children to do investigations.
12. Do children have any choice in selecting materials and equipment? Does the practical work involve the use of simple and safe equipment and materials?	Yes	The activities and materials provided in practical work are indicated . The book uses a symbol to indicate variation from material used in earlier activities. This means that not too much different material needs to be prepared by the school.

Analysis of childrens' book resources

Categories	Decision	Justification/Evidence
1. Does the lay-out and presentation assist children's learning (e.g. encourage interest, attention, retention, support less able reader)	Yes	The presentation helps children to understand and remember facts, e.g. on flashing lights-pictures of ambulances, robots and pictures of coloured areas.
2. What sort of illustrations are involved? Are they clear? Would they assist children's learning?	No	Pictures. Most do not help e.g. on 'activity A' on testing whether plants need light to grow. Even the drawing of a childrens activity-the picture does not assist children in learning.
3. Is there a balance of the text and illustration in the book?	Yes	Each illustration is associated with an explanation relevant to the concept being taught.
4. How readable is the book for children at key stage two (7 to 11 year-olds) in terms of the length sentences and use of technical vocabulary?	Yes	The book is readable, as the language used is not too difficult or outside the children's vocabulary, but some scientific concepts to be learned by children are not expanded at all.

Categories	Decision	Justification/Evidence
5. What types of questions are provided in the book? How 'productive' are the questions given? Are they open ended? Do they promote children's activity and reasoning?	Yes	The questions used are open ended and very productive-because they seek the children's views. e.g. questions like Can you investigate to find out how sun glasses help you to see in bright sunshine? or What happens when you mix two different coloured lights?- These seek the child's views and are not restrictive because children can give varied answers. They do really promote reasoning and being open minded and critical in analysing facts.
6. Does the book provide questions for practical work?	Yes	e.g. on transparency, and the question on pointing a torch towards a wall in order to see whether the beam of light will go straight to the wall. Most activities are question oriented. Activity A, activity B and other ideas sections encourage children to do a practical activity .
7. Does the book clearly explain what the children are to do?	Yes	The explanations of activities are very good and clear. Children can carry out activities on their own without difficulty.
8. Does the book stimulate children's' curiosity through the ways the activities are presented? Would the book motivate children to learn?	Yes	The varied activities stimulate children to work, e.g. catching balls when closing one eye, children can be stimulated by this activity which will raise curiosity. Also, on whether plants need light, there an open activity which children can pursue when looking at plants colours and give explanations.

Table 5. Analysis of Tiga Serangkai for the topic of Light

Analysis of teachers' book resources

Categories	Decision	Justification/Evidence
1. Does the book take account children's ideas?	No	Most of the concepts explained in the book are written from scientists' perspectives. Memorization of facts is emphasised and definitions are given of list of 'big words'. No children's ideas are provided. Teachers are not given guidance or encouragement to find out children's ideas about light.
2. Does the book relate to childrens' everyday experience?	Yes	E.g. The experiments on light travelling from candles, reflections from clear objects, light travelling from mirror, plywood, clear water and muddy water, the use of light bulbs at night as a way to explain the uses of light; all these relate to everyday experience.
3. Does the book give opportunities to consider applications of ideas introduced both in and out of school?	Yes	In the experiment about light traveling in clear water and muddy water and in the experiment on light traveling through plywood, links are made with science out of school.

Categories	Decision	Justification/Evidence
4. Does the book help teachers to develop their background knowledge and understanding of science?	Yes	This book helps teachers in developing their background understanding about light, but information on how this can be linked to teaching and learning is not provided.
5. Does the book encourage the development of scientific process skills and procedural understanding?	No	Children are given instructions to follow (p.39, 40). Questions in the activities do not allow the introduction of children's views, hence the development of science process skills is limited.
6. Which concepts of science are involved? Are the key concepts clearly identified for the teacher and child?	Yes	Concepts are very clearly spelt out: 1. Light travels in a straight line 2. Light passes through a clear object 3. Reflections 4. Light is reflected at the boundary between two different materials. 5. White light can be split up into a range of colours 6. Light and seeing 7. We can see light, because it has travelled to us. 8. Optical equipment helps us to see the objects.
7. Does the book give guidance about teaching approaches? (starting points, progression, sequence of events, planning and assessment)	No	There is no guidance on strategies used in this book. Assessment strategies are not provided.

Categories	Decision	Justification/Evidence
8. Does the book help a teacher to create activities which provide opportunities for children to work together and promote positive attitudes, e.g. respect for evidence, sensitivity to living and non living environment...?	Yes, partly	The book does not provide opportunities or encouragement to work together (e.g. p.40,41). Positive attitudes to the environment are encouraged, for example: not to drink muddy water; and living things cannot live in muddy water.
9. Does the book give opportunity for practical work?	Yes	For example: an experiment about light travelling from a candle (p.39), and about light travelling from a mirror, plywood, clear water and muddy water (p.40). The use of optical equipments (p.50, 51)
10. Is there a balance of types of practical work? (Basic skills, observations, illustrative work, investigation)	No	The book provides illustrative work and practical activities to develop skills (see p.39, 40, 46, 47,), but many problems (e.g. p.47) have been solved in advance (p.40). This means that the purpose is only as a reinforcement, because children already know the answers.
11. Are there opportunities for investigations?	Yes, few	Investigating the use of microscope to make objects look bigger
12. Do children have any choice in selecting materials and equipment? Does the practical work involve the use of simple and safe equipment and materials?	No	The book does not give choice of materials to be used in practical work. Issues related to the safety of materials and procedures used are not indicated.

Analysis of childrens' book resources

Categories	Decision	Justification/Evidence
1. Does the lay-out and presentation assist children's learning (e.g. encourage interest, attention, retention, support less able reader)	Yes	Diagrams are used to assist children in understanding abstract concepts, e.g. the reflection from concave/curve objects (p.44,45), the propagation of light (p.44).
2. What sort of illustrations are involved? Are they clear? Would they assist children's learning?	No	Diagrams are provided in this book, but are not clear enough to help children's learning.
3. Is there a balance of the text and illustration in the book?	No	The book consists mostly of written text with few illustrations. Children are likely to find difficulties in interpreting the material without teacher support.
4. How readable is the book for children at key stage two (7 to 11 year-olds) in terms of the length of sentences and use of technical vocabulary?	Yes	Generally, the language provided in this book is simple. There is need of a glossary to explain each scientific term provided in the book. The use of words printed in blue is confusing, because there is no consistency in it. For example; p.45-45, some blue is used to emphasise a word, some is used for the title of the illustrations.

Categories	Decision	Justification/Evidence
5. What types of questions are provided in the book? How 'productive' are the questions given? Are they open ended? Do they promote children's activity and reasoning?	Yes, few	The book provides mostly unproductive questions. Children will know the answers easily because the answers are stated. So, the book emphasises memorising and recall. The question of how light travels (p.47) is clearly discussed already on a previous page (p.40). Children are not eager to do any thinking because they already know the answer.
6. Does the book provide questions for practical work?	Yes	Most of the practical work involves developing practical skills. Even though all the results of the practical work are provided in advance, children still need to do it as a reinforcement of knowledge and for improving basic skills.
7. Does the book clearly explain what the children are to do?	Yes	The instructions are given for children to organise the activities.
8. Does the book stimulate children's' curiosity through the ways the activities are presented? Would the book motivate children to learn?	No	Childrens' curiosity will be developed if teachers encourage them to do the activities, not just memorise information.

CHAPTER V

DISCUSSION AND CONCLUSIONS

This section will deal with the findings from the analysis of four resource books from the education system in the UK and one book from the Indonesian education system. Following on from this, I am going to make some suggestions about the structure of supplementary resource material to be used with the Indonesian textbook. The topic of "light" is going to be used as a pilot in making suggestions about the structure of the book and strategies for implementing the suggested activities. Suggestions to be made on this topic are based on the five books analysed.

A. Description of the data

The comparative analysis of each book resource is given in the table below. Detailed analysis of each scheme in relation to the criteria developed in chapter II is provided in the tables in chapter IV. This gives a decision in relation to each criterion and provides examples of evidence to support this.

The data from the table shows that most of the books took into account children's ideas, but in different ways. Only the Nuffield teachers' guide gave explicit suggestions on finding out childrens' ideas through the development of exploratory activities and questions to elicit their thinking. This book thus complies with what Harlen (1993) says about children using existing ideas in attempting to make sense of new experiences. The Collins, Oxford and Star

Table 6. A Comparison of the schemes

CATEGORIES	NUFFIELD	OXFORD	T_SERANGKAI	STAR	COLLINS
TEACHER'S SCHEME					
1. Does the book take account children's ideas?	Yes, explicitly	Yes, Implicitly	No	Yes, implicitly	Yes, implicitly
2. Does the book relate to childrens' everyday experience?	Yes	Yes	Yes	Yes	Yes
3. Does the book give opportunities to consider applications of ideas introduced both in and out of the school?	Yes	Yes	Yes	Yes, partly	Yes
4. Does the book help teachers to develop their background knowledge and understanding of science?	Yes	Yes, partly	Yes	No	No
5. Does the book encourage the development of scientific process skills and procedural understanding?	Yes	Yes, implicitly	No	Yes	Yes, partly
6. Which concepts of science are involved? Are the key concepts clearly identified for the teacher and child?	Yes	Yes	Yes	Yes	Yes, partly

CATEGORIES	NUFFIELD	OXFORD	T_SERANGKAI	STAR	COLLINS
TEACHER'S SCHEME					
7. Does the book give guidance about teaching approaches? (starting points, progression, sequence of events, planning and assessment)	Yes	Yes	No	Yes	No
8. Does the book help a teacher to create activities which provide opportunities for children to work together and promote positive attitudes, e.g. respect for evidence, sensitivity to living and non living environment...?	Yes	Yes	Yes, partly	No	Yes, partly
9. Does the book give opportunity for practical work?	Yes	Yes	Yes	Yes	Yes
10. Is there a balance of types of practical work? (Basic skills, observations, illustrative work, investigation)	No	No	No	Yes	Yes
11. Are there opportunities for investigations?	Yes	Yes	Yes, few	Yes	Yes
12. Do children have any choice in selecting materials and equipment? Does the practical work involve the use of simple and safe equipment and materials?	Yes	Yes, partly	No	Yes	Yes

CATEGORIES	NUFFIELD	OXFORD	T_SERANGKAI	STAR	COLLINS
CHILDREN'S BOOK					
1. Does the layout and presentation assist childrens' learning (e.g. encourage interest, attention, retention, support less able reader)?	Yes	Yes, partly	Yes	Yes	Yes
2. What sorts of illustrations are involved? Are they clear? Do they assist children's learning?	Yes	Yes, few	No	Yes	Yes
3. Is there an appropriate balance of text and illustration in the book?	Yes	No	No	Yes	No
4. How readable is the book for children at key stage two (7 to 11 year-olds) in term of length of sentences and use technical vocabulary?	Yes	Yes, partly	Yes, few	Yes	Yes
5. What type of questions are provided in the book? How 'productive' are the questions given? Are they open ended? Do they promote children's activity and reasoning?	Yes	No	Yes	Yes	Yes
6. Does the book provide questions for practical work?	Yes	No	Yes	Yes	Yes
7. Does the book clearly explain what the children are to do?	Yes	No	Yes	Yes	Yes
8. Does the book stimulate childrens' curiosity through the ways the activities are presented? Would the book motivate children to learn?	Yes	No	No	Yes	Yes

schemes provide many activities in explaining a concept and implicitly take into account children's ideas by providing encouragement and opportunities for children to offer ideas. However, the Indonesian book is different from these four book resources, because we hardly ever find tasks or activities involving children's ideas.

All of the five book resources do consider children's everyday experiences. The evidence given shows the use of events in the environment, applications of ideas in and out of the school, and use of familiar materials-such as traffic lights, mirrors, and torches. This allows children to use what they already know in explaining things and also use it in exploring and investigating new ideas. As Russell (1992) says, it is important for science book resources to help teachers by referring to children's everyday experience as starting points for practical investigative science.

Teachers need background knowledge and understanding which helps to raise their confidence in teaching science. Nuffield and Oxford provide basic knowledge about each topic and make links to teaching and learning in the classroom. Star and Collins do not provide this information, whereas Tiga Serangkai defines the background knowledge only.

In Star and Collins, the development of process skills is encouraged. Teachers and children are helped to build up the concepts through performing given activities. The activities provided encourage children to create their own procedures for solving the problems. This aspect requires some creativity skills,

hence process skills are well developed in these two books. Nuffield and Oxford provide activities where process skills are used; however they are given more priority in the Star and Collins books. The development of process skills in Tiga Serangkai is limited; there is still a need for a general improvement in the activities suggested so that scientific procedures and process skills would be encouraged which should help develop children's understanding and creativity.

In Nuffield, Oxford, Star and Tiga Serangkai, concepts are identified clearly for the teacher. However, Collins only gives some background related to the concepts. The concepts are developed in different ways, and activities suggested to develop concepts vary from one book to another. For example, in the National Curriculum in England and Wales the concepts related to colours are not mentioned; however the Nuffield, Star and Oxford schemes talk about the different colours that make up white light.

Some books give teachers guidance on teaching approaches, planning and assessment skills. Nuffield Primary Science is a good example of this. Oxford Primary Science provides suggestions for follow-up activities, but does not link these in any sense to the assessment to be made by teachers. Collins and Tiga Serangkai do not address the relationship between planning and assessment. Teachers have to plan assessment themselves. These books suggest that teachers should find their own ways of organising resources and carrying out activities. Thus, these books are appropriate for those teachers whose scientific knowledge is highly developed. If teachers have poor knowledge, there is a risk, as Ramsden (1988) mentioned, that teachers will tend just to follow the pattern

of the book resources used, which will not help children to develop their understanding.

Attitudes towards science are important because they influence children's reactions to people, objects and events. Positive attitudes associated with learning science should be promoted to encourage greater cognitive growth (Woolnough, 1991). Analysis shows that, all the books promote positive attitudes to some extent, mostly in relation to respect for the environment and sensitivity to living things, e.g. the importance of light for growing. Curiosity is also another important attitude related to the learning of science. Some of the books promote curiosity through activities and questions provided which lead a child forward into new experience and first hand investigations.

Gott and Duggan (1992) argue that children need to develop an understanding of scientific evidence and the way in which it is assembled. In some books, like the Indonesian one, the practical work used was not helpful in encouraging children's understanding of concepts closely related to these practical activities. All the books from the UK promoted practical investigations, even though they addressed them in varying degrees. Most of them promoted investigations and observations. Investigations are recommended by Gott and Duggan (1992), when they state that by undertaking investigative work in schools, children will gain both an accurate procedural understanding and an opportunity to use and refine their conceptual understanding in practical contexts. Illustrative and basic skills activities are found in the Collins and Tiga Serangkai books, which less effectively encourage children to develop their procedural understanding.

The five books involve use a wide range of materials and these materials are quite safe for children. They clearly state safety guidelines, with the exception of Oxford and Tiga serangkai.

Children learn best if books provide them with illustrations which assist them by conveying concrete images and providing support materials. The UK books use pictures in assisting children to understand the explained concepts, however Tiga Serangkai does not have pictures; diagrams are more used in this book. Furthermore, the proportion of illustrations and text varies with each book. Oxford gives more pictures than text, whereas Tiga Serangkai gives more text than diagrams. Nuffield, Star and Collin have a balance between text and illustrations.

The length of sentences and technical vocabulary were also examined. Most of the books use simple and everyday language and make links to everyday objects and events. The UK books do not include many big ideas that children would find difficulties in interpreting. By contrast, Tiga Serangkai includes many scientific terms, so a glossary to explain all these is needed.

Questions provided by these books vary from factual to productive. However, Tiga Serangkai tends to give questions which require recall of facts and do not ask for children's views, whereas the other books put more emphasis on children's opinions about the taught concepts.

B. The Importance of evaluating book resources: strength and weaknesses of the schemes

It is common knowledge that books are of enormous importance in educational activity. Book resources will play an important part in helping teachers to achieve the intended goals. However, this study indicates that teachers should think carefully in choosing books to be used in their classrooms, because the way each book is presented varies and each is intended to be used in a different way. Some books are not appropriate for promoting an approach to teaching science which considers children's current level of understanding and identifies how children's thinking might progress.

In helping Indonesian teachers by providing good book resources, I would like to give indications of the strength of teachers' schemes published in The UK and provide recommendations for Indonesia about modifying the structure of materials used and different ways of using them.

The Strength and Weaknesses of the Indonesian textbook

The Indonesian textbook provides a background of knowledge which is relevant for both teacher and children. Teachers can easily use this as information for their teaching, whereas it seems too difficult for children at key stage 2 (7-11 years olds). Tiga Serangkai has limited emphasis on children's ideas as a starting points for teaching and learning. Also, the type of questions provided do not encourage children to think critically, because most of them require recall

only. The development of process skills and procedural understanding through practical work is not addressed in the Indonesian textbook, so the development of these skills needs to be given priority.

The strengths of the UK schemes which offer useful suggestions for improving the Indonesian textbook

(1) **Focus on the teacher.**

Nuffield Primary Science gives good starting points for teaching and learning by introducing exploratory activities for children before any direct teaching. The activities provided help teachers to focus on the childrens' thoughts. The Star scheme provides good linking of activities to the systematic development of knowledge and understanding. Applications of ideas related to childrens' experience at home are common in this book. Furthermore, Oxford suggests interesting starting points by introducing concepts through story, rhyme and songs. The activities provided offer good methods of developing motivation and children's curiosity.

Information provided in the book should clearly explain what children are to do. The use of a 'core activity' required by the Oxford scheme helps teachers in organising classroom activities.

Asking questions is central to exploring children's understanding. Nuffield offers various types of questions which help children to develop scientific process skills. Most of the questions are productive and provoke a response of attention, action and problem solving.

Teachers' own understanding of scientific ideas is needed to guide children to materials and activities which develop their understanding. Nuffield primary science gives well shaped background knowledge and understanding linked to teaching and learning in the classroom.

(2) **Focus on the children.**

Children's interests will be aroused if book resources have a good layout and include pictures or stories. The Star project provides a good example of illustrations linked well to the text.

Practical activities which allow children to express and challenge their own thinking are well developed in the Star Project. Most of activities are based on games, so learning becomes exciting for them. Practical activities and questions given in the Star and Nuffield primary science children's books promote factual learning, and provoke children's creativity and thinking.

The strengths of the UK schemes above are used to suggest supplementary materials that could address some of the weaknesses of the Indonesian textbook, in particular the need to take into account children's ideas, promote children's own thinking, provide more opportunities for investigations and ask productive questions.

C. Suggestions for developing supplementary materials and activities that could be used to improve on the Indonesian textbook.

In recommending new strategies for using book resources for Indonesian Primary Science, I would like to give some examples of activities that could be used alongside sections of the textbook, drawing on ideas from the UK Scheme.

1. Light sources and their importance to everyday life.

In the first paragraph, the textbook explains that 'Light has many useful characteristics for daily life' . This is introducing the use of light and other concepts which it will present later.

I suggest that the book should provide questions where children are given the chance to list some sources of light. A distinction between primary and secondary sources of light should be made. Activities accompanying these strategies should involve children in groups, writing down their ideas about sources of light, and a follow-up report back session. Discussion of pictures of the use of light in daily life, such as plants growing, traffic lights or children playing hide-and-seek games would help teachers find out what children already know and think.

2. Light travels in a straight line.

The concept that light travels in a straight line is well developed. However, questions to ask about children's views are not given. The question, "Does light

from the torch always travel in straight lines? Try out your ideas," and "the granny's peephole" games are good examples of investigative activities from the Star scheme that could be used here. The activities on light beams provided in the Indonesian scheme can be modified by giving more questions, such as, What is happening in the picture? Try it. How many holes did your beam of light go through? How does light go from the torch to the dot? Then, after these questions, the structure of the book continues with information about the concept of light travelling in a straight line, as stated in the previous version.

3. Transparency and Reflection

The topic is explained explicitly in the Indonesian book. It lacks practical activities which would reveal children's misconceptions about light travelling through clear objects; for example, the book explains that light can travel in clear water, but not in muddy water. Research has found that children often show confusion between shadows and reflections, so I suggest that the progression of concepts should lead to the idea of shadows, where children explain why they have shadows, with the comparison of these shadows and their real self to be emphasised. Question such as 'Can you escape from your shadow?', activities where children are to jump from one point to another and observe the behaviour of their shadows, and making Indonesian shadow puppets are good examples of this.

In tackling reflection, I am going to suggest activities which involve children in revealing their misconceptions about this phenomenon. Firstly, I would like to

introduce the idea of what is a reflection by discussing, What kinds of surfaces do the reflections appear in? Do the reflections look exactly the same as the objects? and then letting the children make their own pictures of reflections. It will be important to discuss shadows and reflections are the same and how are they are different.

All activities recommended should allow children to work together and promote the importance of making reports and communicating their findings to other children. The teacher can make use of this atmosphere for probing children's responses and giving clear feedback to children about their ideas. Additional activities like these would help promote an active approach to learning with understanding.

D. Recommendations for learning science through book resources.

After explaining the supplementary materials and activities which could be used to improve on the Indonesian textbook, I would like to give some suggestions on the way textbooks can be used to improve the teaching of science and to explain some general strategies that can be used by teachers to develop ways of thinking during the process of teaching and learning. This information is needed because different teaching styles are found when teachers use textbooks. Textbooks are seen as a staple diet by teachers and children in Indonesian Primary Schools and properly used they can help to promote conceptual change.

I agree with Roth and Anderson, in Ramsden (1988), who give some ways of helping children read for understanding. They identify six major points which should be looked at when using the textbook based approach to teaching;

(1) **Focusing on few critical issues**

It is a common feature in most science textbooks, that many ideas are brought in and certain specialist vocabulary is emphasized. In order to cope with these ideas, children tend to rely on strategies that emphasize memorization of facts and definitions of lists of 'big words' rather than on strategies that enhance conceptual understanding. Now, in order to use these textbooks appropriately, i.e. for promoting conceptual understanding, teachers should define the content to be covered in ways that differ substantially from these books. The question 'why' should be asked in order to determine the critical issues in the text. A 'good' teaching method in using the textbook does not require children to remember all the vocabulary and load them with the 'big words', but focuses on issues which are problematical for children.

(2) **Asking questions to elicit and challenge children's thinking and misconceptions**

Most science textbooks are written from scientists' perspectives. Children's alternative ways of thinking about topics are rarely seriously considered in organising text content. Children use their everyday knowledge to interpret the text and therefore, it is the duty of teachers to find ways in which children's thinking differs from the concepts in the text. 'Good' teaching using a textbook requires asking questions that elicit and challenge childrens' misconceptions. Those teachers who stick to the

questions in textbooks, limit the children's ways of thinking, as these questions from textbooks require children to give factual knowledge and definitions of terms and seldom match children's everyday experiences with the scientists' perspectives.

(3) **Asking questions that give children repeated opportunities to apply text concepts to explain everyday phenomena.**

Mostly, textbooks give many questions for children which simply ask them to repeat or recognize facts and definitions. They rarely ask children to construct explanations that link concepts with the children's real world experiences. Children when answering these types of questions look for facts and big words. Hence the learning becomes passive. It is this crucial mistake which teachers should avoid, by asking questions that give children opportunity to apply text concepts to explain everyday phenomena.

(4) **Probing children's responses and giving clear feedback to children about their ideas**

When I looked at the questions in some of the science textbooks, I saw that they present content and give questions in ways that suggest that learning is a fairly simple process, where new information is added to memory and if it is understood correct answers are given. When using a textbook, teachers should go beyond the search for correct answers, and listen and respond to children's statements in ways that will shape, guide and support their thinking. Listen to children's thinking not the right answers. Praising good answers and passing over incorrect answers when responding to children's answers encourage children to find the

right answer. Using words like 'why' in response to childrens' answers helps in moulding their thinking and enhances their conceptual understanding.

(5) **Constructing alternative representations of text explanations that make explicit the construct and connection between scientific explanations and children's misconceptions.**

Most explanations given by textbooks about concepts are very abstract and each explanation about one concept is separate from the other concepts. If we are dealing with a slow learner, he or she may distort the whole text because of poor understanding of the different concepts. Therefore, a teacher should have different ways of explaining the concept so as to help the children to understand the text content. It should be remembered that the connection between children's ideas and scientific explanations is very important in their understanding of the text. Repeating key explanations in several ways can also help in clearing the misconceptions which exist in children's thinking.

(6) **Selecting and using activities to create conceptual conflict and developing conceptual understanding.**

In planning class activities, teachers tend to look for textbooks with activities which are appropriate in terms of both time and quality. Writers of science text books in response to this problem should provide a variety of activities that teacher and children may use to accompany the reading of the text. Because the contribution of these activities is not made clear in the teacher's guide, teachers may do these activities only for the sake of experimenting and trying to induce interest in children. Thus Bennet,

in Bourne (1994), wrote 'there is little to be gained from high pupil involvement on tasks that are either not comprehensible or worthwhile'. Teachers should select activities that will contribute to children's understanding of the central science concepts. Activities should challenge children's ideas and provide opportunities for them to acquire new evidence that could help them change their own explanations.

E. Limitations of the study

There were several weaknesses in the study. First, the analysis of the UK and the Indonesian book resources is based on the researcher's point of view only, based on her experience in teaching and primary in-service training. There is no counter-judgement made by other teachers in the two countries. Second, the criteria for evaluating book resources developed here reflect the purpose of the study, to develop good teaching material which promotes children's investigative and analytic skills. The criteria might not be the same for others, who may have different priorities in evaluating book resources, for example: they might consider to gender differences or equal opportunity issues. Third, deciding if a book meets some of the criteria will be based on a personal judgement, for example: Does it take account of children's ideas and everyday experience? and Does the physical format provided help children assist learning? Decisons on only some of the criteria can be based on purely factual information, for example: Does it give background information? Does it give guidance on teaching approaches and opportunities for practical work?

Finally, the process of analysing book resources is recommended. It could be used by teachers in evaluating materials they are using and also it helps them to think more analytical and critically about how to use them most effectively.

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Appendices

NOTES

LIGHT 2

THEME: LIGHT

■ **OBJECTIVE:**
To investigate the way that light travels from a source to a target.

■ **KEY IDEAS:**
Usually, light travels from its source in straight lines until it meets an obstruction.

■ **WHY IS IT IMPORTANT?**
Knowing that light usually travels in straight lines is essential to the understanding of how shadows are formed and of reflection.

■ **RELEVANT STATEMENTS OF ATTAINMENT:**

SCIENCE Sc1/2abc, Sc4/2d.
MATHS Ma1/2bc, Ma4/2b, Ma5/2a.

■ **LINKED PUPIL MATERIALS:**
Flopover Book, page 26.
KS1 Book 13: *Light.*

■ **CORE ACTIVITY – REQUIREMENTS:**

Time: One or two sessions.

Place: In the darkest part of the classroom.

Resources: Small Duracell torches or similar torches with self-focusing bulbs; card slits and targets (see last page this Unit); large sheets of white paper; metre rules.

■ **ASSESSMENT POINTERS:**
*Sc1/2a *"ask questions such as 'how ... ?', 'why ... ?', and 'what will happen if ...?', suggest ideas, and make predictions."*
*Sc1/2b *"make a series of related observations."*
*Sc1/2c *"use their observations to support conclusions ...."*
*Sc1/2c *"... compare what they have observed with what they expected."*
Sc4/2d *"know that light passes through some materials and that when it does not shadows may be formed."*

NOTES

SCENE-SETTING ACTIVITIES

- Take the pupils into a completely dark place such as a large cupboard and let them shine torches about.
- Taking appropriate safety precautions, read the pupils a story by candlelight in a darkened classroom.

CORE ACTIVITY

● *How does light go from this torch to this target?*

Open a torch and lie it on its side on the table. Set up a target about 1 metre away so that light from the torch shines onto it. Discuss how the torch works and how light goes from it to the target.

This card has a slit in it. What will happen if we stand it between the torch and the target?

Show the pupils a card slit. Discuss what will happen if it is placed between the torch and the target.

Sc4/2d The pupil indicates that light will not pass through the solid part of the card and that this may make a shadow on the target.

Place the slit, dark edge downwards, about half way between the torch and the target so as to make a bright line on the target. Discuss what happens.

Try moving it about.

Allow each pupil in turn to slide the slit about, observing the bright line.

What if we put a second slit in the way?

Put another slit between the torch and the first slit or between the first slit and the target. Again let each pupil slide it about. Discuss what happens.

● *Let's do an experiment to see how slits have to be placed to let light right through.*

Let the pupils spread out a large piece of paper on a table and tape it in place. Help them to put a pencil dot on the paper near one end and to set up a target so that the line on it stands exactly on the dot (see last page this Unit). Help them to set up a torch at the other end to before so that it shines onto the target and to draw a pencil line round its outline.

Put one slit in place.

Ask the pupils to place one slit about half way between the torch and the target so as to make a bright line exactly on the line on the target.

NOTES

Mark its position.

Help the pupils to put a pencil dot exactly under the slit, taking care not to move it.

Now add another slit.

Ask the pupils to place a second slit between the torch and the target so that the bright line is still on the target. Mark its position.

Now add two more slits.

Ask the pupils to place two more slits between the torch and the target so that the bright line is still in place. Mark their positions.

*Sc1/2b The pupils observes the effect of placing four successive slits between the torch and the target.

Look at the pattern.

Let the pupils clear everything off the paper and look at the dots. Discuss how they are arranged. Use a metre rule to develop the idea that they are all in a straight line.

*Sc1/2c The pupil concludes that if light is to reach the target the slits must be in a straight line.

Does it always work?

Let the pupils replace the torch and target and try placing slits at various positions. Ask them to use the plotted line to predict whether or not light will reach the target. Discuss what happens and why.

*Sc1/2a The pupil actively discusses what will happen if slits are placed at various points and why, and, with prompting if necessary, says what he or she expects will happen in at least two cases.

*Sc1/2c The pupil compares the relevant outcomes with his or her predictions.

FOLLOW-UP ACTIVITIES

- Let the pupils observe sunlight, or the light from a projector, shining through dust or smoke. Let pupils partially obstruct the light. Discuss the effect.
- Make a collection of pictures showing unusual lighting conditions, for example, rays of sunshine from behind clouds, a scene illuminated by a single light source such as a candle, or a laser display. Discuss what the pictures show. Let the pupils make their own pictures based on them or write about them.

The Star Science concept chain cont'd

Key Stage 1	Key Stage 2
ENVIRONMENT	
Concept 1 There are many different living things. We can sort living things into groups. **Concept 2** Living things are suited to the habitat where they live. **Concept 3** Some animals eat plants. Some animals eat other animals. Some animals eat both plants and other animals. **Concept 4** A good habitat provides everything a plant or animal needs. **Concept 5** A change in their habitat can affect plants and animals.	**Concept 1** There are different kinds of environment. **Concept 2** Living things are adapted to their environment. **Concept 3** There is a relationship between plants and animals in an environment. **Concept 4** Habitats change. **Concept 5** An environment is a system which can be harmed.
ELECTRICITY	
Concept 1 Many things use electricity. We must use them safely. **Concept 2** We can make a bulb light by using a battery. We call this a circuit. The bulb will not work if there is a break in the circuit. **Concept 3** Some materials in a circuit allow a bulb to light. We call these conductors. Some materials in a circuit do not allow a bulb to light. We call these insulators. **Concept 4** We can use a switch to break a circuit and turn things on and off. **Concept 5** We can draw pictures to show a circuit. We can make circuits using pictures.	**Concept 1** A complete circuit is needed for an electric current to flow. **Concept 2** We can use different components in a circuit to do different jobs. **Concept 3** A switch can be used to stop an electric current from flowing. Materials which are conductors allow electricity to flow. **Concept 4** Circuit diagrams are special ways of showing a circuit. **Concept 5** There are two ways of wiring a circuit called series and parallel.
LIGHT	
Concept 1 Some things give out light. **Concept 2** We need light to see. It is dark when there is no light. **Concept 3** Some things block light. **Concept 4** Light does not bend around things.	**Concept 1** Very hot things are sources of light. Light travels from sources in straight lines. **Concept 2** Some things do not let light through. We call these things opaque. Opaque things cast shadows. **Concept 3** Some things let light through. We call these things translucent or transparent. **Concept 4** Flat shiny things reflect light and then we can see an image. **Concept 5** Everything reflects some light. We see objects because they reflect light which enters our eyes.

CONCEPT 1

Some things give out light.

tarter Book pages

troducing the concept

(the children's ideas about what things give out ıt and discuss their suggestions. Alternatively, ask children to draw pictures of things that give out ıt.

ıking connections

ılain that light is given out when things get hot. e the children plenty of examples, e.g. the sroom lights get hot when they are switched on. computer screen is warm, etc.

Starter activity

Encourage the children to observe a sparkler or a candle burning. This should be done under close adult supervision. The sparkler and candle do not give out light when they are in their packaging. When a burning match is brought close to the sparkler or candle it lights. Only when the sparkler or candle gets hot enough does it start burning and gives out light.

Activity cards

Card 1

ing out light

pose

inforce the idea that some things give out light.

vity

is activity the children are asked to draw things at ol which give out light. They are also asked to e a list of things that give out light at home.

stions

(gives out light in the classroom?
t gives out light at home? in the street?
t lights help us to see our way. Why do other gs give out light? Think about a traffic light.
t is the most unusual thing you have seen that out light?

ch out for

lren confusing light souces – bulbs, flames, the – with light reflectors – mirrors, cats eyes, the n.

Card 2

Light bulb

See **Photocopy Master 1**.

Purpose

To develop understanding of the parts of a light bulb.

Activity

Here the children use a hand lens to observe a small bulb in a circuit. They are asked to draw the bulb and to colour the part that lights up. They should then see if they were right by switching on the bulb. The children are asked to touch the bulb when it is off and when it is on. What do they notice? (The bulb gets warm.)

Alternatively, a drawing of a bulb is supplied on **Photocopy Master 1** which the children can colour in.

Questions

Which part of the bulb lights up?
What can you see inside the bulb?
What is the bulb like to touch when it is off and on? Why?

Watch out for

Great care should be taken when touching the bulb. Children often think that it is the glass that lights up. The filament is the fine wire held between the two uprights. This lights up.

The magic troll

Card 3

Purpose

To develop the children's knowledge of things that give out light.

Activity

In this activity the children are introduced to Jog, the magic troll. The children are asked what Jog could use to light his cave. There are four things to choose from. The children are asked to paint a picture of Jog and his light.

Questions

Have you ever seen any of the things in the pictures?
Which one do you think would give out the most light?
Which thing(s) would you choose? Why?

Watch out for

The children may need to have the examples explained to them. The glow-worm is a beetle which emits a green light from its abdomen. Stars give out light. The light wand is fluorescent and glows in the dark. The Moon is not a light source. It reflects the light of the Sun.

Adventure in the dark

Card 4

See Photocopy Master 2.

Purpose

To apply the children's knowledge of things that give out light.

Activity

Here the children are asked to imagine that there are no street lights and two children have to find a way to get home. They are then challenged to think of things to help them see and to write about and draw their ideas.

Questions

What would you do if there were no lights and you could not see?
Have you ever been in a power cut? What was it like?
What did your parents do?
What did people use for light before electricity?

Watch out for

Discuss the scene with the children before they start writing and make a list of their suggestions for helping the children to find their way home.

Extension cards

Amazing story

Card 5

See Photocopy Master 3.

Purpose

To extend the children's knowledge of things that give out light.

Activity

This activity challenges the children to write a story.

Questions

Which lights have you never seen before?
What kind of adventure do you think your story will be?
How could the different lights be used in your story?

Watch out for

It will probably be necessary to discuss each of the lights with the children to ensure that they know what they are and their different uses.

Seen in the dark

Card 6

Purpose

To extend the children's knowledge of things that give out light.

Activity

This is an investigation in which the children are asked to find about reflective strips and how they work. They are asked to try out their ideas.

Questions

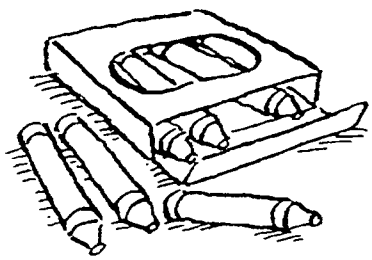
The words 'reflect' and 'reflective' are not shown on the card, but can be introduced at this point.
What do you think the words reflect and reflective mean?
Where have you seen reflective strips used?
Do you have anything else that is reflective? Why do you use it?

Watch out for

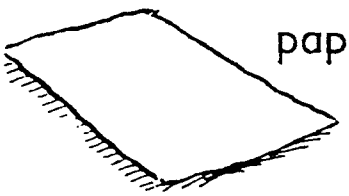
Discuss the investigation with the children before they begin. Encourage the use of a planning house. Discuss in detail how they will carry out their test. This is an opportunity to plan and carry out an investigation.

Concept 1

Card 1 Giving out light



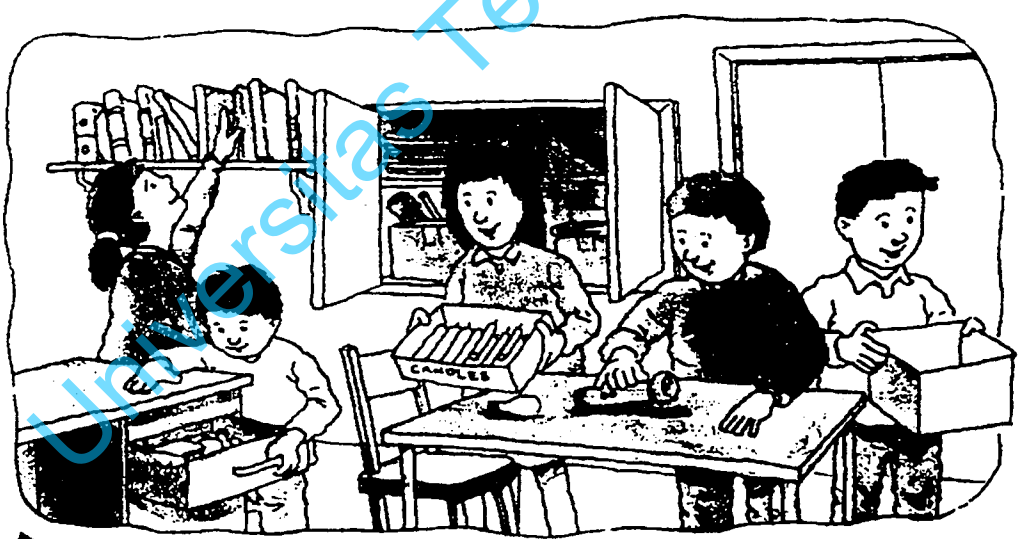
crayons



paper

pencil

Draw some things at school which give out light.



What gives out light at home? Make a list.

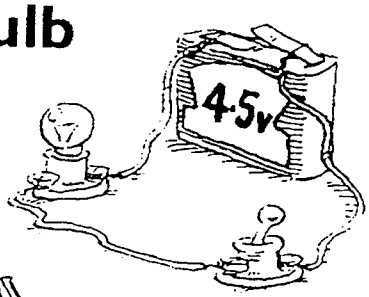
Concept 1

Card 2

Light bulb

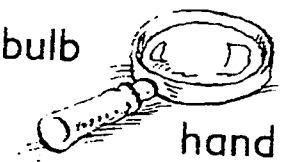
PCM

yellow crayon



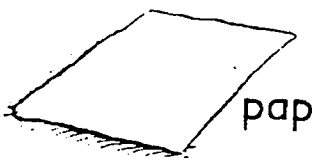
circuit

bulb



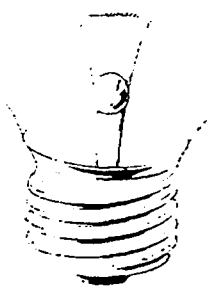
hand lens

pencil



paper

Look carefully at the bulb.
Use a hand lens.



Draw the bulb.
Do you know the part that lights up?
Colour it yellow on your drawing.
Switch the bulb on.
Which part lights up? Were you right?

Touch the bulb when it is off.
Touch the bulb when it is on.
What do you notice?

8800542441

Concept 1

Card 4

Adventure in the dark

There are no lights.
These children cannot see their way home.

What could they use to help them see?
Write and make drawings
to show your ideas.

Concept 1

Card 5

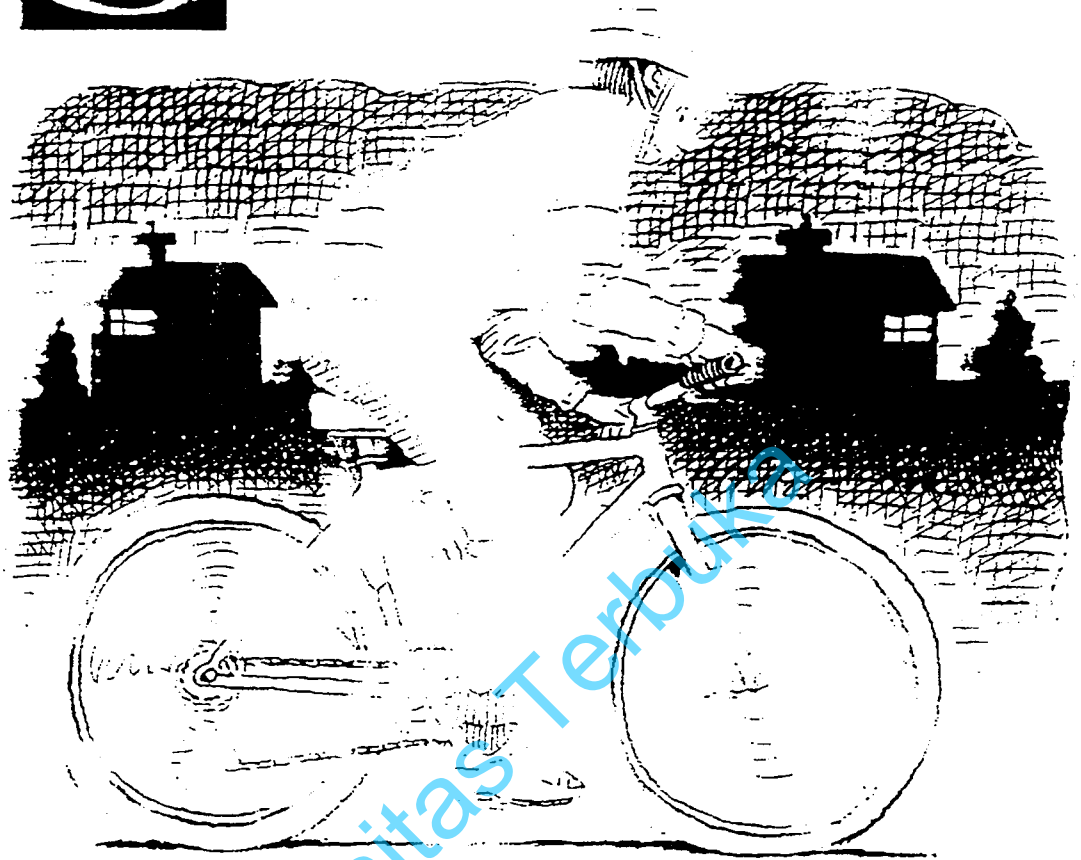
Amazing story

How many different lights can you see?

Write a story.

Card 6

Seen in the dark



The cyclist is wearing a special strip of material.

What does it do?

How does it work?

Try out your ideas.

What did you find out?

Appendix 3. Nuffield Primary Science

CHAPTER 3

Exploring light

Theme organizer

LIGHT

LIGHT SOURCES AND VISION

Light comes from a variety of sources: primary sources which give out light directly, and secondary sources, which reflect light.

Objects can be seen because they either give out light or reflect light.

Objects are seen when light enters the eye.

[illegible]

The position, shape, and size of a shadow depend upon the position of the object in relation to the position of the light source.

Light travels through some materials but not through others.

Light is reflected off objects.

*Light travels in straight lines.

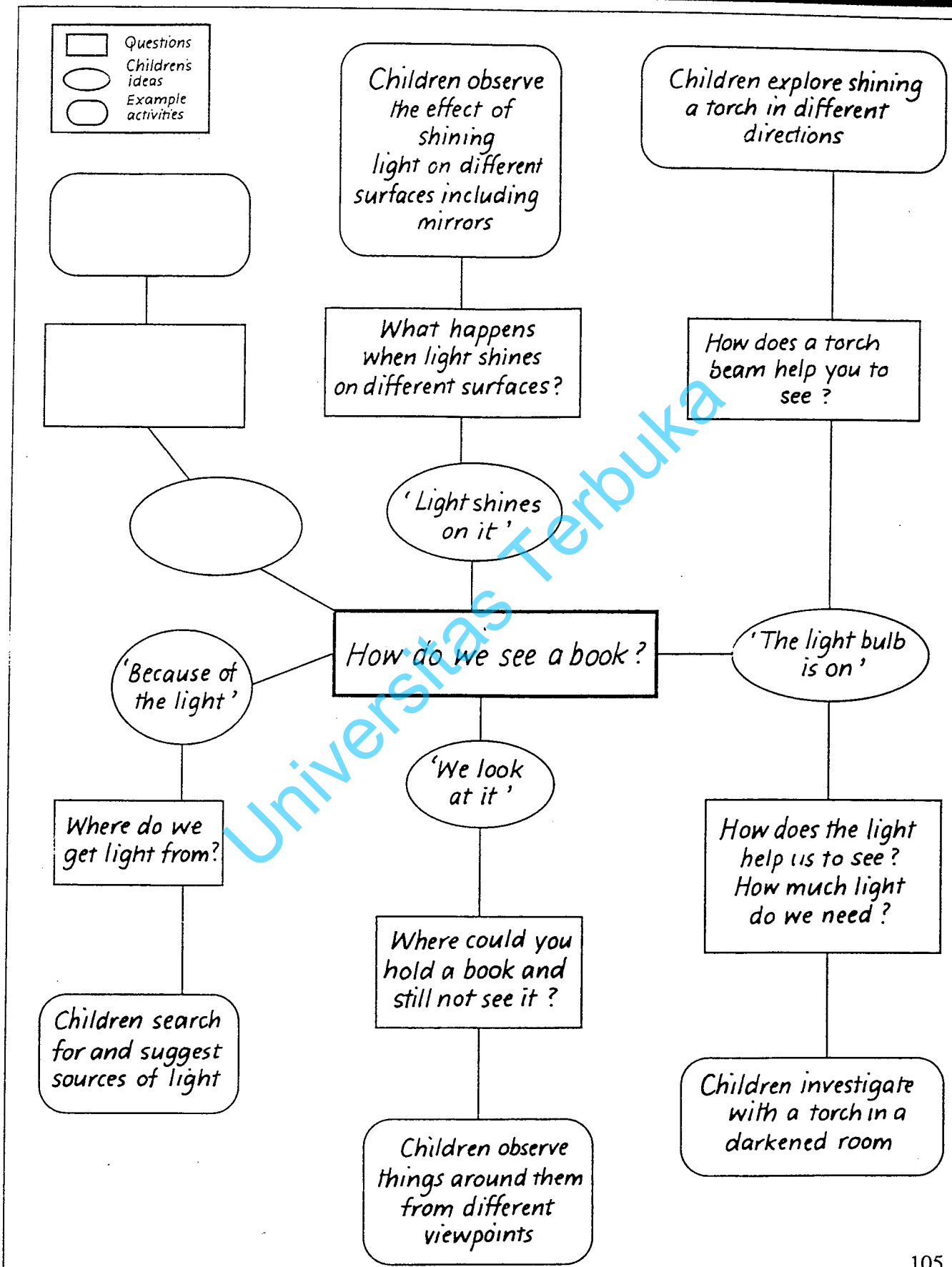
COLOUR

Colours in the environment often have a particular significance for plants and animals, including humans – for example, warning coloration and camouflage.

Different colours can be created by mixing coloured paints, or by using filters.

(*Asterisks indicate ideas which will be developed more fully in later key stages.)

Helping children to develop their ideas about light sources and vision

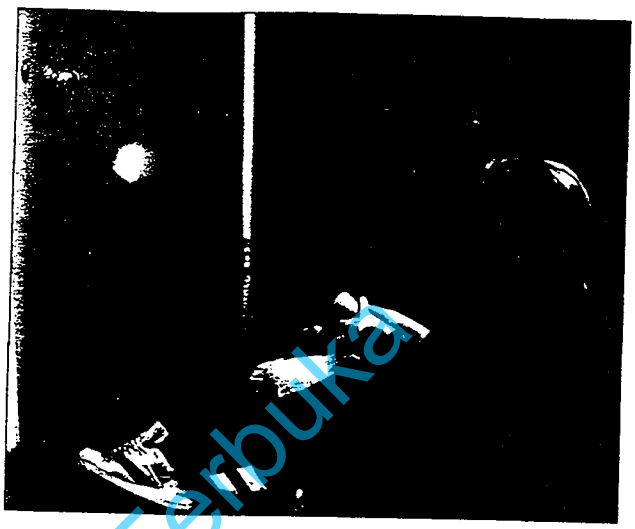


18 EXPLORING LIGHT

Appendix 4. Collins Primary Science

Light travels in straight lines but it can be reflected and made to change direction. If you shine a torch onto a wall the beam of light will go straight to the wall and make a spot of light.

ACTIVITY



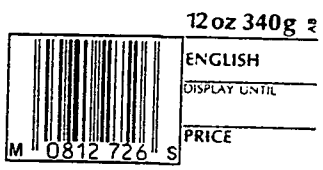
Try shining a torch onto a wall. What do you think will happen to the size of the spot on the wall if you:

- move the torch nearer?
- move the torch further away?

Try it. Were you right?

As you move the light away from the wall the light beams spread out and are not so powerful. In 1958 two scientists discovered a way to stop the light spreading out. This made a very powerful beam called laser light. Lasers are used in lots of different ways. They are used:

- in hospitals
- in banks
- in Space
- in shops.

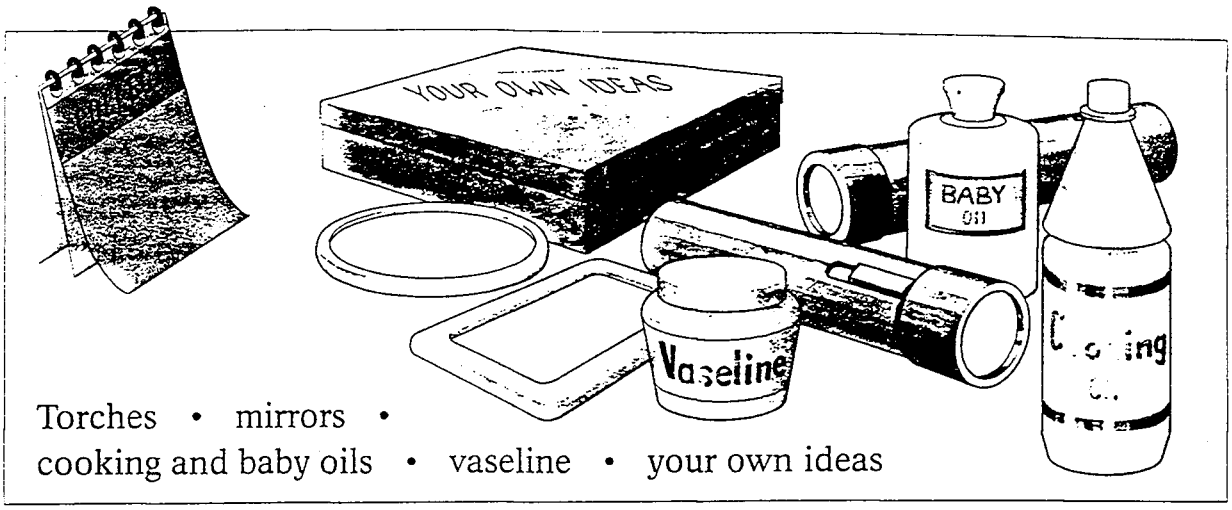


Shop goods have special labels like these called bar codes.

Each product has a different code. At the check out a laser reads the bar code and sends the right price to the till. The till also stores information in *microchips* which says how many of that thing have been bought so that the shop manager knows when to order some more.

If you look on the back cover of this book you will see an oblong full of black lines. This is the bar code for this book.

Exploring light effects



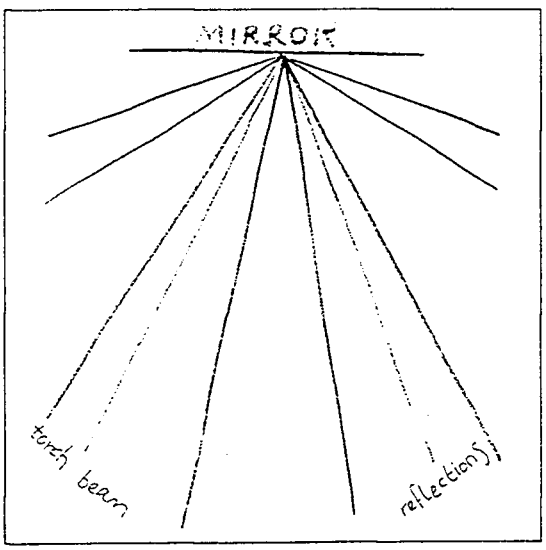
Torches • mirrors • cooking and baby oils • vaseline • your own ideas

ACTIVITY – A –

Shine your torch on some mirrors. What do you see? Make patterns on your mirrors using the oil and vaseline. How does this change the reflections you can make? Can you say why?

ACTIVITY – B –

If you face a mirror and shine a torch onto it, the reflection will come back to you. If you shine the torch so that it hits the mirror at an angle, it will reflect back in a different direction. Put a mirror near the wall. Shine the torch onto it from different directions. What do you notice happening? Draw what you find out like these children.



ACTIVITY – C –

When you try to walk across a swimming pool, the water slows you down and it is hard to walk in a straight line. Light can travel through the air easily but some materials may slow the light down and make it change direction. Find different things to shine light through. Which make light change direction?

6. Cahaya dan Penglihatan

Appendix 5. Tiga Serangkai

A. Cahaya Mempunyai Sifat-Sifat yang Berguna dalam Kehidupan Sehari-hari

Pada waktu malam hari, di dalam rumah gelap. Jika di rumah dinyalakan lampu, tampak meja, kursi, gambar di tembok, dan benda-benda lain di rumah itu. Benda-benda itu tampak karena cahaya. Mata kita tidak dapat melihat benda-benda di sekitar kita tanpa bantuan cahaya. Cahaya dari lampu jatuh pada meja, kursi, gambar di tembok, dan benda-benda lain. Cahaya kemudian dipantulkan mengenai mata kita. Akhirnya kita melihat benda-benda itu.

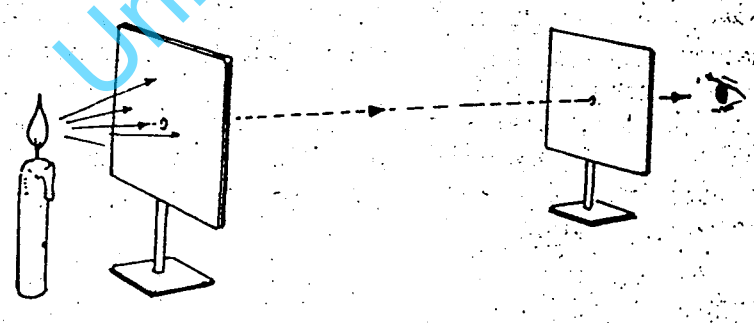
Cahaya merupakan rangsang yang mengenai indera penglihat kita. Cahaya mempunyai sifat-sifat, antara lain: merambat lurus menembus benda bening, dapat dipantulkan, dapat dibiaskan bila melalui dua zat yang berbeda, dan cahaya putih terdiri dari berbagai warna. Sifat-sifat itu sangat berguna dalam kehidupan kita sehari-hari.

1. *Cahaya Merambat Lurus*

Cahaya dapat merambat di berbagai zat perantara (medium). Cahaya dapat merambat di udara, di air, maupun di kaca. Bahkan cahaya dapat merambat pada ruang hampa udara.

Pernahkah kamu memperhatikan cahaya yang merambat? Misalnya cahaya yang masuk ke rumah melalui celah-celah genting atau cahaya yang berasal dari proyektor waktu kamu melihat bioskop. Bagaimana arah cahaya itu? Bukankah cahaya itu merambat lurus? Memang demikianlah sebenarnya. Cahaya pada sebuah zat perantara merambat lurus.

Arah rambatan cahaya yang lurus itu dapat dibuktikan dengan alat sebagai berikut.
Ambillah sebuah sumber cahaya (misal: lampu lilin). Siapkan pula dua helai kertas karton yang dapat dipasang tegak sedemikian rupa, pada sebuah tempat. Nyalakan lampu lilin dan pasang dua karton seperti gambar di bawah ini!



Cahaya merambat lurus.

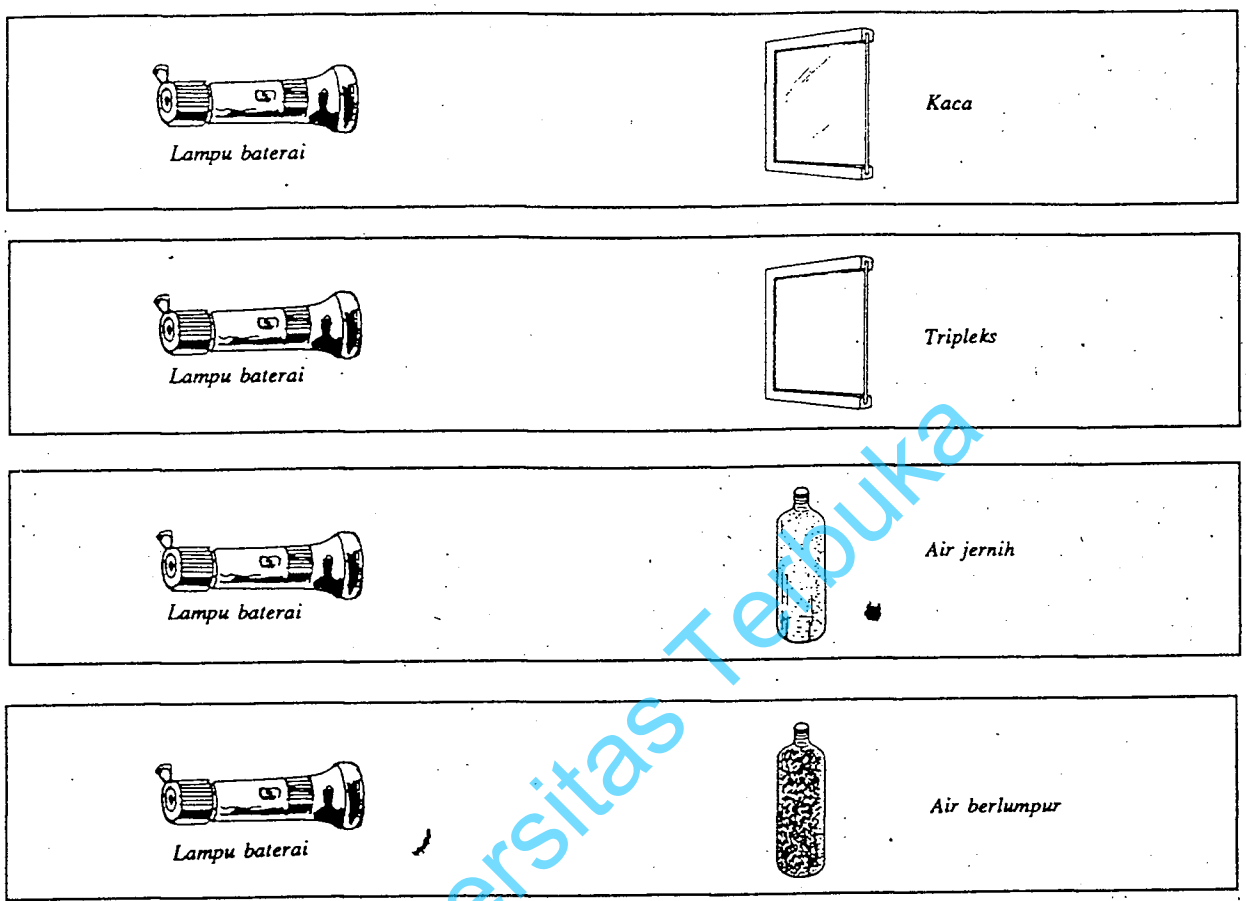
Kegiatan ini membuktikan, cahaya dapat merambat lurus pada sebuah zat perantara. Cahaya juga merambat dengan kecepatan tertentu. Sebuah percobaan yang dilakukan oleh *Albert Michelson* berkesimpulan, bahwa cepat rambat cahaya di ruang hampa 3.10^8 m/det. atau 300.000.000 m/det.

inframerah, semakin terasa panas. Ultraungu mempunyai efek kimia terbesar. Sinar ultraungu membantu pembentukan vitamin D. Sinar ultraungu dapat menghitamkan kulit serta merusak retina mata. Pakailah kacamata hitam untuk menghindari gangguan sinar ultraungu!

Kegiatan 1

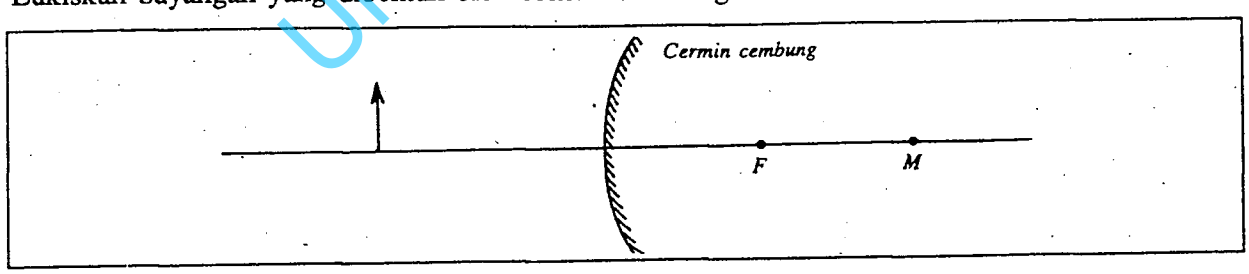
Selesaikan gambar di bawah ini!

Bagaimanakah cahaya yang mengenai benda-benda seperti di bawah ini?



Kegiatan 2

Lukiskan bayangan yang dibentuk oleh cermin cembung!



Latihan Soal-Soal

I. *Isilah titik-titik di bawah ini!*

1. Sifat-sifat cahaya ialah .....
2. Cahaya dapat merambat melalui .....
3. Yang termasuk benda bening ialah .....