Development of a pilot concept of environmental education at schools

Using the example of the introduction of separate waste collection at Assumption College Thonburi, Thailand

Author

Dr.-Ing. Gunnar Hädrich

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List of Abbreviations

ACEID	Asian Pacific Centre of Educational Innovation for Development
ACT	Assumption College Thailand
ADM	Arbeitskreis Deutscher Markt- und Sozialforschungsinstitute e.V. (association of German market and social research institutes)
ASEAN	Association of South East Asian Nation
AWK	Abfallwirtschaftskonzept (Waste management concept)
BAWO	Bezirkliche Abfall-Wirtschafts-Optimierung (local waste management optimization)
BLK	Bund-Länder-Kommission für Bildungsplanung und Forschungsförderung (German Bund-Länder Commission for Educational Planning and Research Promotion)
BMA	Bangkok Metropolitan Administration
BSR	Berliner Stadtreinigungsbetriebe (Berlin city cleaning companies)
Danida	Danish International Development Assistance
DCID	Department of Curriculum and Instruction Development
DEQP	Department of Environmental Quality Promotion
DGE	Department of General Education
EEEC	Energy and Environmental Engineering Center
EGAT	Electricity Generation Authority of Thailand
EMAS	Environmental Management Audit Scheme
MOE	Ministry of Education
MOI	Ministry of Interior
MOSTE	Ministry of Science, Technology and Environment
MUA	Ministry of University Affairs
NED	National Education Development
NESDP	National Economic and Social Development
ONPEC	Office of the National Primary Education Commission
OPM	Office of the Prime Minister
PEEC	Provincial Environmental Education Centres
SEET	Strengthening Environmental Education in Thailand
TEF	Thai Education Foundation
UN	United Nations
UNCED	United Nations Conference of Environment and Development
UNEP	United Nations Environment Program
UNESCO	United Nations Educational, Scientific and Culture Organization
UNO	United Nations Organization
WCED	World Commission on Environmental and Development

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Abstract

Environmental problems are an international topic in the present time of the globalisation. Also in countries in Southeast Asia these problems increase by rising world-wide trade for example in the Kingdom of Thailand. Further, a rise of consumption is interconnected with this economic recovery. In this context, the increase of the solid waste production represents an essential one problem. This is additionally promoted by the population growth especially in conurbations.

Environmental problems are mainly based on population's ignorance. However, each individual should support the protection of environment and improvement of the world-wide situation by environment-conscious behaviour. Therefore basic knowledge is necessary and it is considered meaningful to integrate environmental education in all life areas especially in school education.

In Thailand, environmental education isn’t a component of the general instruction until the present time. However, the Thai government is striving for adjustment the education to a sustainable development. In order to support these efforts an environmental school project was started at a Thai comprehensive school. It contains the realization of a waste management master plan and an environmental educational concept. The concept to the environmental education based on current school projects and is adapted to the present school situation. It should bring the purpose and the function manner of the separate waste collection after value materials home to the students. Therefore knowledge of utilization possibilities and to the separate waste collection is arranged in lessons. The separate waste collection after value materials is introduced at the school in the framework of the waste management master plan. So a practice-near possibility is given to the students to apply the knowledge.

1 Environmental education at schools

1.1 Environmental education in Thailand

As early as 1991, following a motion of the national environmental council submitted by the Ministry of Science, Technology and Environment (MOSTE), the Thai cabinet declared December 4th as the Thai Day of Environment. This had been initiated by the speech of the king on December 4th, 1989, in which he referred to the increasing destruction of the environment on a national and international level. The speech reinforced the role of public and private institutions in encouraging the public's participation in environmental protection through environmental campaigns [www - 9].

1.1.1 The education system of Thailand

The Thai system of government is a constitutional monarchy. The education system is subject to the responsibility of four government agencies, see Appendix A [www - 5]:

- the Ministry of Education (MOE),
- the Ministry of University Affairs (MUA),
- the Ministry of Interior (MOI), and
- the Office of the Prime Minister (OPM).

There are public and private schools in Thailand. Both school types have been to date subject to government agencies in terms of scope and content of the education.

Since 1960 the obligatory school education has had a duration of six years, it starts for students at the age of seven years and ends when they reach the age of 14. The general education structure and the education duration as decided in 1977 are determined as follows [www - 5], see Table 2-1:

Table 2-1: Education structure and duration at Thai schools

Thailand			**Respective German name**	
Grade level	Name	Duration [a]	Name	Grade
Primary Education	Pathom 1 – 6	6	Grundschule	1-6
Lower Secondary Education	Mathayom 1 – 3	3	untere Sekundarstufe	7-9
Upper Secondary Education	Mathayom 4 – 6	3	obere Sekundarstufe	10-12

Since 1961 quinquennial national education and development plans (NED plans) serve as the basis and guideline of school education. These are adjusted to the national economic and social development plans (NESDP). The seventh and eighth NED plans (1992-2001) focused on the development of the society. These plans aimed at [www - 5]:

- improving the quality of education,
- supporting the principle of lifelong learning,
- directing education to productive working, and
- involving the private sector in the organization of education.

Therefore, Thai school education was expected to focus on areas such as:

- social and technological development,
- the development of competences,
- health development, and
- the promotion of democracy.

Currently, the school education is based on the NED plans published since 1992 and complies with the following four principles [www - 5]:

1) The fostering of individual wisdom, opinion, of thinking and ethics is an essential goal to establish a balance between social culture and the economy.
2) Being a part of nature and living in coexistence with it, humans should use natural resources carefully and avoid harmful influences on the environment.
3) The appreciation of local knowledge, of the language and culture of the Thai societies is to be promoted in order to optimally adapt the usage of modern knowledge, technological advances and foreign or exogenous cultures to the local context.
4) The right balance between dependence and autonomy is an essential basis of the cooperation of individuals, societies and national levels to support a sustainable development that improves Thailand's status in the global community.

According to the Ministry of Education, education is a process that enables people to improve their quality of life, to lead a peaceful and social life, and to make valuable contributions to the state's development in accordance with national contexts. Thus, the goals of education are wisdom and the fostering of the mental, physical and social development [www - 5].

In the course of Agenda 21 the term “sustainable development” has gained in importance also in Thailand. In 1998 the Thai government compiled a report to the UN Commission on Sustainable Development on the current status of education. This report tells that the eighth NED plan (1997 – 2001) was prepared jointly by

- the Ministry of Education,
- the Department of Environment Quality Promotion (DEQP), and
- the Ministry of Science, Technology and Environment (MOSTE).

All of these are members of the National Coordinating Body for Sustainable Development. At that time the Ministry of Education supported by DEQP and MOSTE made an effort to include environmental topics and sustainable development concepts in the national curriculum of all grades. This was to be implemented by using print materials and audiovisual tools as well as by establishing special classes, study groups and workshops [www - 6]. The project “green learning room” can be cited as an example:

- It is the goal of the project to make the students understand the production and the economizing of energy. For this purpose the Ministry of Education, the Bangkok Municipal Administration (BMA) and the Electricity Generating Authority of Thailand (EGAT) set up laboratories and compiled guidelines that serve as school materials at elementary and lower secondary levels.

The Department of Environment Quality Promotion (DEQP) is responsible for promoting the cooperation and coordination of government agencies, public enterprises and private concerns. This institution is thus the interface between the public and private sector. DEQP supports and conducts research and development in the field of environmental management. Further fields of activity are [www - 8]:

- Supporting public education and establishing connections between environmental protection and media,
- Developing and establishing databases with environmental information, and
- Providing environmental knowledge for government representatives and private sectors.

The economic crisis hitting Asia in 1997 also had an impact on education. In order to counteract such crises in future, the consequent improvement of the education system is aspired. It is intended to not only impart general knowledge to the Thai population but also to teach them appropriate learning skills so that they are able to acquire knowledge independently. In October 1997 the constitution of the Kingdom of Thailand was revised. In this context the state wants to implement reforms regarding education whenever it is necessary. As soon as possible the educational situation should match the economic and social situation. So in August 1999 the first “national education resolution” was stipulated. After a transition phase that started in October 2002 this resolution serves as the basic law of the administration of education. The goals, which correspond in part with those of the NED plans, are [ONEC, 2001]:

- Lifelong learning for all Thai people,
- Participation of all social strata in education, and
- Continuous development of teachers and the learning process.

The first “national education resolution” includes a variety of innovations. One basic innovation is that from October 2002 onward all Thai students are able to participate in school education that is free, qualitative and takes 12 years. The duration of obligatory school education is increased from 6 to 9 years. Furthermore, the resolution states that education should be based on the principle of self-learning. That means that the students are taught skills that foster independent learning. In addition, the education commission will specify a core curriculum in future. This will be given contents afterwards by institutional education facilities with regard to the needs of the society. Chapter 2, section **Fehler! Verweisquelle konnte nicht gefunden werden.** elaborates on this. Private school education will be supported by the government but administrated and run independently from the government [ONEC, 2001]. The report does not address the contents of education. Thus, no statement can be made on the development of environmental education from the administrative perspective.

1.1.2 Projects of environmental education

There are also Thai projects aiming at the implementation of environmental education at schools. The topics are in part much diversified, similar to German projects. They primarily range from forest and landscape protection to wildlife protection to the topics of energy conservation, waste reduction and recycling. In the following some projects are listed and their approaches of implementing environmental education are explained.

Environmental Education Centers

The Thai Education Foundation (TEF) is a non-profit organization for the improvement of education in Thailand and came into existence between 1970 and 1980 due to numerous cooperation between the Ministry of Education and World Education, Inc. [www - 7].

It is the task of the foundation to:

- evaluate the quality of the education centers,
- develop and run training courses for the staff members, and
- provide technological support for future developments.

Supported by DEQP, MOSTE and the Ministry of Education, TEF ran an environmental programme (Provincial Environmental Education Centers) between 2001 and 2002. 31 provinces launched rural environmental education centers (PEEC) in the secondary levels. The goals were [www - 7]:

- the development and introduction of environmental education at schools and in the society,
- the formation of networks, and
- the distribution of information and material about the topic.

Unfortunately, so far the author has not been able to get access to more detailed data regarding the program.

Education for a sustainable environment

Projects on the education for a sustainable environment at Thai schools have been developed not only by and in Thailand itself. The advancements of the 20th century not only brought social and economic prosperity to the whole Asia-pacific region but also a number of environmental problems. In order to limit these problems cooperation between individual countries is necessary to search for scientific, technological, legal and economic solutions. This is why Thailand and its neighboring countries jointly developed programmes for the implementation of environmental education. Organizations have been founded that jointly develop environmental projects. There are for example:

- the Asian Pacific Centre of Educational Innovation for Development (ACEID) [FIEN et al., 1994], and
- the Association of South East Asian Nations (ASEAN) [www - 10, 2003].

ACEID developed the program “Learning for a sustainable environment – Innovations in teacher education” in cooperation with Griffith University in Brisbane, Australia, supported

by the governments of Australia and Japan and UNESCO. The goal of this programme is the improvement of knowledge, competence and understanding in teacher education with regard to curriculum planning and teaching methods in environmental education.

Within a year first guideline principles were defined on the basis of reports from the participating countries. During the following years these principles have been developed into several workshop modules with different topic areas. These were at first tested in the participating countries and subsequently revised and improved. Since 1997 these workshop modules have been published in the participating countries and reflect the content of the program and the approach to introducing environmental education in the form of teaching materials for teachers [FIEN et al., 1994].

The underlying concept of the programme is to impart knowledge and skills for environmental education to the teachers in the Asia-pacific region with the help of ten modules. The contents of the modules constitute a guideline and database for implementing education necessary for sustainable development. The knowledge is subsequently applied by the teachers at the schools [FIEN et al., 1994].

What is of interest for this paper is module 2 entitled:

- “A whole-school approach to environmental education”.

The module is based on designs by John Fien and was tested also in Thailand, beside countries like Malaysia and Vietnam. It contains a number of measures that address the integration of environmental education in [FIEN et al., 1994]:

- the official curriculum of a school, and
- the organizational and everyday activities at a school based on environmental management – the unofficial curriculum.

These measures are explained by the idea that teachers should encourage the students to live in a sustainable environment and to be committed to it. The goal is not to introduce environmental education as an additional subject but to integrate it in the whole curriculum with the dimension of a separate subject. This key principle is listed in the recommendations of the Tbilisi conference, amongst others.

Furthermore it is regarded as important that schools act as a sustainable environment regarding consumption, use of resources and waste management. In this way the knowledge, values and goals of environmental education are fostered as part of the formal curriculum. Module 2 is intended to help teachers in the search for ways to transform the school into a model that demonstrates a sustainable way of living to students, parents and the society [FIEN et al., 1994]. The programme mentions an environmental audit as a possibility to develop a sustainable environment at the school. Involving the students in the auditing process is regarded as important to integrate environmental education into the curricula [FIEN et al., 1994].

Strengthening environmental education in Thailand

The project “Strengthening Environmental Education in Thailand – SEET” is headed by the Danish International Development Assistance (Danida) and supported by the Danish

foreign ministry, the Thai Ministry of Education, and DEQP. Its official launch was in October 2001 and the duration of the project was set at three years [www - 11].

The overall goal of this pilot project is:

- an integrated environmental education that focuses on the students, is based on the approach of the competence to act, and is in interaction with society,
  i.e. the students should develop and improve skills of independent action that enable them to find problem solutions on their own.

The immediate goal is:

- to find those teachers at the pilot schools who have the skills to develop and promote integrated environmental education and to make it a part of the interaction with the local society,
  i.e. teachers are trained as multiplicators, and environmental education should be guided by real, locally existing environmental problems.

It is the intention of the project to strengthen environmental education in terms of methods, ideas, teaching and teaching materials. Students, teachers and supervisors should be able to work together interactively, to exchange experiences and ideas. These measures are supposed to promote the development of new applications and opportunities [www - 11].

For this purpose the main activities are:

- introductory events of concepts and methods of environmental education for employees of the Ministry of Education, executives of the Office of the National Primary Education Commission (ONPEC) and of the Department of General Education (DGE), school administrators and teachers,
- information transfer to parents and the school committee,
- the development of a data basis of environmental education with exemplary materials of environmental education and a computer-based information platform (website),
- the development of a system for research activities and for the evaluation of experiences in environmental education,
- the development and distribution of materials for management staff and teachers,
- the calling of regional, national and international conferences for experience exchange.

Within the SEET project members of the Danida staff hold positions in the steering committee and in the project group. The executives are responsible for the implementation and merely pass on information [www - 11].

The target groups of the project are:

- employees of the Ministry of Education,
- local and regional management staff of ONPEC and DGE, and

- school administration and teachers,

who are trained as multiplicators, and

- the students,

to whom the knowledge is imparted by the multiplicators.

In each of the five provinces (regions) seven elementary schools and two secondary schools were chosen for the conduction the project [www - 11].

1.1.3 Principles of implementation

The principles are very similar to those of German projects because what happens in Thailand are often international developments. But there are no uniform orientation guidelines.

Module 2 “A whole-school approach to environmental education” of the ACEID project “Learning for a sustainable development – Innovations in teacher education” contains interesting principles and suggestions of implementing environmental education in the Thai school education. The advantage of the project is the fact that it is jointly developed and tested by countries of the Asia-pacific region. The SEET programme contains comparable fundamentals.

Both projects are based on two focus areas [FIEN et al., 1994, www - 11]:

1. Environmental Education across the Curriculum, and
2. A sustainable school environment.

The following two didactic principles are recommended for the implementation of the first focus area [FIEN et al., 1994]:

- Content Integration, i.e. the content-related goals of the general curriculum are connected to activities and examples from the environment, e.g. learning environmental vocabulary in language classes
- Process Integration, i.e. environmental activities are also integrated in the general curriculum but with emphasis put on:
    - critical and creative reflection,
    - the search for problem solutions,
    - decision-making and analyses,
    - cooperative learning, and
    - communication skills,

    e.g. knowledge transfer of opposite value systems and their influence on the individual and the society.

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The second focus area is to be realized through the following three possibilities [FIEN et al., 1994]:

- Organizational principles, i.e. the school administration should develop principles like democracy, cooperation, active participation, and justice in all areas.
- Operational practices, i.e. the school administration should practice sustainability in all areas.
- Physical surroundings, i.e. the school site and the school building should be designed in such a way that a sustainable development is promoted.

The ACEID project lists possible ways of creating sustainable school environment such as:

- waste reduction and recycling,
- energy and water savings, and
- a better purchasing policy.

The contents of the projects show parallels to the set of guidelines of the German Bund-Länder Commission for Educational Planning and Research Promotion (BLK) (e.g. system orientation and problem-solving approach, communication and value orientation, etc.). But the projects are not conducted directly at schools but rather aim at the training of management staff.

According to the opinion of the persons responsible in the school sector, fulfilling the following conditions is necessary to successfully realize the projects [www - 11]:

- the trained management staff should transfer the gained and applied knowledge from the pilot schools also to other schools in their administrative district – function as multiplicators,
- the methods and approaches of environmental education should become part of teacher training,
- during the project phase, management staff should not change schools or leave the project, and
- the society surrounding the school has to be open to activities in the field of environmental education.

Didactic methods and contents

No methods are mentioned in the projects concerning the implementation of environmental topics in teaching.

But the ACEID project gives suggestions and an overview of the didactic contents, see Appendix B. Topics are listed and explained that can be addressed in class. These lists differentiate between individual subjects, e.g. in [FIEN et al., 1994]:

- the subject Mathematics – discussion of environmental problems by means of data collections and their graphical representations, and in
- the subject Economy – packaging, its necessity and disposal.

Workbooks, similar to those of German projects, were not available at the time of this thesis.

1.1.4 Regional characteristics

Teacher-student relationship

A working paper by the University of Bielefeld written in the context of a Southeast Asia programme reports on the relationship between teachers and students in Thailand [EVERS, 1998].

According to the paper the class situation is characterized by strong formalization and hierarchy between teachers and students. This situation is explained by the fact that the teacher possesses knowledge that is imparted to the students. The students receive it as "a gift" and thus have to be grateful for it. The teacher's knowledge should not be questioned or discussed. The teacher him/herself can also not discuss or criticize the knowledge he/she is to teach as this would question his/her own status. This leads to the situation that teaching contents are rarely changed in the long term. The attitude of emphasizing authority strengthens the positions themselves and teaching contents are excused from criticism and reflection.

The students absorb the imparted knowledge and reproduce it in examinations. This means the exact reproduction of the contents, definitions and sentences that were taught during class. Deviations are regarded as mistakes [EVERS, 1998].

Although the school reform mentioned in section **Fehler! Verweisquelle konnte nicht gefunden werden.** intends to distance itself from this situation of merely imparting general and ready-for-delivery knowledge to the students, the author is, due to own experiences, of the opinion that the formalized and hierarchical relationship between teacher and students persists for now.

Public spirit concerning Thai knowledge

An aspect that has to be heavily considered is the distinctive emphasis of Thai culture and identity. Already in school books culture is addressed extensively and students are warned of Westernization. Thailand never was a colony and thus never adopted the education strategy of a motherland. The school education system was developed on their own initiative with the assistance of foreign advisers and the training of Thai abroad.

Today, there is the demand in various sciences not to lapse into Western instrumental rationality and thinking but to maintain own traditions. The Western goal is to acquire knowledge to improve oneself and thus invent methods, and to understand the world through analyses and to master nature.

In Eastern thinking the goal is to acquire knowledge to help mankind. That is why Thai education institutions are not permitted to impart solely Western forms of knowledge. The Thai way of understanding and thinking is to be made clear as well. Western knowledge is of great importance, however, it is seen as important to change it and adapt it to Thai

culture. At the same time, it is essential to develop independent knowledge and thinking that have their roots in the people's own culture [EVERS, 1998].

1.2 Conclusion of environmental education

Environmental education is a subarea of a comprehensive field that is concerned with environmental protection. The goal is to teach skills to the individual and the society to make them understand the complexity of the environment, recognize problems in time, and be able to develop suitable solutions. The resolution of Agenda 21 aimed to counteract the deterioration of the general world-wide situation and to establish environmental aspects in the education system.

In 1987 a first catalog of criteria for including environmental issues in the education system was developed in Germany and in 1999 the pilot project "BLK-Programm 21", which was based on Agenda 21, was approved. The goal of the project is the integration of education for sustainable development into common school practice. It serves as guideline for some of the school projects conducted in Germany. Other projects are not based on this programme but follow the core statement of Agenda 21.

The national education and development plans of Thailand contain first attempts of an education for sustainable development. Furthermore, there are programmes for the implementation of environmental education. These include joint developments between Asian and European countries and between Asia and Australia. The implementation does not take place directly at schools but mainly through the training of teachers as multiplicators. They pass on the knowledge within their schools.

Table 2-2 compares the current status of environmental education in Germany and in Thailand.

When implementing environmental education measures the following factors have to be considered:

- environmental education should be integrated in the whole curriculum and the school environment,
- environmental education should start in elementary schools and orientation stages as young students have a higher motivation and carry on the knowledge to subsequent grades,
- didactic methods for implementing environmental education are interdisciplinary and action-oriented lessons, specialized teaching and workgroups, project weeks and the multiplicator principle,
- the principles of Thai education are designed for sustainable development, i.e. rudiments of environmental education are existent,
- the education reform assigns more autonomy to the private schools

Table 2-2: Similarities and differences in environmental education

	Germany	Thailand
Similarities	• The state and private associations make joint efforts to implement the Agenda 21 and to integrate environmental education • Agenda 21, based on the Tbilisi recommendations, is the international basis of integrating environmental aspects in education • Two main principles of implementing environmental education o Integrating environmental aspects in the whole general curriculum by giving methodical and content-related suggestions o Involving the whole school area by giving suggestions for implementation • Principles of "participative learning" and "joined-up thinking" to understand complex problems • Development and conduction of pilot projects • Use of audit instruments from the economy	
Differences	• Integration of environmental aspects in education since 1987 • Nation-wide consistent framework directive of BLK • Development and compilation of detailed guidelines as teaching aids for teachers • Current projects are conducted directly at the schools but are not run exclusively by the teachers but by external project managers	• In 1997 first attempts of integrating environmental topics in nation-wide curricula • Environmental projects are mainly conducted with other partner countries • No standard framework directive of environmental education available • Most current projects aim to train teachers and not to take place directly at the schools • Lack of detailed guidelines

2 Assumption College Thonburi

2.1 General information

The pilot school of the environmental school project, Assumption College Thonburi – ACT for short – is located in Thonburi, the twin town of Bangkok. Thonburi is situated to the West of the river Chao Phraya.

Both cities form a densely populated area with a joint administration and with Bangkok as its capital. The cities are divided into districts. ACT is located in the Bangkae district of Thonburi [DORING et.al, 2001]. In Thonburi urbanization is not as advanced yet as it is in Bangkok. The Bangkae district and the surroundings of the school are characterized by one big arterial road and many small streets, retail trade, small houses, separate residential areas and sporadic agriculture.

The school grounds cover an area of app. 13.4 ha (in Thai 84 rai – 1 rai ≅ 1600 sqm) and are surrounded by a high wall, as are many real properties in Bangkok. A security service monitors the entry and exit of all people at six gates. The security service is subject to the service department of the school, see Figure 2-1.

All relevant institutions are located on the site, such as teaching and office buildings, libraries, a canteen, sport fields and swimming pools, and school gardens and service buildings.

The ACT is a Catholic private school, founded in 1961, and is a member of the Brothers of St. Gabriel Foundation. This foundation acts as the highest internal education authority. 14 schools across the country are affiliated to the foundation. Although the school practices Catholicism, the majority of students, teachers and staff members are Buddhists.

Principal and head teacher is Brother Dechachai (status: 2. semester 2002/2003). The position is re-occupied in regular intervals. The principal supervises seven departments with one department head each. Beginning with the school year of 2003 the school administration decided to re-occupy the position of department head every two years. Every department is responsible for certain fields of activity at the school. Figure 2-1 presents the structure of the school's departments.

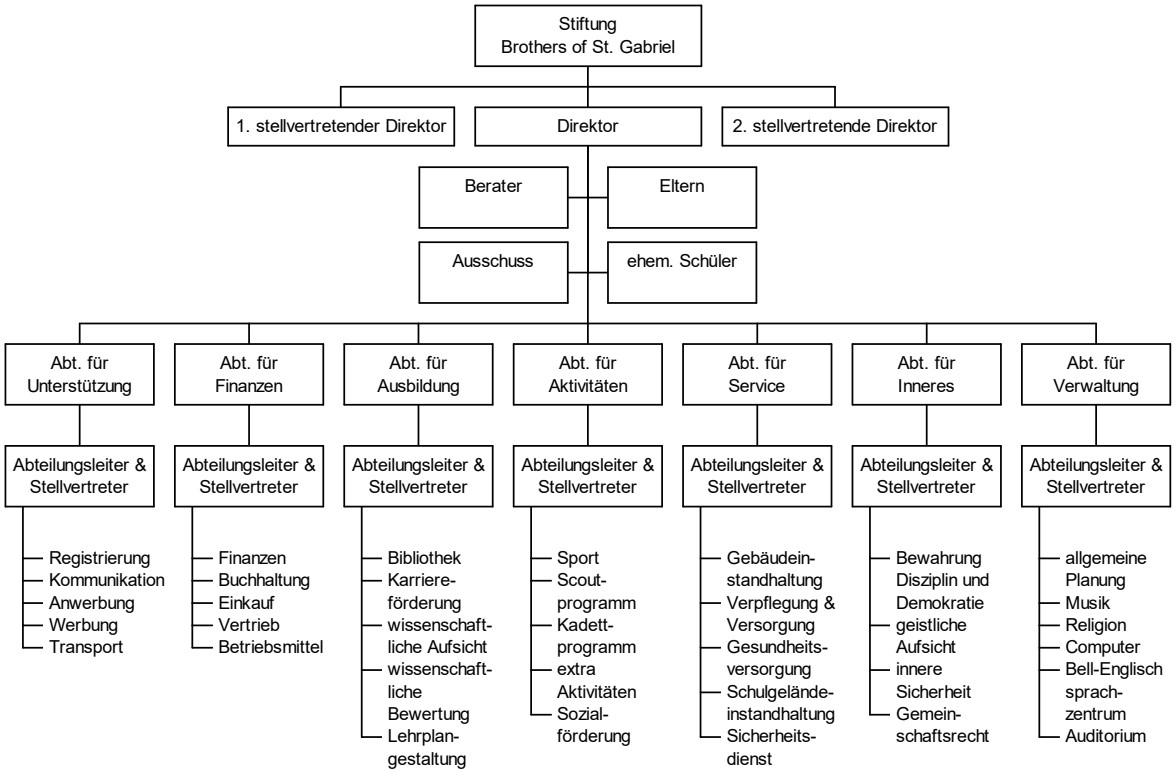


Figure 2-1: Administrative structure of ACT [FRITSCHE, 2001 – EDITED]

Assumption College Thonburi is an all-day school. According to the author's own insights, the students of ACT are not exclusively from rich homes. There are also students from average households. The children of school employees are permitted to attend classes free of charge.

Table 2-1 lists the number of students, teachers and staff members of ACT. These are 5173 people in total.

Table 2-1: Number of people involved in the daily school routine at ACT (status: 2. semester 2002/2003)

	Male	Female	Total
Students	4689	78	**4767**
Teachers	176	102	**278**
Staff members	41	87	**128**
		Total:	**5173**

The tasks of the staff members include the provision of meals for students and teachers, the maintenance of buildings and open areas, the cleaning of the whole school grounds, the collection and removal of waste, and the security on site.

2.2 Waste removal and handling of waste

2.2.1 The waste collection system

This section presents the findings on the waste collection system and on the waste awareness at the school. This is necessary because separate waste collection is the thematic focus of the environmental education concept.

As part of the waste management concept, several waste analyses were conducted at the school. According to these, students, teachers and staff members produce a total of app. 6,500 kg of waste a week. Based on this analysis the waste was divided into the following fractions: hazardous wastes (batteries etc.), drink cartons, metal, glass, paper and cardboard packaging, catering waste, fat (cooking residuals from the canteen), plastics, garden waste, and residual waste [KLAUß-VORREITER, 2003]. This waste is called commercial waste similar to domestic waste and residual waste [BILITEWSKI, 2000] and has to be collected and removed.

The current waste collection system was introduced in 1995 in the Bangkae district by the local administration. Since 1998 this system has been gradually adopted at ACT by Master Chuchart, the department head of the service department. The collection system uses three waste containers of different colors, see Figure 2-2.

Figure 2-2: Waste containers of different colors with plastic bags at ACT

The containers have a holding capacity of 260 liters each. The following Table 2-2 shows the intended use of each container.

Table 2-2: Intended use of the waste containers at ACT

Container Color	Green	Yellow	Gray
Intended use	Wet waste	Dry waste	Hazardous waste
Translation of label	“All wet materials are to be disposed of in this container”	“Cups, paper, plastics, bottles, styrofoam, wood, metal, leather, etc.”	“Hazardous waste”
Number of containers	62	69	4

The containers are located outside the buildings. The green and yellow containers stand together at those places that are often frequented during breaks and in the afternoons.

The gray containers are not located, as assumed, close to laboratories or workshops where the occurrence of hazardous waste can be assumed. These containers can be found for example at the sports field. At ACT, hazardous waste includes fluorescent tubes, spraying cans, batteries, etc.

There is often merely a waste bin in the classrooms and offices, see Figure 2-3. The bins have a volume of 80 liters. All waste fractions are disposed of here. Paper is collected separately to some extent.

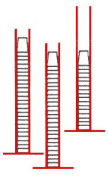
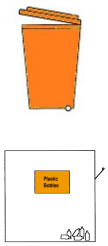
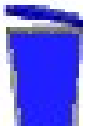
Figure 2-3: Waste bin in classroom/ office at ACT

All of the bins are equipped with black plastic bags into which the waste is thrown. These make it easier for the staff members to remove the waste that is subsequently disposed of together with the bags. The plastic bags filled with waste are brought by vehicle to a central collection site on school grounds, see Figure 2-4. The plastic bags filled with waste are collected from this site once a week by Bangkok Municipal Administration (BMA). BMA transports the wastes to a transfer station from which they are brought to a landfill. The question arises of what purpose the differently colored containers have.

Figure 2-4: Vehicle for collecting waste at ACT

A waste management concept was developed for the Assumption College Thonburi, see [KLAUß-VORREITER]. It includes further and more detailed information on the waste management. This also includes details on the improved or rather new waste collection system of Assumption College Thonburi. The types of waste container and their functioning are planned for the future as follows:

Table 2-3: Structure of the improved or rather new waste collection system at ACT

Waste type	Plastic cups	Plastic bottles	Paper	Catering waste	Garden waste	Residual waste
Container color	Red	Orange	Blue	-	Green	Yellow
Container type	Cup collector	260-liter containers/metal boxes	260-liter containers	Stainless steel container	260-liter containers	260-liter containers
Illustration						
Use/disposal	Recycling	Recycling	Recycling	In part composting	Composting	Landfill

According to the improved or rather new waste collection system, the waste fractions of plastic cups, plastic bottles, paper, catering waste and garden waste are to be separately collected. In order to do so, new collection containers are introduced, like the cup collector

and the blue and orange 260-liter waste containers. Existing collection containers are re-functioned. All the other waste fractions are disposed of as residual waste.

The newly listed cup collector was designed, produced as a prototype and set up by the author with material assistance from Master Chuchart during the author's stay at the school. The new collection container was immediately accepted by the students in first trial runs. Due to the positive feedback it is added to the new collection system.

Figure 2-5: Prototype of cup collector at ACT

2.2.2 Waste awareness

The majority of people involved in the school routine associate environmental problems with bad odor and air pollution. In contrast, the commercial waste similar to domestic waste and the residual waste are not regarded as a big problem [FRITSCHE, 2001]. In order to better assess the awareness of this waste and the handling of the current collection system, the author conducted a survey at the school using the "Questionnaire on current waste awareness", see Appendix C.

Questionnaire development

The contents of the questionnaire are adjusted to the environment and circumstances of the school, i.e. the current collection system and the accruing waste fractions.

The structure of the questionnaire is chronological – similar to resumes – and designed according to the didactic principle of "from general to specific". This is supposed to make answering the questions easier for the respondents. The structure is also based on the questionnaire of HILDEBRAND (1998). Closed fact-based questions were chosen as question type [KUHNT, 2003]. These questions aim to determine facts, having several answers preset by the author of the questionnaire. But this is feasible only if enough information on possible answers is already available or if the questions are limited to a pre-defined amount of answers. The questions are drafted in plain language and are easy to understand for everyone. The questionnaire intended for students and teachers was written in

English. Due to the staff members' lack of knowledge of foreign languages, it was decided to subsequently translate the questionnaire into Thai as well.

The questionnaires were distributed after a presentation of the project. The intention was to make all involved persons aware of the project and informed about its contents in advance. Additionally, it was essential to gain the trust of individual groups of people with regard to the project. During the presentation of the project some first test questionnaires were distributed to individual people. This measure was supposed to eliminate problems in advance, like incomprehensibly phrased questions. Later modifications would have been impossible with this written questionnaire.

According to KUHNT (2003) it is also essential to give questionnaires an appealing design as this facilitates the understanding of the questions. Thus, the attempt was made to give the questionnaire a clear structure.

Questionnaire structure

The questionnaire consists of six questions, some of which are subdivided into parts a) and b). The explanatory text at the beginning of the questionnaire points out that it is also possible to give several answers to one question. The questionnaire for the elementary school students consists of four questions, see Appendix C.

Question 1) is intended to gather general information.

1) Personal Statement – I'm (a)…

student O teacher O staff O female O male O

How old are you? I'm ……years. Nationality: ……...

Question 2) looks for answers concerning the current waste collection system. Elementary school students were asked only part b) of the question.

2) Waste collection system

a) *Do you have a separate waste collection at A.C.T.?*

*no O (go on to Quest. **3**)) I don't know. O (go on to Quest. **3**)) yes O*

b) *How do you separate waste at A.C.T.?*

size (small and big) O dry and wet O material (plastic, metal…) O

Question 3) describes the disposal of specifically chosen waste fractions and indirectly answers question 2).

3) There are <u>green</u>, <u>yellow</u> and <u>grey</u> bins at A.C.T.! Where do you drop…?

plastic cups:	*green O*	*yellow O*	*or grey O*
paper:	*green O*	*yellow O*	*or grey O*
food:	*green O*	*yellow O*	*or grey O*
plas. cups with ice:	*green O*	*yellow O*	*or grey O*
glass:	*green O*	*yellow O*	*or grey O*
plastic bottles:	*green O*	*yellow O*	*or grey O*
metal:	*green O*	*yellow O*	*or grey O*

Question 4) addresses locations of waste disposal and was not posed to elementary school students.

4) Places of waste disposal

a) Where do you dispose waste at A.C.T.?

in the classroom / office O *at the school area O* *in the kitchen O*

b) What type of waste do you dispose in the classroom / office?

paper O *plastic O* *glass O* *food O* *metal O*

Question 5) serves to determine whether the groups of respondents see a value in waste. Elementary students were not asked this question.

5) What can you do with waste?

a) ***Is it possible to sell waste?***

*no O (go on to Quest. **6**))* *I don't know. O (go on to Quest. **6**))* *yes O*

b) ***What type of waste can you sell?***

food O *paper O* *plastic O* *glass O* *metal O*

Question 6) collects information about the handling of paper, a material that is frequently used at schools.

6) What do you do with paper at A.C.T.?

drop it into the bins O *collect it O* *collect and sell it O*

Questionnaire distribution and results

The questionnaire was distributed to students, teachers and staff members, who form the basic population in terms of statistics. However, it was not possible to have everyone fill out the questionnaire. That is why target groups were defined out of which a sample of each group was selected, see

Table 2-2. The simple sampling procedure used in each group was arbitrary selection, also called “convenience sampling”. Here, the basic population is not explicitly defined [ADM, 1999]. The sample is supposed to represent the basic population as accurately as possible [KUHNT, 2003]. Thus, when defining the sample size it is generally accepted that the bigger the sample size is the more accurate is the result. According to the association of German market and social research institutes (ADM) that represents the interests of private-sector market and social research agencies (ADM, 1999), the size of a sample is generally specified with at least 30 to 50 items. Only if at least this size is reached it can be assumed that the major part of the distribution of the results approximates the normal distribution. Samples only give an estimated value that does not exactly reflect the true value of the basic population. This statistical spread follows the normal distribution in case of almost continuous variables [ADM, 1999].

Within the conducted survey the number of respondents equals the number of items. Regarding the target group of staff members the number of items is with 20 under the minimal requirements of 30, i.e. these results are the most imprecise and do not approximate exactly the normal distribution.

At first, the questionnaire was handed out to the teachers. Subsequently, it was distributed to the students. In part, the teachers handed out the questionnaires in class. The elementary school teachers opined that the questionnaire was too difficult for the elementary school students despite the smaller number of questions. Therefore, they did not support the distribution in the classes.

Table 2-4: Distribution of questionnaire on environmental awareness at ACT

Responding target groups	Number of respondents			Number of people at ACT	Questionnaire language
	Female	Male	Total		
Elementary school students	-	135	135	2578	English
Lower-secondary level students	-	276	276	1240	English
Upper-secondary level students	22	92	114	943	English
Teachers	28	11	39	278	English
Staff members	8	12	20	128	Thai
Total	**58**	**526**	**584**	**5167**	

The following diagrams show the evaluation of the results of the questionnaire. If a question allowed multiple answers, the answers were based on 100%. In order to assess the awareness of all the people involved in the daily school routine, the results of the sample from each target group are calculated in relation to the percentage of this target group in the basic population (5167 people).

Question 2a) asking whether there was a waste separation system at Assumption College Thonburi was answered with yes by 77.9 % of respondents on average. This portion is the biggest among the teachers with 92.3%. In contrast, 30.0 % of staff members are of the opinion that there is no separation system at the school. Among the students, it is the upper secondary level that is most uncertain about the existence of waste separation.

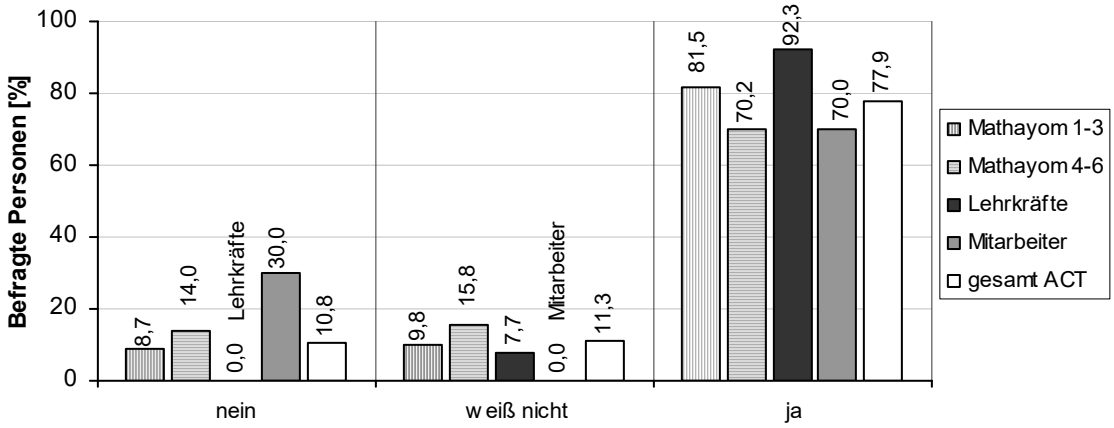


Diagram 2-1: Is there waste separation at ACT?

Diagram 2-2 presents the answers to question 2b) asking about the type of waste separation. The data refers to those people in Diagram 2-1 who are of the opinion that there is a separation system. The elementary school students were asked only part b) of question 2). About a third of them each think that the waste is separated according to size, wet or dry state, and material respectively. So, no tendency regarding the type of separation is recognizable among the elementary school students. Approximately one third of staff members separate the waste according to material type. 56.5 % are of the opinion that they separate the waste according to its state. It has to be mentioned that the staff members collect sellable materials for their own use during their daily work. For example, the staff members collect tin cans and subsequently sell these. The ACT average (51.7 %) separates the waste according to wet or dry status, as is the requirement of the waste separation system.

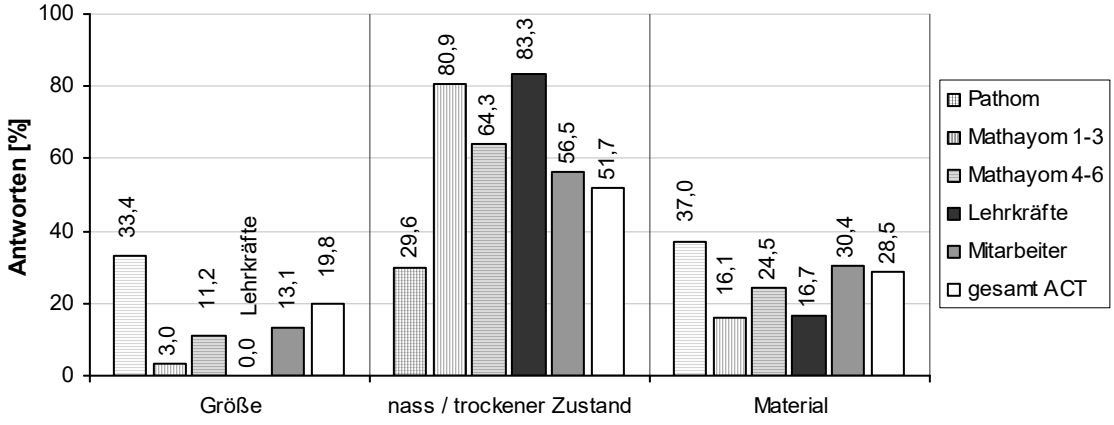


Diagram 2-2: Criteria of waste separation

The adherence to this separation method is confirmed by the results of the following two diagrams; see Diagram 2-3 and Diagram 2-4. The groups of persons were presented with seven waste fractions and asked into which container these are disposed of.

This adherence to the separation system becomes most obvious using the example of plastic cups with or without ice. Cups without ice are disposed of in the yellow container with 85.3 % and in the green container with only 9.5 % on average. In the case of cups with ice 67.3 % of the cups are on average disposed of in the green container. Although the yellow container includes the label “cups”, the disposer is uncertain because of the residual ice in the cup. This is a wet material. Plastic bottles are largely disposed of in the yellow container. In contrast, 87.2 % of catering waste is disposed of in the green container as it is often wet materials due to eating habits.

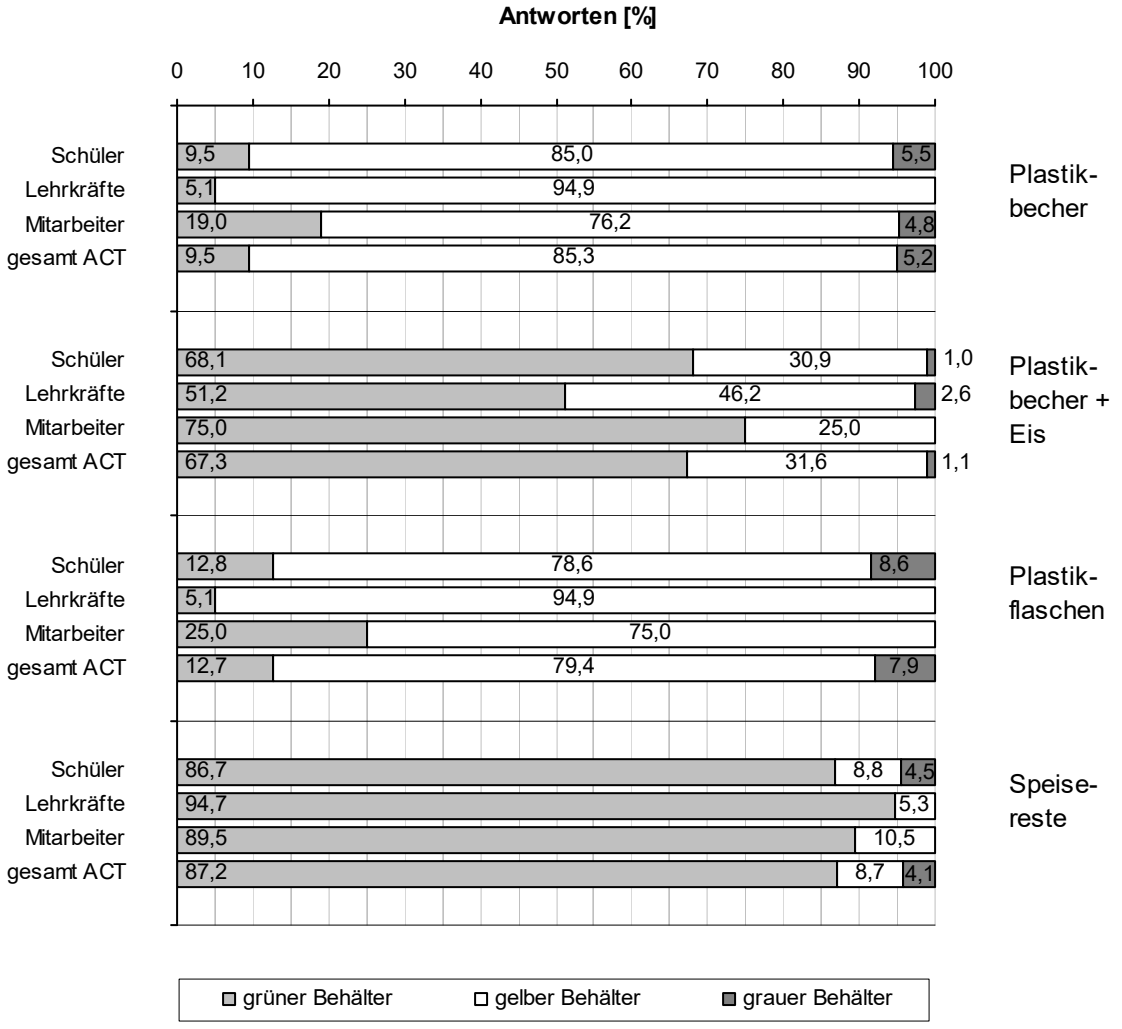


Diagram 2-3: Specific disposal of wastes I

Paper, shown in Diagram 2-4, is a dry material. Because of that and the label on the yellow container it is disposed of in this container with an average of 93.1 %.

Glass is not listed in the label of the yellow container, and it is not a wet material. The respondents are not sure without any doubt into which container it belongs. An average of 35.6 % of respondents chose the gray container and 55.9 % the yellow one. 8.5 % dispose of glass in the green waste container.

Although the word “metal” is listed on the yellow containers 76.9% of it is disposed of in the gray container for hazardous materials.

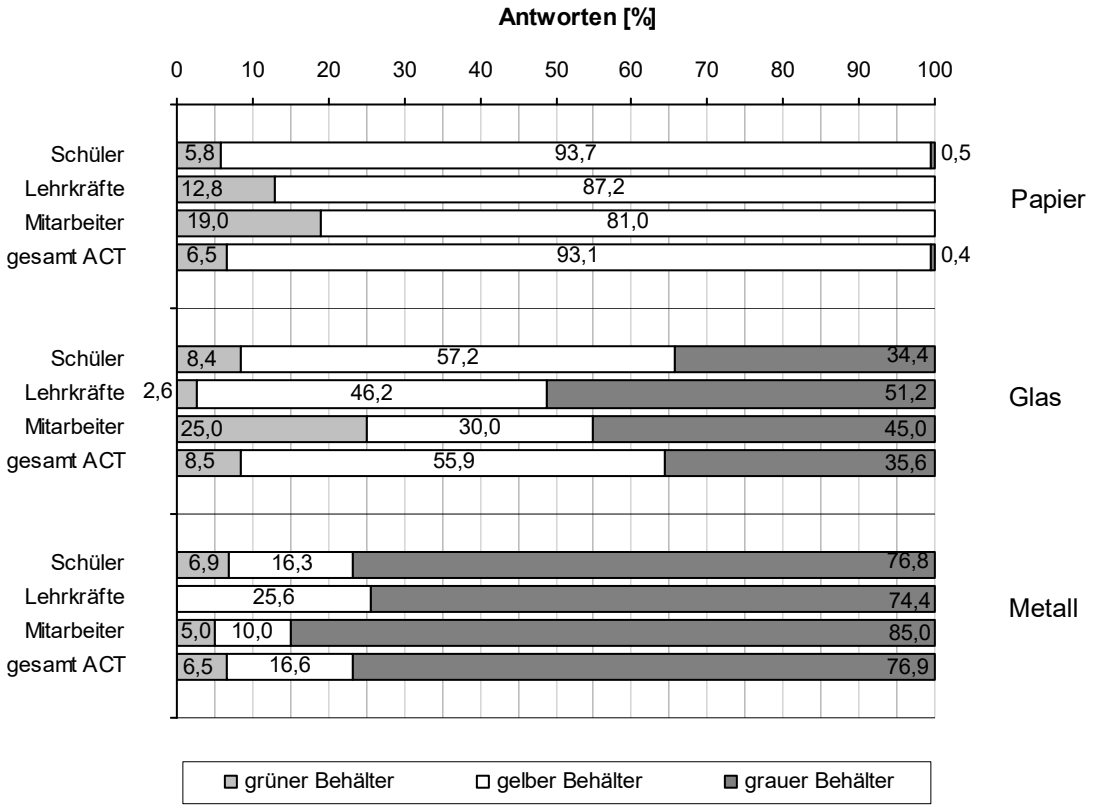


Diagram 2-4: Specific disposal of wastes II

Asked about the location of waste disposal, an average of 66.4 % of respondents named the school grounds. This is followed by the classroom or the office. Why the results from the students of the lower and upper secondary level show such a difference between school grounds and canteen cannot be explained without speculating. The majority of staff members are responsible for the maintenance of the school grounds and spend less time in offices. This is also reflected in the results. Teachers, too, dispose of the majority of waste (63.2 %) on school grounds.

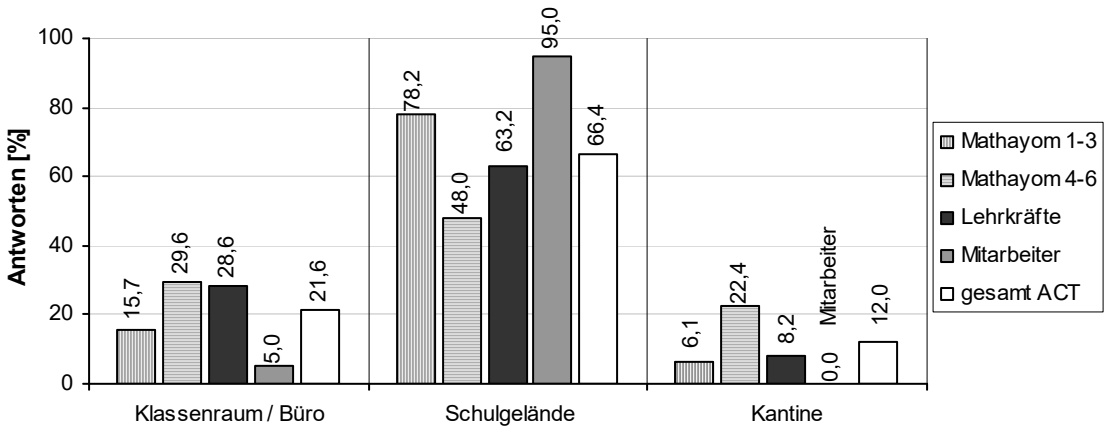


Diagram 2-5: Locations of waste disposal at ACT

The question asking about what type of waste accrues in the classrooms or offices tends to be answered similarly by students, teachers and staff members. On average, paper is the most commonly accruing type of waste with 59.8%. Plastics come second. Metal accrues with only app. 3.0 %. It has to be mentioned that the students are not forbidden to bring food, beverages and similarly items to the classrooms.

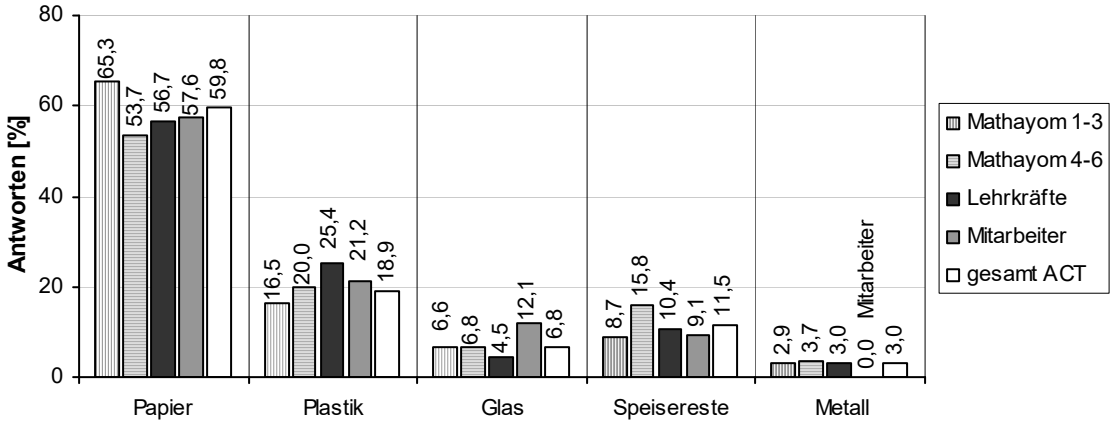


Diagram 2-6: Waste in classrooms or offices

Paper is the most often used raw material and can be recycled in most cases. What happens with this material after its use is of particular interest. That is why the results of question 6) are already addressed at this point and are presented in Diagram 2-7.

The surveyed groups of secondary level students and teachers show the same tendencies. About half of these groups dump waste paper in the waste containers. One third states that they collect and sell the paper. The answers of elementary school students and staff members show different results. 80.8 % of elementary school students state that they collect the paper. In contrast, 78.3 % of staff members claim that they collect and sell the paper. 17.4 % state that they dump the paper.

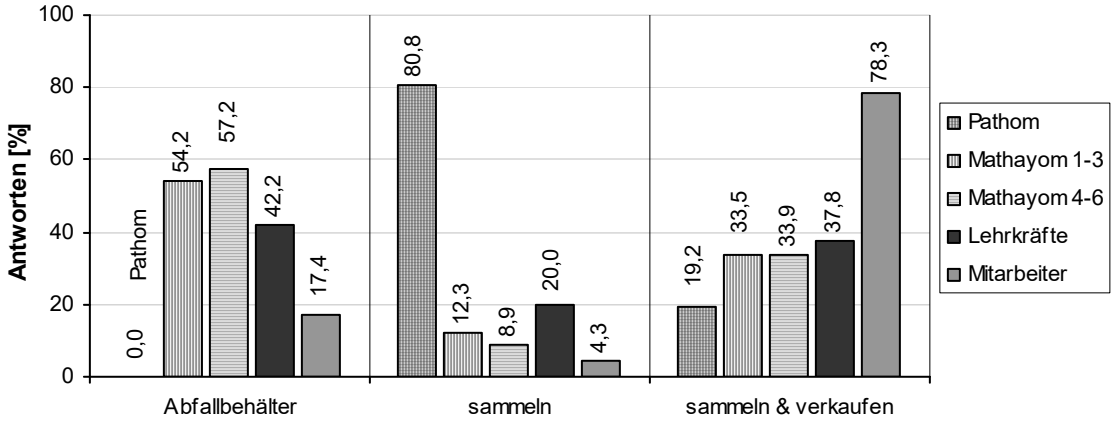


Diagram 2-7: Handling of waste paper

Diagram 2-8 shows the results of question 5). It shows whether the groups of persons are aware of the fact that waste can be sold. Again, the same tendency can be identified. 72.8 to 76.0 % of secondary level students are aware of this. 94.8 % of teachers and 95.0 % of staff members know about this. On average, a majority of 77.8 % is aware of the fact that wastes can be sold.

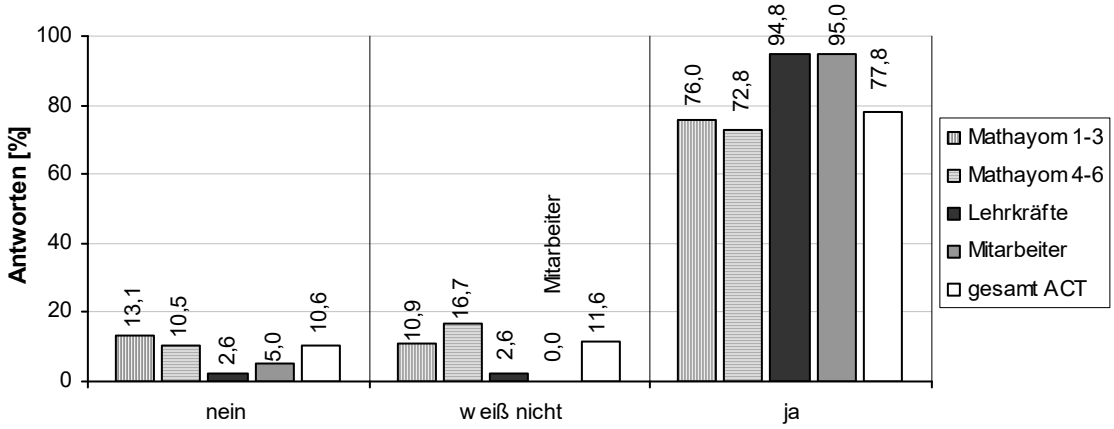


Diagram 2-8: Is it possible to sell waste?

In the second part of the question the groups were given five types of waste and asked which of these could be sold. Here, paper ranks first. App. 35 % of secondary level students and 29.9 to 32.2 % of teachers and staff members name paper. Plastics come next with 26.9 % on average. According to students, teachers and staff members, catering waste is the least likely type to be sold.

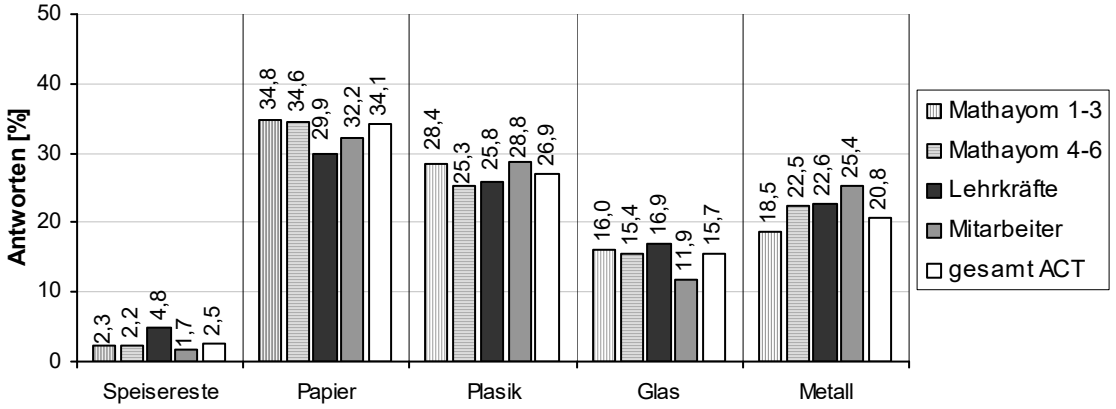


Diagram 2-9: Which types of waste can be sold?

Questionnaire evaluation

This survey was intended to assess specifically the handling of commercial waste similar to domestic waste and residual wastes, and the current waste collection system. The following conclusions can be drawn from the results.

- Most people state that there is a separation system at ACT.
- Based on this system, wastes are separated according to wet or dry state. And indeed the vast majority of secondary level students, teachers and staff members adhere to this. The elementary school students do not know the criteria of separating waste at ACT. The separation system is confirmed by Diagram 2-3 and Diagram 2-4. For example, plastic cups without ice are dumped in the yellow container and plastic cups with ice in the green container.
- The majority of wastes is disposed of in the containers on school grounds. Waste paper mainly accrues in the classrooms and offices.
- There are differences between the target groups concerning the handling of this waste paper. While elementary school student mainly collect the paper, the majority of secondary level students dispose of it in the waste containers. However, the majority of staff members collect and sell the paper. This result confirms the author's own experiences. For example, the staff members collect cardboard packaging from the canteen and pick up the collected paper from the offices. Therefore, it probably is an issue of interpretation on the part of the students and teachers whether they state that they "collect" the paper or "collect and sell" the paper. But the staff members dispose of littered paper in the waste containers when cleaning the school grounds.
- All target groups are aware of the fact that waste can be "exchanged" for money at certain places. The adults are aware of this to a larger extent than the students. Waste paper is mentioned as a sellable material more often than plastics and metal. This result can be confirmed insofar that there are collection points for paper, plastics, glass and metal in Bangkok. Some

wastes are also collected directly at the school. This employee of a recycling station is picking up cardboard packaging and plastic bottles collected at the canteen directly at the school, see Figure 2-6.

Figure 2-6: Paper purchase at ACT

Summing it up it is to be said that the people involved in the daily school routine adhere to the requirements of the current waste collection system. But all of the target groups are aware of the fact that some types of waste can be recycled.

2.3 School Education

2.3.1 The school system

The Assumption College Thonburi is comparable to a German comprehensive school, i.e. the school includes grades 1 to 12 (in Thai: Pathom 1 – Mathayom 6). Up to grade 9 (Mathayom 3) only boys are admitted to the school. Starting with grade 10 (Mathayom 4) girls are permitted to attend classes.

Grades 1 to 9 each have eight classes, with the exception of grade 3 that has nine classes. Grades 10 and 11 have six classes, and grade 12 has seven classes. An average of 50 students is taught per class. Each grade is headed by an elected teacher and each class has a homeroom teacher. The elementary grades 1 to 4 each have all subjects taught by one teacher. During this period the students stay in the same class. Starting with grade 5 the students are regrouped into classes by the teachers with the goal of achieving a balanced average achievement. Lower secondary level (Mathayom 1) again starts with the regrouping of classes by the teachers. These classes are kept until the end of grade 9 (Mathayom 3). Starting with the upper secondary level students have the opportunity to chose between two specializations. Thus, classes are regrouped again. Every grade has between six to eight periods a day (status: 2. semester 2002/2003).

The academic school years starts in the second half of May and finishes at the end of February. There are about 20 days of school holidays in October, and summer holidays from March to mid-May. During theses holidays a summer school takes place in April that can be attended by all students. Mid-term exams are hold in late December and end-of-term exams in mid-February. The end-of-term exam of grade 9 is the precondition for the upper secondary level. In case of failing the exam the students have to transfer to a different school or pursue a different course of education elsewhere.

2.3.2 The curriculum

Since 2002 the Thai curriculum has been developed in two steps based on the first "national education resolution". On the national level, the education commission that is subject to the Ministry of Education specifies the core curriculum. Subsequently, this core curriculum is filled with contents on the institutional level. This level is expected to foster the further development of the curriculum contents, e.g. adjusting the contents to the current status of the economy.

The implementation of the new curriculum is guided by the following three steps that were specified by the Ministry of Education [ONEC, 2001]:

- The curriculum framework determines the specific goals and standards and the examination methods of teaching.
- The implementation of the core curriculum proceeds in four temporal main phases starting with grades 1-3 (Pathom 1-3) of elementary school in the school year of 2002. In the school year of 2003 the core curriculum is implemented in grades 4-6 (Pathom 4-6). Afterwards lower secondary level (Mathayom 1-3) follows in 2004 and upper secondary level (Mathayom 4-6) in 2005.
- The educational institutions are supported with guidelines and instructions that are supposed to help in developing the individual education contents of the schools.

In preparation for the school curricula every school has to form a committee composed of teachers, administrative officers, scholars and curriculum experts. This committee is responsible for the development, management and implementation of its own school curriculum. The committee is given guidelines and instructions for orientation [ONEC, 2001].

As the change to the new curriculum started with the new school year 2002, i.e. mid-May 2002, only limited information on the structure of the new curriculum were available at this juncture.

The curricula of elementary school and secondary level that have been used so far are versions that were edited and translated into English in 1990. Based on these curricula the teachers develop the curriculum of the school.
The subjects that have been regarded as relevant so far at Thai schools and that are in identical form also part of the new core curriculum are [BUASRI et.al, 1990, 1995 & 1996; ONEC, 2001]::

- Thai and foreign languages,
- Mathematics and Science,
- Health and Physical Education,
- Social studies and Arts, and
- vocational preparation classes.

These subjects are part of the curriculum as either compulsory subjects or free elective subjects according to grade. The compulsory subjects are further subdivided into core subjects and prescribed elective subjects selected from a number of predetermined subjects, see Figure 2-7. The core subjects and their number of teaching units are specified by the Ministry of Education. The prescribed elective subjects and the free elective subjects and their contents can be assembled by the teachers at their own from a number of specifications. Additionally, predefined units are to be filled with additional activities.

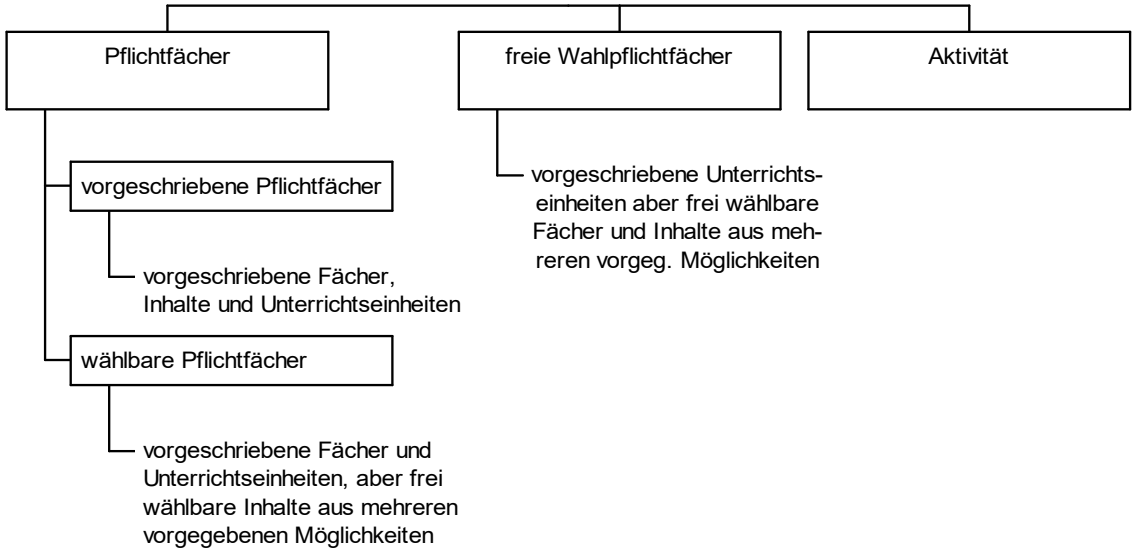


Figure 2-7: Structure of Thai curricula

After thorough research conducted by the author the structure of the curriculum at Assumption College Thonburi was analyzed. Structure and subjects of the curriculum of the individual grades are shown in the following Figure 2-8.

Every subject or subject area at ACT is headed by a teacher as its division head. The division heads are replaced in certain time intervals. In April the department and division heads meet. This school-internal commission consults and decides which teachers will teach which subject in which grade in the following school year. But this replacement affects only a small number of teachers. Teachers who are assigned a different class or a different division usually remain in the same grade. There is no overlapping between elementary and secondary levels.

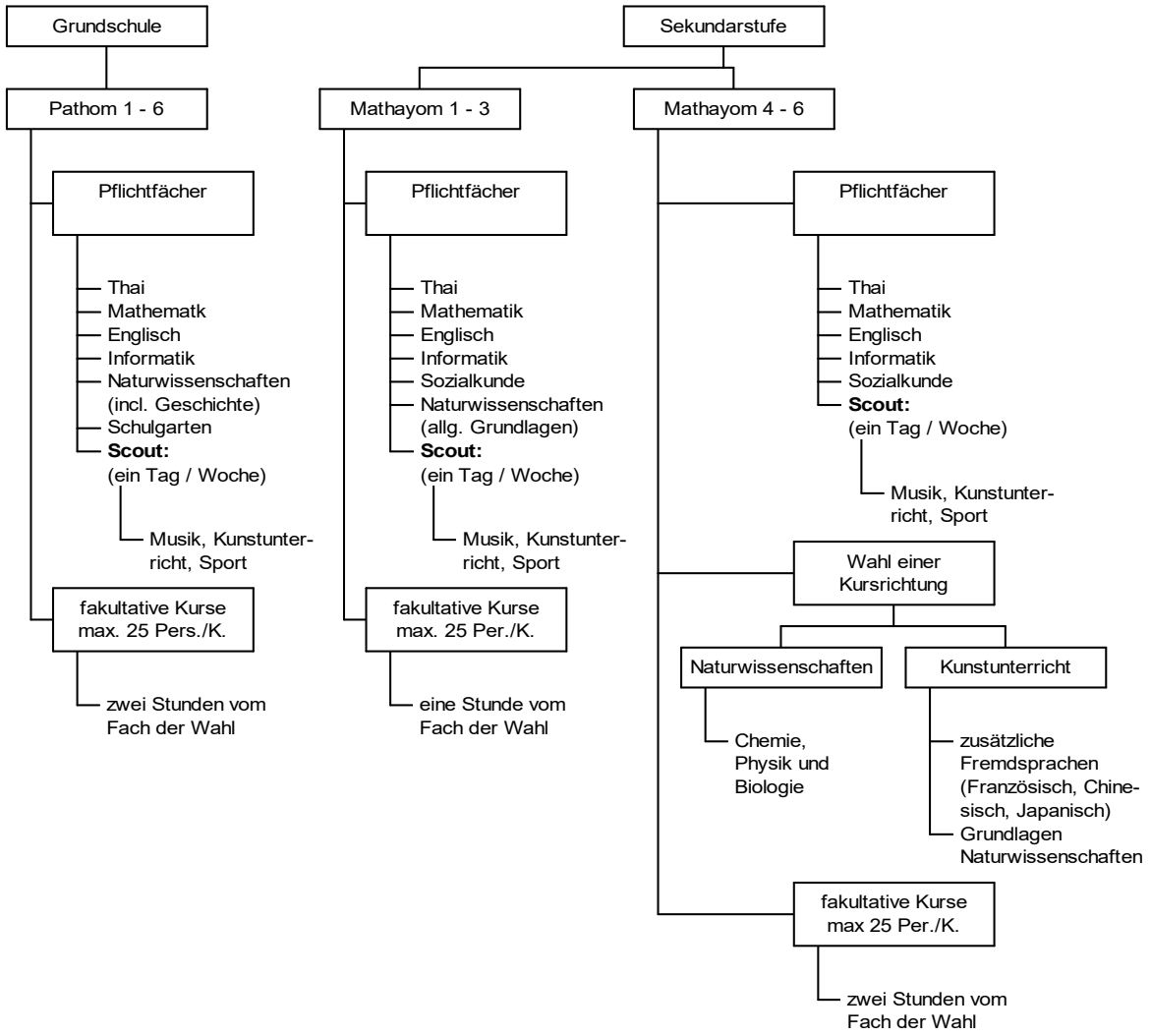


Figure 2-8: Curriculum structure at ACT (status: 2. semester 2002/2003)

2.3.3 Environmental education

In order to be able to assess the influence of the current school education on the knowledge and the awareness of the environmental situation, it was researched which school subjects included relevant topics on environmental education. Due to language-related communication difficulties, limited willingness to cooperate and the size of the school in terms of different classes and subjects only individual lesson plans of the secondary level were studied. Based on this research the following subject areas have so far been identified in the school's curriculum that address relevant topics on environmental education:

- Science,
- Social studies, and
- foreign language classes.

Science

In the context of Science lessons, the “Green learning room” has to be mentioned, see Figure 2-9.

Figure 2-9: “Green learning room” at ACT

This separate classroom is one of 350 laboratories of the nation-wide project of the same name which was launched in 1998 by the Electricity Generating Authority of Thailand (EGAT) together with the Ministry of Education. It is the goal of the project to make the students understand the importance of the sustainable use of resources and develop

awareness for the environment during class. For this purpose these lessons are to be taught based on the principle of “learning by doing” and promote the ability to work in a team. EGAT provides materials and devices for experimenting, e.g. electricity generators, measuring devices and computer systems.

The establishing of the “Green learning room” complied with the following steps both nation-wide and at ACT:

- Organizing of a first meeting between EGAT Governor and the executive school commission,
- Searching for a suitable teaching space,
- Assembling a member committee of teachers, students and parents,
- Specifying lessons for each class, and
- Conducting lessons and further activities if opportunities arise.

Furthermore, EGAT offers assistance with the development of curricula and with the collection of information necessary for teaching and provides further items on loan.

The “Green learning room” project is intended for both elementary school and secondary level. As part of the electronic lessons of the secondary level at ACT, grades 7 (Mathayom 1) and 9 (Mathayom 3) are taught in this room by Mr. Surasin and Mr. Wetchajai (status: 2. semester 2002/2003). The teaching units per class are 2 hours a week. Topics like the generation of electricity from alternative sources of energy are discussed during the lessons, see Figure 2-10.

Figure 2-10: Model of a hydroelectric power station at the “Green learning room”

The electronic lessons at ACT are a mixture of lecture-style teaching and action-oriented teaching. The students are taught basics and can try their hands on it by means of devices that they assemble themselves such as small electrical circuits. The room is part of the lessons but can also be used outside these times.

Another subject in the field of natural sciences is “Ecology and eco-systems” taught by Ms. Udomlak in grade 7 (Mathayom 1) (status: 2. semester 2002/2003). The contents cover:

- the functioning of eco-systems, e.g. the cycle of organic materials (natural composting),
- the relationship between eco-systems and their environments, and
- the development and conservation of the environment.

Here, it is mainly the natural environment that is discussed, which is free of human influences.

In grade 10 (Mathayom 4) the subject “Discussion of environmental problems” is taught by Ms. Nongnat (status: 2. semester 2002/2003). The topics of this subject are:

- pollution of water, air and soil,
- impacts that result from pollution,
- discussions on how these problems are to be solved, and
- the search for further solutions.

In this field the school cooperates with Kasetsart University. For example, the students are taught how oxygen is injected into waters and what impact this has. Unfortunately, only pollution and its impacts are discussed. But the origin and the places of emission of pollution are neglected.

Social studies

The field of social studies provides the most comprehensive and interesting topics on environmental education. The subject of Geography is part of this field. It thoroughly covers environmental topics and is taught in all grades of the secondary level. The subject is equally part of both specializations of the upper secondary level. The lower secondary level is headed by Ms. Atchara and the upper secondary level by Ms. Kuntalee (status: 2.semester 2002/203). Two main topics are addressed in the lessons [ACT, 2002]:

1. Lessons on the natural geography, the relations between the objects in nature, and geographic methods, like the reading of maps with the goal of extracting and using geographic information.
2. Recognizing and understanding the interdependency between humans and their natural environment to create a culture and an awareness that help to preserve the environment and the natural resources.

The second issue is of interest. It is subdivided into four key aspects in each lower and upper secondary level that are shown in Table 2-5 and Table 2-6 [ACT, 2002]. In the lower secondary level the scope of these key aspects is gradually extended with each increasing grade. In Mathayom 1 these contents concern Thailand, in Mathayom 2 the Asian region, and in Mathayom 3 the whole world.

Table 2-5: Contents relevant to the environment in the subject Geography in Mathayom 1-3 at ACT

Mathayom 1 Thailand	Mathayom 2 Asia	Mathayom 3 whole world
• Analysis of the environment and the natural resources with reference to the economic and social system in Thailand, Asia, the whole world; Recognizing and understanding the guidelines, rights, events and actions that concern the treatment and handling of natural resources and the local environment; Discussing possible solutions for the improvement of the handling of natural resources and the environment		
• Recognizing the values of the Thai cultural environment; Comparison of Thai and other lifestyles with their impacts on the environment; Recognizing, understanding and solving problems with the aim of adjusting social values and lifestyles to the conservation of the environment; Analysis of the new social environment with regard to changing population, economy, society and culture		
• Evaluation of the influence of human activities and demographic changes, Recognizing the results and the impacts on the quality of life; Recognizing the usefulness and the effect of the environment; Attempts to solve the environmental problems; Developing skills of handling local resources and managing the environment		
• Holding precise expertise on environmental information and using it to solve problems		

In the upper secondary level the key aspects are as follows [ACT, 2002]:

Table 2-6: Contents relevant to the environment in the subject Geography in Mathayom 4-6 at ACT

Mathayom 4	Mathayom 5	Mathayom 6
• Analysis of natural resources and environmental crises in Thailand; Methods for environmental protection in Thailand	• Analysis of international natural resources and environmental crises; Methods for international environmental protection	• Analysis of the role of organizations and their cooperation at home and abroad; Teaching skills of evaluation and assessment to handle natural resources and the environment
• Recognizing the process by which humans make use of the environment to create a unique civilization – with regard to Thailand	• Recognizing the process by which humans make use of the environment to create a unique civilization – with regard to the world	• Analysis of the changes in the natural environment from the past to the present; Discussion of the lifestyle necessary to preserve the social, cultural environment and Thai wisdom
• Recognizing how natural resources have to be used to make progress		• Analysis of the problems of global case studies and the approaches for solving them; Extracting information from the media, following environmental events and discussing these

Mathayom 4	Mathayom 5	Mathayom 6
• Recognizing the importance of the natural environment and reflecting on ways to solve environmental problems	• Analysis of possible cooperations to preserve the environment and improve the situation	• Knowledge of protection and methods of improvement

It is the goal of the subject to recognize and understand the process of how humans use the natural environment. The students are to be taught skills that help them with following environmental events and with understanding environmental problems.

The optional course “Conservation and Environment” is also offered as part of social studies at ACT. A maximum of 25 students can enroll in this course. It is taught by Mr. Thananan (status: 2. semester 2002/2003). The teaching content of this course consists of the following points [ACT, 11/2002]:

- analysis of the school grounds regarding the organization of the green areas during a tour,
- documentation of the condition of the green areas in terms of positive and negative impressions,
- selection of an area with negative impressions by the students and presentation of ideas for re-designing it, mainly through planting trees,
- teaching knowledge of the treatment and use of trees by the teacher,
- learning about the contribution that plants can make to reduce environmental damage,
- imparting basic knowledge of natural medical plants by the teacher.

Foreign language teaching

Individual lessons with contents relevant to environmental education can also be found in the teaching of English as a foreign language. These are limited to grades 8 and 9, see Table 2-7.

Table 2-7: Contents relevant to the environment in teaching of English as foreign language at ACT

Mathayom 2	Mathayom 3
• Rainforest – problems of using it as a resource, • A sustainable development for protecting the rainforests	• Global warming and the disappearance of rainforests • Traffic problems – transport and pollution

It can be assumed that there are other subject areas with topics that are relevant for environmental education but which were not identified during this research.

2.4 Summary of Assumption College Thonburi

Assumption College Thonburi is a Catholic private school. Approximately 5200 people are involved in the daily routine of the comprehensive school, 4800 of which are students. Together, these people produce a weekly amount of approximately 6500 kg of waste. This waste is mainly disposed of in three differently colored waste containers lined with black plastic bags. Staff members of the school collect the plastic bags filled with waste from all containers at the same time. Bangkok Municipal Administration (BMA) collects the waste from the school for further disposal. Due to the fact that all wastes including the plastic bags are collected at the same time the question arises whether there is any benefit from using differently colored containers.

A survey was conducted at the school using a questionnaire. This survey was intended to assess the awareness regarding the commercial waste similar to domestic waste and the residual waste. Additionally, the handling of the current collection system was to be documented. The evaluation of the results showed that the majority of secondary level students, teachers and staff members are aware of the existence of the separation system and its criteria. The elementary school students are in need of further explanation. They do not know the separation criteria. Using the current system the wastes are to be separated according to their condition into wet and dry waste respectively. The example of metal shows that also the groups of secondary level students, teachers and staff members are not sure in every case. Although the word “metal” is printed on the yellow containers the majority of the material is disposed of in the grey containers. Here, it also becomes evident that further knowledge is necessary. On the other hand, the survey results show that the surveyed groups of people are aware of the fact that some types of waste (e.g. paper) can be sold.

No subject of the school's curriculum discusses waste directly. Topics that are often addressed and that are suitable for integrating the field of waste are:

- the analysis, the sustainable use and the protection of natural resources,
- the functioning of eco-systems, and
- the pollution of individual habitats.

The knowledge is here in part taught through the use of action-oriented lessons.

What is interesting and can be seen as an example of how to approach the implementation of environmental education is the integration of the project “Green learning room” into the lessons. In agreement with the school administration and a committee consisting of teachers, students and parents, the project is gradually integrated in the lessons.

Table 2-8 shows again the results of the research as an overview. It records which grade is taught topics relevant to environmental education in which subject area.

Table 2-8: Overview on environmental education in secondary level at ACT

Subject area or subject	Grade (Mathayom)					
	7 (1)	8 (2)	9 (3)	10 (4)	11 (5)	12 (6)
Science						
• "Green learning room"	2 h / week		2 h / week			
• "Ecology & ecosystems"	X					
• "Discussion of environmental problems"				X		
Social studies						
• Geography	X	X	X	X	X	X
• Environmental protection and environment			max. 25 students			
Foreign languages						
• English		X	X			

3 First environmental education measures conducted at ACT

3.1 General principles and backgrounds

First environmental education measures were conducted in the second semester of the school year 2002/2003 during the author's stay at Assumption College Thonburi. These measures were part of the environmental school project and were used in the development of the environmental education concept. They included:

- a general project presentation,
- first teaching units of environmental education, and
- an organized school environmental day for the students.

The presentation of the environmental school project was done by staff members of German Transfer Centre Environmental Technology KNOTEN WEIMAR GmbH drawing on their experiences with the realization of former presentations. The aim of the presentation was to make everyone who is involved in the daily school routine aware of the environmental school project.

The focus of the environmental school project at ACT is, as mentioned, not only on the waste management concept but also on the development of an environmental education concept. That is why first teaching units of environmental education were conducted in November and December 2002 and January and February 2003. This field test of environmental education was documented and records first impressions and experiences. The gathered information will be incorporated in the development and realization of the individual teaching modules of the environmental education concept. The development of these first teaching units was based on the specifications regarding didactics and content of already available documentations of current projects on environmental education. At the end of the field test the students were asked to assess it by means of a questionnaire. The results of this survey are also incorporated in the development of the teaching modules.

The introduction of an improved or rather new separate waste collection concerns all people involved in the daily school routine at ACT. In order to sensitize especially the students of Assumption College Thonburi to this topic, a school environmental day was organized at the end of the school semester in February 2003.

3.2 Project presentation

The public presentation of the environmental school project represented a first general education activity. It was scheduled for the beginning of the second semester in November 2002. The concept included the voluntary acquiring of information about the contents and the goals of the project. This information was to be complemented by visual aids. A

major event like the annual sports festival offered the best of conditions. All the students and teachers of the individual grades participate in this festival either as athlete or as spectator. The students' parents are also invited as spectators. The staff members are responsible for organizing the event and providing the athletes and spectators with food on this day.

3.2.1 Planning and conduction

The sports festival took place on a Saturday. During this major event the environmental school project was introduced by means of an information point, see Figure 3-1. The motto was “Waste has a value”.

Figure 3-1: Project information point during the sports festival at ACT

The contents and the goals of the project were communicated through:

- the display of an information board,
- the distribution of flyers,
- conversations at the information point,
- the establishing of a waste exchange station, i.e. recyclable materials like plastic cups and bottles were taken back and a reward like beverages, pencils or rubbers was given in return, and
- the separate collection and storage of the recyclable materials.

The exchange station was mainly supposed to create an awareness of the fact that there is an advantage in reusing waste and thus to collecting it separately. A mascot built out of recyclable materials (plastic bottles) symbolically emphasized this idea.

The service department provided the materials that were necessary on this day, and the staff members helped with setting up and dismounting the information point. The location of the information point and the intended activities were agreed upon with the school administration in advance.

3.2.2 Evaluation and acquired insights

The students' interest was awakened very quickly. However, it was rather based on the fact that there was a reward for each empty cup. But the students became aware of the idea that the empty cups and bottles had a value. Through the children some of the parents and teachers approached the information point and were interested in the contents and goals of the project.

3.3 Teaching units of the course "Environmental protection and the environment"

At the beginning of each school year the students choose a voluntary course in addition to their compulsory courses, see Figure 2-8. Courses with different, freely selectable topics for a maximum of 25 participating students per course are offered. The number of courses depends on the number of students in the grade. The first teaching units on environmental education were conducted as part of the voluntary course titled "Environmental protection and the environment". This course belongs to the subject area of Social Studies and is offered for grade 9 (Mathayom 3). The course took place on Fridays during the first two regular periods, i.e. from 8.40 to 10.20, and had a duration of 100 minutes per week. 23 students chose this course.

In agreement with the school administration, Ms. Atchara (the division head of Social Studies), and Mr. Thananan, the topics and contents of the course "Environmental protection and the Environment" were modified in favor of the environmental school project.

3.3.1 Development of the teaching units

The development of the first teaching units conformed to the specifications of already available materials of similar projects. The following didactic approaches were taken from available current projects:

- the structure of the teaching units, i.e. definition of knowledge range and the structure of knowledge from general to detailed,

- content-related data on the topic area of waste, and
- the methods for conducting the teaching units, e.g. use of action-oriented teaching.

The author specified the key aspects of the teaching units and their order. The key aspects of teaching complied with the goal of the project, namely the introduction of an improved or rather new separate collection of the waste at ACT, and were determined as follows:

- introduction of the environmental school project and its goals,
- examination, visual analysis, and presentation of the school's wastes,
- analysis of the current waste separation system at the school,
- Imparting of background knowledge on the individual material types and presentation of reutilization possibilities,
- creating an awareness of the improved or rather new waste separation system.

The teaching units were developed based on the didactic methods and the key aspects, see Table 3-1. They consist of theoretical and practical lessons. Content-related references were made to the data of the waste management concept [KLAUß-VORREITER, 2003]. The developed teaching units were discussed and revised in advance with Mr. Thananan and the responsible teachers at ACT. This step was regarded as necessary to ensure that the students understand and learn to implement the contents of the teaching units.

The theoretical lessons were intended to provide background knowledge and formed the major part of the teaching. Topics like the use of resources, the production of paper, and the composition of commercial waste similar to domestic waste and residual waste of the school, were addressed, see Figure 3-2.

The practical part was intended to improve understanding and to enliven lessons. The action-oriented lessons included tours around the school grounds, the setting-up of an experimental compost heap, and the manual production of recycled paper. This self-reliant practical activity was supposed to reinforce the acquired knowledge and to engage all the senses of the students.

Figure 3-2: Theoretical lessons in a classroom at ACT

3.3.2 Implementation

The teaching contents of the course consisted of ten individual teaching units, see Table 3-1. The contents were prepared in English. Some topics were explained by the author in English. If the teaching units contained comprehensive information Mr. Thananan taught in Thai. Texts and graphics were presented on overhead transparencies to make the presentation clearer and understanding easier. These transparencies were also written in English. After prior agreement, some of the practical lessons were supported by the service department. It provided the necessary staff members, tools, resources and work spaces.

Table 3-1: Lesson plan of the pilot course at ACT

Unit	Date	Topic	Short content summary
1	15.11.02	Places of origins and paths of the waste at ACT.	• General information on the course • Asking some questions on the topic of waste at ACT • Walking around the school grounds and exploring where which waste is generated, e.g. first aid room
2	22.11.02.	Composition of waste, and natural resources.	• Evaluating the questions from lesson 1 • Presenting and explaining the transparency with the results of the waste analysis • Explaining and discussing the origins of plastics and wood, and of kitchen and garden wastes
3	29.11.02	Setting up a small demonstration compost heap.	• Presenting general information on composting; use of transparencies • Asking questions on composting • Students set up a small compost heap on their own
4	06.12.02	Waste has a value!	• Discussing all recyclable materials • Discussing the purchase values of different waste materials
5	13.12.02	How can the waste be used at ACT?	• Discussing again purchasing values • Analyzing the current collection system at ACT • Tour around the school grounds; students record which materials can be seen in which containers
6	10.01.03	Paper production	• Some students make paper on their own (not all students are present in class due to evaluation exams for Mathayom 3)
7	17.01.03	Paper and recycled paper	• Analyzing the tour of lesson 5 • The history of paper • Comparing the production of paper and recycled paper • Other possible uses of wastepaper
8	24.01.03	Paper production and composting	• Students make recycled paper on their own • First evaluations of composting progress
9	31.01.03	Summary of previous lessons	• Summarizing which wastes are generated at ACT, how these are collected and what happens to them • What are the options of reusing waste? • Introducing an improved or rather new waste collection system

Unit	Date	Topic	Short content summary
10	07.02.03	Instructions on the school environment day	• Results of recycled paper production • Discussing the schedule of the school environment day and designing information boards

3.3.3 Evaluation and acquired insights

The evaluation of the "Questionnaire on environmental lessons" shows the interest with which the test course was received by the students and what improvements in the conduction of the course are feasible, see Appendix C.

Questionnaire structure

The structure of the "Questionnaire on environmental lessons" was based on the same principle as the "Questionnaire on waste awareness", i.e. the questionnaire is chronologically structured from the general to the specific. But in addition to closed factual questions, open questions were used as well, i.e. according to KUHNT (2003) questions without predefined answers.

The "Questionnaire on environmental lessons" consists of 5 questions written in English and is structured as follows:

Question 1) is used to record general information.

1) Personal Statement

I'm a student of Mathayom …… . *female O male ⊗*

How old are you? I'm ……years. *Nationality: ……Thai……...*

Question 2) asks about the reason for choosing the course.

2) General Questions to the lesson "Conservation and Environment" in the subject "Social studies"

I chose this subject as extra activity because…
I was interested O somebody advise me (told me I should choose it) O
I didn't know what subject I should take (I had no other idea) O
Others…….....

Question 3) asks about the interest in the individual teaching units.

3) Questions to the lessons

a) Were you interested in the lessons?
no O yes O in some lessons O

b) In what lessons were you especially interested?
3 – "We make compost by ourselves" O
4 – "Waste has a value!" O
5 – "How can we use waste at A.C.T.?" O
7 – "The knowledge of paper and recycling paper" O
8 – "We make paper by ourselves" O
In no lesson O

Question 4) shows the types of encountered problems.

4) What type of problems did you have during the lessons?

I had general problems to understand the content O

I had problems with some special words O

I had problems to understand the English part of the lessons O

I had problems to read and understand the films O

I had ……...

Question 5) asks about suggestions for improving of the course.

5) What would you wish for the next environmental lessons?

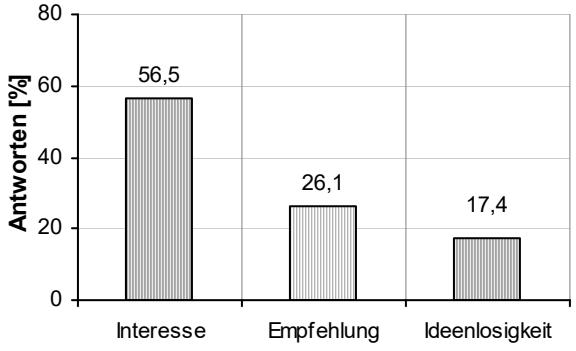
More knowledge about recycling O *More general knowledge about waste O*

More activities during the lessons O *I would change nothing. O*

I would wish that……..……....

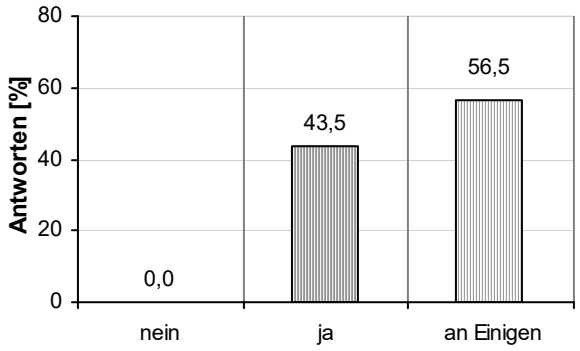
Questionnaire distribution and results

The questionnaire was distributed to all 23 students attending the course during the last teaching unit. Thus, the selection of a sample is unnecessary and the results are as precise as possible. The results are presented in the following diagrams.



Answering the question on their reason for choosing the course “Environmental protection and the environment”, 56.5 % of the students indicate interest. 26.1 % were advised to attend the course. In contrast, 17.4 % chose the course to fulfill the required number of lessons, see Diagram 3-1.

Diagram 3-1: Reasons for choosing the course “Environmental protection and the environment”



Asked about their interest in the taught lessons, 43.5 % of students stated full interest. 56.5 % were interested in only some lessons. The answers for no interest were 0 %.

Diagram 3-2: Interest in course contents

Diagram 3-3. shows the teaching units in which the students were particularly interested. Here, the pre-defined answers were limited to some few teaching units. Contents and practical and theoretical units respectively were distinguished. The making of paper and

the evaluation of the composting progress ranked first with 39.1 %, followed by lesson 5 about how waste is to be used with 30.4 %.

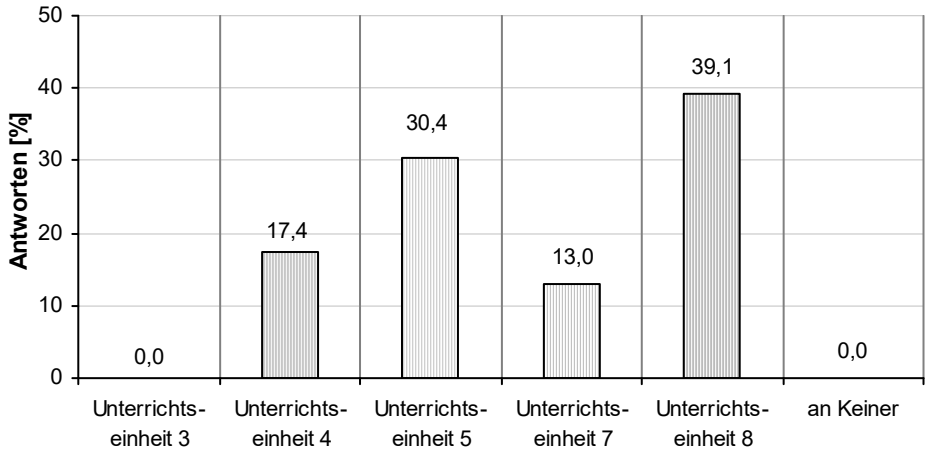


Diagram 3-3: Distribution of interest in the teaching units

Answering the question about which problems occurred, 34.8 % of students indicated that primarily the understanding of the English language and the usage of unknown specific terms caused problems, see Diagram 3-4. A subset of 17.4 % of students had difficulties with reading and understanding the transparencies.

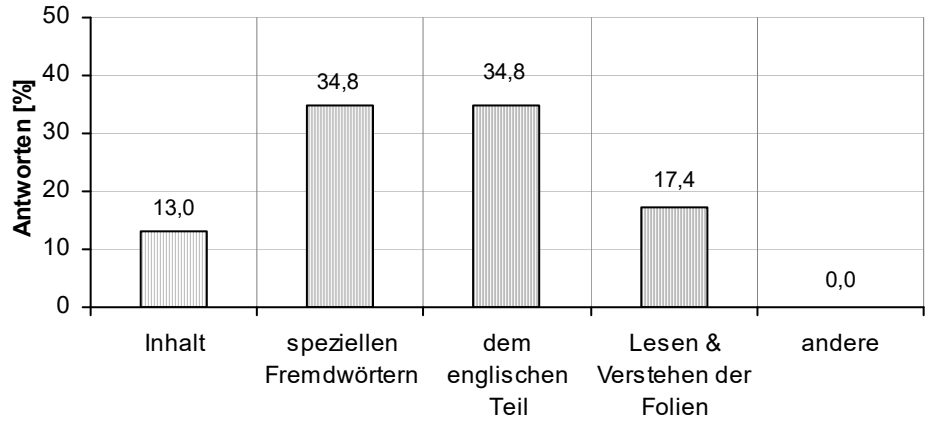


Diagram 3-4: Main problems during the lessons

Diagram 3-5 shows desirable changes to subsequent teaching units. Here, the students' request for more information on the issue of recycling is in the first place with 69.6%. In contrast, 26.1% of students prefer a greater proportion of practical lessons. However, no student requested a higher proportion of general information on waste.

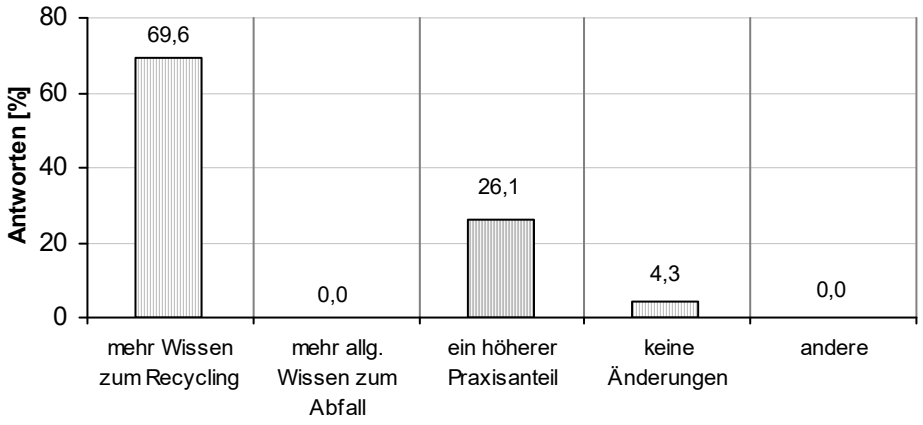


Diagram 3-5: Desirable changes to future teaching units

Questionnaire evaluation

This questionnaire can be used to conduct a first evaluation of the taught lessons. Thus, students chose the course “Environmental protection and the environment” predominantly due to interest. Out of the conducted teaching units the practical lessons were preferred. If the course was repeated students would request more information on the topic of the recycling of waste. According to a study conducted by the German Bielefeld University in 1998 Thai private school students have higher-than-average language proficiency. This can be explained by English lessons starting in first grade (Pathom 1) and by subjects taught in English. [EVERS et al., 1998]. The evaluation, however, showed that there were difficulties with the lessons conducted in English. Furthermore, the students indicated to have problems with the understanding of specific foreign words.

In addition to the results of the questionnaire, the following points are to be listed that are based on the author's own experience and have an advantageous impact on the development of the teaching units. Thus:

- when using a foreign language, important and fundamental information, texts and tasks should be presented in written form,
- tasks and questions should be phrased using simple vocabulary and easily understandable formulation,
- complex and important issues should be put at the beginning of the teaching unit due to reasons of concentration,
- the extent of tasks should be defined exactly and in written form,
- illustrations and graphs should be used often for simple and descriptive explanation, and
- the students should be involved actively in the lessons, e.g. by gathering information on the blackboard etc.

But the behavior of Thai students and the relationship between teacher and student has to be taken into consideration in the development of the lessons.

3.4 The school environment day

At the end of the semester a school environment day was organized. The goal of this day was to prepare the students of Assumption College Thonburi for the introduction of an improved or rather new separate waste collection by giving them basic information. The students should get acquainted with the functioning and handling and furthermore understand the purpose of this new or improved waste separation. In agreement with the school administration it was decided against a voluntary information event, similar to that during the sports festival. The teachers were of the opinion that only few students would ask for information on their own. That is why it was decided to directly teach the students.

3.4.1 Planning and conduction

The school environment day was intended to make all students of ACT understand the issue of "separate waste collection and reutilization of wastes" and to sensitize their awareness of the following issues:

- waste fractions and amounts produced at ACT,
- separate collection of waste fractions, and
- direct reutilization of organic waste at ACT by means of composting and a digestion plant.

The third point was supposed to impart basic information to the students as the construction of a composting and a digestion plant was planned in the course of the environmental school project. Later these plants will be integrated in the environmental education as demonstration material.

It was decided to set up three information stations with the following topics:

- Station 1: "Fundamentals of waste and its reutilization possibilities"
  - Setting up of two information boards with a comparison of the current and the new collection system, and the reutilization possibilities of the different waste fractions;
- Station 2: "Fundamentals of composting"
  - Setting up and demonstration of the machines used in composting and explanations of the composting process from garden waste to compost using the example of material brought along by the students;
- Station 3: "Fundamentals of digestion"
  - Setting up and demonstration of an experimental digestion plant, introduction of the input materials and the product biogas;

Station 1 was led by Mr. Thananan and the author. Professor Kanoksak and his assistants from the Energy and Environmental Engineering Center (EEEC) of the Faculty of Engineering of Kasetsart University, Thailand, were responsible for setting up and attending to stations 2 and 3.

The permission, organization and conduction of such an event falls into the responsibility of the school administration together with the departments responsible for activities and service, see Figure 2-1. All the students were expected to be involved in the school environment day. But upon consultation with the responsible persons, the direct teaching of all of the 4767 students is not possible on one day. That is why a specific group of students was selected. The following points were worked out in cooperation with the responsible departments:

- Selecting grade 7 (Mathayom 1) with app. 400 students and grade 10 (Mathayom 4) with app. 300 students as both grades will stay at the school for the following three years due to admission requirements and will thus be able to pass on the knowledge to other students;
- Setting the date of the event;
- Developing and coordinating the time schedule;
- Choosing suitable locations for conducting the event and for setting up the stations;
- Instructing the teachers of grades 7 and 10 regarding the supervision of the students during the event, and
- Developing the “Questionnaire of the school environment day”, see Appendix C, with questions about the individual stations.

The school environment day was held on the morning of February 14th, 2003. The opening took place in a big hall open to both long sides on the ground level of a teaching building (the Assumption Building), see Figure 3-3. This location easily accommodated all of the app. 700 students. Following the opening, Station 1 was set up in this hall. Stations 2 and 3 were set up in front of the hall.

Figure 3-3: Opening of the school environment day at ACT

The following table summarizes the time schedule and the individual events of the day.

Table 3-2: Time schedule and events of the school environment day at ACT

Time	Events
8:45	• Opening with a speech by first assistant principal Brother Prasit in front of all participating students, teachers and contributors
9:00	• Dividing the app. 400 students of grade 7 (Mathayom 1) in three groups • Start of the information event at the three stations • Distribution of the questionnaire to the students
10:30	• End of the event for grade 7 • Collection of questionnaires
10:45	• Dividing the app. 300 students of grade 10 (Mathayom 4) in three groups • Start of the information event at the three stations • Distribution of the questionnaire to the students
12:05	• End of the event for grade 10 • Collection of questionnaires
12:15	• Gathering of all students of both grades • Acknowledgement of contributors and responsible persons
12:30	• End of the school environment day

The students had a pre-defined teaching time of 30 minutes at each station. Afterwards they changed stations. At the beginning of the information event each student was given a questionnaire. The questions referred to the lectures given at each station. Due to an onset of rain the event locations had to be changed. Stations 2 and 3 retreated under the roof of the hall, and Station 1 moved into a big conference room. The school environment day ended with the students acknowledging the organizers and contributors of the event.

3.4.2 Evaluation and acquired insights

The school environment day was very successful. As a conclusion the following positive insights were gained:

- there was full support from the school and from the team of Professor Kanoksak;
- unambiguous agreements and schedules are the prerequisites of an unproblematic course of events**;**
- groups of 100 students remain well-manageable;
- 30 minutes are a sufficient amount of time with regard to the information to be imparted and the concentration capacity of the students;
- involving some students in the presentations enlivened the situation and increased the attention of the listening students;
- the Station 1 presentation given in a closed room due to weather conditions had fewer distractions for the students and a better sound atmosphere;

- as the contents were presented on information boards at Station 1 the students were able to read up on all imparted data at any given time.

There are also negative insights to mention. These include the following points:

- Station 1 imparted information only in oral or written form, demonstration material was lacking, like new collection containers that could have been tried out by the students;
- according to Professor Kanoksak, Stations 2 and 3 were lacking a direct demonstrative connection to the school and a written presentation of the information;
- groups of 133 students, as in grade 7, become too chaotic and difficult to manage;
- changing stations takes some time and should be included in the time schedule;
- missing buffer times caused deviations from the time schedule.

To what extent the students absorbed, understood and processed the information is shown in the evaluation of the questionnaires.

Questionnaire Structure

The structure of the “Questionnaire of the school environment day” is based on the same principle as the first two questionnaires, i.e. it starts with answering some personal questions. The only used question type was closed factual questions grouped according to the stations. Questions 1) to 4) refer to Station 1, questions 5) to 7) to Station 2, and questions 8) to 10) to Station 3. The questions about Stations 2 and 3 were developed by Professor Kanoksak. This questionnaire, too, points out in a short explanatory text that sometimes several answers are correct.

The questionnaire consists of the following questions:

Questions 1) to 4) refer to the waste fractions and reutilization possibilities at Station 1.

1) What type of waste is created at A.C.T.?

Plastic:	*O*
Paper:	*O*
Chemical waste:	*O*
Metal:	*O*
Old oil:	*O*
Glass:	*O*

2) How much waste is created per week at A.C.T.?

a)	*3500*	*kg/week*	*O*
b)	*5000*	*kg/week*	*O*
c)	*6500*	*kg/week*	*O*
d)	*8000*	*kg/week*	*O*

3) How much waste is reusable and recyclable at A.C.T.?

a)	*36% of waste is reusable and recyclable*	*O*
b)	*64% of waste is reusable and recyclable*	*O*
c)	*20% of waste is reusable and recyclable*	*O*
d)	*More than 50% of waste is reusable and recyclable*	*O*

4) What type of waste is recyclable – has a value?

a)	*Garden waste*	*O*
b)	*Plastic bottles*	*O*
c)	*Paper*	*O*
d)	*Metal*	*O*

Questions 5) to 7) refer to the composting explained at Station 2.

5) What is compost?

a) Organic matter that is treated under anaerobic digestion O
b) Organic matter that is treated under aerobic digestion O
c) Mixed waste that is treated under aerobic digestion O
d) True for both b and c O

6) What is the standard quality of compost?

a) Ratio of N, P and K of 1:1:2 O
b) Ratio of C/N less than 20:1 O
c) Ratio of C/N more than 20:1 O
d) True for both a and b O

7) What are the advantages of composting?

a) Use as fertilizer for plant growing O
b) Reduce waste problems O
c) Provide clean environment for school and cities O
d) True for all a b and c O

Questions 8) to 10) refer to the digestion addressed at Station 3.

8) What is Biogas?

a) Gas generated from aerobic digestion of organic matter O
b) Gas generated from anaerobic digestion of organic matter O
c) Cooking gas O
d) True for all a b and c O

9) What kind of gas that can be used as fuel?

a) Oxygen O
b) Carbon dioxide O
c) Methane O
d) Nitrogen O

10) What kind of materials those are suitable for digester?

a) Wood and stem of trees O
b) Fruit, vegetable and food waste O
c) Papers O
d) True for both a and b O

Questionnaire distribution, results and evaluation

The questionnaire was distributed to all students participating in the school environment day. Thus, it is not necessary to define a sample, and the results are as precise as possible.

The questions were evaluated by means of a points-based system. Some questions allowed multiple answers. That is why the questions were evaluated as follows:

- each correct answer was awarded with one point, i.e. with a maximum of four possible answers the highest score is four points per question,
- in case of a wrong answer the total score per question was zero.

The following Table 3-3 summarizes the points gained per question and grade in percentages based on the maximal possible score per question and grade.

Table 3-3: Evaluation of the questions about the school environment day at ACT

Questions		Grade 7 gained points in [%]	Grade 10 gained points in [%]
Station 1:	1	**51.8**	48.7
	2	75.8	**76.3**
	3	**40.2**	39.7
	4	**46.9**	46.6
Station 2:	5	**24.5**	17.3
	6	**12.6**	7.7
	7	25.7	**29.3**
Station 3:	8	**56.7**	40.4
	9	**58.7**	55.8
	10	**54.6**	25.0
Average		**43.1**	40.0

Both grades exhibit similar tendencies regarding the points gained in each question. But the comparison reveals that grade 7 has a slightly higher number of points gained per question on average. It has to be mentioned that grade 7 was given the questionnaire in Thai and grade 10 in English at the request of their teachers. The evaluation also shows that the foreign language English creates difficulties for the students of ACT.

The questions about Station 1 scored 50 % of the possible points on average. The lowest results with app. 20 % of possible points were scored at Station 2 about “Fundamentals of composting”. As the results of both grades show similar tendencies it can be assumed that the difficulty level of the questions or the presentation at the individual stations is the reason for this poor performance. The results of the questions about Station 3 show an average score of 56 % of grade 7 and of 40 % of grade 10. Grade 10 achieved only 25 % of possible points of question 10 while grade 7 gained 54.6 %. A clear reason for this result cannot be given.

The evaluation of the questions shows that the conduction of such an information event needs further improvement. First modifications would be the simpler phrasing of the questions, the setting up of information boards at all stations, and a higher number of demonstration objects and material. Whether an extended length of stay at the stations could have positive effects cannot be determined. It should be noted that the students grew restless over time.

3.5 Conclusion of the conducted environmental education measures

First educational measures were conducted at ACT during the second semester of 2002/2003. An information point was used to make the people involved in the daily school routine aware of the environmental school project. The presentation took place during the annual sports festival. The information point gave all participants the chance to voluntarily learn about the contents and goals of the environmental school projects through information material. Especially the students' interest was aroused by a waste exchange station. The parents' interest was low because the project was not the main focus of that day's events. It cannot be assessed how thorough people used the offered information.

Interesting and informative impressions and experiences of environmental education were collected during first teaching units in the voluntary course "Environmental protection and the environment". 23 students of grade 9 (Mathayom 3) participated in this course. A total of 10 teaching units were conducted that consisted of theoretical and practical lessons. The educational measure was evaluated at the end of the school year through a questionnaire. This led to the insight that, according to the students, the topic of "recycling of waste" drew special interest. The students requested more information on that in case of a repetition of the course. The practical lessons were preferred by the students. Integrating such practical lessons enlivened the teaching and made the lessons more interesting. Problems with reading and understanding teaching contents arose when the English language and certain special technical terms were used. Improvements are necessary in this area. The overhead transparencies used in class also have to be designed more effectively as difficulties with reading the English text arose. But the transparencies should not be left out as they can improve understanding through visualization. The basic rule is to choose a simple and understandable language and representation method.

The school environment day directly imparted information about the introduction of an improved or rather new separate waste collection at ACT to a larger group of students. Here, a group with a maximum of 100 students can be managed most easily and effectively. But the results of the questionnaire show that all information should be made available for re-reading and that more demonstration materials should be employed. The highest need for knowledge is in the field of composting. Furthermore, efforts have to be made to increase the students' attention. What is important for the conduction is an exact time schedule and good communication between all persons involved. The school environment day proved that it is in general possible to directly teach a larger group of students within 90 minutes.

4 Development of the teaching modules

4.1 General principles

This chapter addresses the development of teaching modules for the environmental education concept. Each module represents one building block of the environmental education. The development is divided into the organizational and structural as well as the content-related and methodical conception. Organizational and structural conception means on the one hand the way of integrating environmental education in the curriculum and on the other hand the structure of each module. Content-related and methodical conception is concerned with the selection of the topics that are to be taught as part of environmental education. In doing so the main concern of the environmental school project has to be considered. The students should understand the function and use of the improved or rather new waste separation system to reutilize waste and reduce residual waste. Simultaneously, the general goals of environmental education have to be supported. These contain, among others, the understanding of complex relations and the improvement of the environmental quality through conscious action. The development of the teaching modules is based on the collected facts and gained insights of chapters 2 to 3. The following table 4-1 shows which of the researched projects and measures for implementing environmental education are suitable.

Table 4-1: Facts and insights suitable for environmental education

Projects and measures	Approaches of environmental education	Suitable for environmental education at ACT
German counties Commission for Educational Planning and Research Promotion (BLK)	• Includes fundamentals that should be taught in environmental education	• Implementation of fundamentals in teaching modules
German school projects • Audits at schools in Düsseldorf • school project “successfully low-waste” • BAWO project (local waste management optimization)	• Introduction of certifiable environmental management systems • Waste analysis to make an inventory of the waste at schools • Integrating environmental education in existing subjects of the curriculum • Providing structural and content-related guidelines for teachers • Competitions and financial incentives	• Conducting waste analyses (as part of the waste management concept) • Methods of integrating environmental education in the curriculum • Structure and contents of the guidelines for developing teaching materials for the teachers at ACT • Notion of competitions and financial incentives
Asian projects • ACEID Project • SEET	• Integrating environmental education in the subjects of the existing curriculum • Environmental education is sup-	• Methods of integrating environmental education in the curriculum and the whole school area • Use of some topic suggestions in

	posed to take place in the whole school area • Teacher training • Content suggestions for topics of environmental education	content development
Questionnaires	• Opinion research on current situation	• Used in behavior research and in the analysis of demand areas

4.2 Organizational and structural conception

4.2.1 Facts and insights

The evaluation of the bibliographic research leads to the insight that environmental education at schools should not be limited to an independent, additional subject but should be integrated in the existing curriculum with the dimension of a subject. Environmental education should be integrated in the subjects that already exist. This statement is indirectly confirmed by German school projects through the suggestions of pedagogically integrating environmental education in the lessons. For example, several options of integrating the field of waste in different subjects are suggested to the teachers. The ACEID project that was developed for the Asia-Pacific region is based on the recommendations of the Tbilisi conference. These recommendations make the same statement.

The projects conducted in Germany and the listed materials on environmental education mainly target elementary schools and middle schools. This is justified with young students' motivation for learning new things and the fact that the students would carry the acquired knowledge on to subsequent grades. The projects of the Asia-Pacific region do not make any statement on this issue as these projects are aimed at teacher training.

In chapter 2, section **Fehler! Verweisquelle konnte nicht gefunden werden.** the individual curricula for the elementary school and the lower and upper secondary levels of ACT are presented. These curricula show the subjects that are taught at ACT. Furthermore, section 2.3.3 lists subject areas of the secondary level that include topics suitable for environmental education. Based on these insights it becomes evident in which subject areas environmental education can be integrated or expanded. For example, the “Green learning room” can be used for environmental education in the long term. By means of a suitable digestion pilot plant the students could be taught the fundamentals of generating electricity from bio - waste.

Based on these collected facts and insights the structure of the environmental education at ACT should look like the following:

- duration of an independent subject, but integration in the existing subject areas of the whole curriculum at ACT, and
- integration in elementary school and lower secondary level.

At this point the question arises why environmental education should not become an independent subject and impart fundamentals like Thai or mathematics lessons do. What militates in favor of establishing an independent subject is the fact that the students would consciously perceive the lessons under the name of “environmental education”. However, the bureaucratic burden of adding a new subject is enormous, and it would take a long time until its realization.

One advantage of integrating it in all subject areas is that the students would become aware of the fact that environmental education is of importance in all areas of life. Based on the author's own experience it becomes evident that integrating environmental education in other subject areas is possible after consultation with the school administration and

the teachers of Assumption College Thonburi. As requested by the teachers one lesson of the environmental school project was conducted in each class of grade 10.

4.2.2 Integration and structure of the modules

In order to incorporate environmental education at Assumption College Thonburi, the integration of individual modules or parts of modules in existing subject areas and the continuation of a voluntary course are suggested as feasible variants. Based on the projects in chapter 2 module series for both elementary school and lower secondary level are developed. These are to be integrated in the lessons as follows:

- elementary school:
  - Integration of the developed module series of environmental education in the existing subject areas of one of the grades 1 – 4 (Pathom 1-4) upon consultation with the heads of grade and the teachers.
  - Integration of individual modules, e.g. the games, starting with grade 1 (Pathom 1) to early sensitize students regarding the topic of waste
- lower secondary level:
  - integration of the developed module series in the existing subject areas of grade 7 (Mathayom 1) because these students will remain at the school for three more years due to admission requirements and will be able to pass on what they have learned directly and indirectly to their fellow students in the daily routine (role models), and because of the high number of environment-related topics in this grade, see chapter 2, section **Fehler! Verweisquelle konnte nicht gefunden werden.**
  - continuation of the course “Environmental protection and the environment” in grade 9 (Mathayom 3)

The continuation of the voluntary course is justified by the fact that in the short term it is easier in terms of organizational and administrative burdens to offer and conduct a course. Such a course could continue the environmental education with a part of the students at ACT without interruption. Simultaneously, further experiences with the implementation of environmental education can be collected. But in the medium term it should be the goal to integrate environmental education in all subject areas of the curriculum.

One school year at Assumption College Thonburi consists of 40 weeks of school [FRITSCHE, 2001]. On some of these days there were no classes due to holidays or internal events. In the course of the field test at ACT ten double lessons were conducted in one semester, see chapter 3, section **Fehler! Verweisquelle konnte nicht gefunden werden.**. That is why ten definite modules á 100 minutes were developed for both elementary school and lower secondary level. Furthermore, there are additional modules that can be taught if required, see

Table 4-3.

Each individual module consists of Part A and Part B. The individual parts have the duration of a regular period at ACT of 50 minutes. The parts are separate units with regard to content, i.e. they can be taught separately. This is meant to facilitate the integration in the curriculum. It is intended to adjust the content of each module to a subject area or a subject. The modules are structured as follows:

- each module has a number and the acronym “E” for elementary school or “S” for lower secondary level, which is supposed to prevent mix-ups of the modules belonging to different education levels;
- if the modules have the same content they are labeled with both acronyms “E” and “S” and the according number;
- every module has a topic headline;
- the module parts A and B each have a title as they can be taught separately and form separate units;
- for guidance the progress of the lessons is determined by a rough schedule that is not binding;
- each module part contains tasks, allocation of tasks, and teaching contents for teachers and students;
- transparencies, worksheets and templates are included that assist teaching and improve illustration; and
- each module part is assigned to a suitable department.

Module „No.“ – „Topic“

Part	Title	Duration [min]	Contents	Tools	Subject area
A	”Title”	max. 50	“Topic contents” • ”key words”	Transparencies, blackboard or worksheet	...
B	“Title”	max. 50	“Topic contents” • “key words”	Transparencies, blackboard or worksheet	...

.

Figure 4-1: Schematic illustration of a teaching module

Some teaching modules, like the module “Paper production” or the additional module S1 “Visit of a landfill or transfer station”, see

Table 4-3, form an exception in terms of their duration. These modules have the duration of a double lesson or of a whole day respectively.

As the parts of a voluntary course the modules are outlined as double lessons over the period of one semester. As mentioned, Parts A and B can be separated when being implemented in the curriculum. In doing so it is advisable to integrate the modules in the lesson plan in the numbered sequence they were created, see

Table 4-3. When they have been integrated in the curriculum, the modules can be spread out over the whole school year.

4.3 Content-related and methodical conception

4.3.1 Facts and insights

Insights on the content-related and methodical structure were also acquired through bibliographic research. For example, the German projects as well as the ACEID project of the Asia-Pacific region contain detailed topic suggestions for environmental education. These data overlap in part. Very comprehensive suggestions are given in the ACEID project. These also include subject-specific topics from the field of waste [FIEN et al., 1994]. The following Table 4-2 summarizes those suggestions from the variety of proposals that are relevant for environmental education at ACT.

Table 4-2: Suggested topics for environmental education from ACEID project [FIEN et al., 1994]

Subject or subject area	Possible topics
Thai	• Discussing, writing and publishing articles on the current situation at the school in the school's newspaper • Reading stories, novellas and similar works from Thailand and the whole world with topics like recycling measures etc.
Mathematics	• Calculating the waste amounts accruing at the school; representation in diagrams, quantity distribution and calculation of volume and weight • Estimation and calculation of statistical probabilities with regard to waste data • Cost-benefit analysis of disposable and reusable tableware • Interpreting of statistics of trends and developments relevant to the environment
English	• Speaking and writing practice about topics relevant to the environment • Learning vocabulary from the field of waste, recycling etc.
Social Studies	• Discussing the history of waste in Thailand, where does waste originate, where are the different materials produced • Studies on the market type at the school regarding environmentally conscious consumption, recycling etc. • handling of wastes in various countries
Physical Education and Health	• Study of school snacks (packaging, food additives, pesticides, organic products, nutritional value) and planning/introduction of suitable measures to improve the snacks • Addressing a local environmental problem that might have impacts on human health, e.g. hazardous hospital wastes etc.
Arts	• Creating drawings, collages with waste materials from the school etc for sensitizing the students with regard to waste; displaying at the school • Performances on the topics of waste production and recycling to increase awareness

Subject or subject area	Possible topics
Science	• Study of supply structures and ecosystems, the influence of chemical fertilizers, pesticides and waste products • Energy assessments of renewable and non-renewable resources and their impacts on the environment • Addressing composting cycle and stages • Waste situation at a landfill • Inviting guests from society and discussing environment-related problems
Religion	• Analysis of the perspective of various global religions regarding the environment • Studying the impact that moral and ethnic consequences and political, social and economic decisions have on the environment

Insights could also be gained from researching the subjects at ACT that included relevant topics on environmental education. For example, the functioning of ecosystems is covered in the subject area of Science. The topic of composting of organic wastes could be integrated in the lessons at this point. Furthermore, the pollution of individual habitats is discussed. Here, the problems arising with the landfilling of wastes can be addressed. In the subject area of Social Studies the students are concerned with the analysis, the sustainable treatment and the protection of natural resources. The topic of “Resource-product-waste” could be addressed as part of this subject area. The evaluations of the first teaching units and the results of the questionnaires at the school environment day can also give insights. For example, the students request more comprehensive lessons on the topic of recycling. On the other hand, due to the poor results at Station 2 there is a need for knowledge on the topic of composting.

Regarding the waste awareness of commercial waste similar to municipal waste and residual waste it becomes evident that the contents of the teaching modules have to address the various waste fractions. A need for knowledge is also perceived in reutilization possibilities and consequently in the way of separating wastes.

Beside the content-related facts, experiences with the methodical implementation of environmental education were collected, i.e. information on how the students can be taught. According to the author's own experience, the principle of multiplicators is presently not yet recommendable. At present, the students are not able to pass on the acquired knowledge to other students. The reasons for that might be found in the cultural and social conditions at Thai schools. The current school projects provide suggestions on interdisciplinary and action-oriented lessons, see chapter 5. Out of these the following activities are applicable to Assumption College Thonburi:

- tour around the school grounds and documentation of waste types, places of origin, and collection,
- manual production of recycled paper (papermaking),
- setting up a compost heap, observing the composting progress, and testing the compostability of accruing waste materials,
- organization of a low-waste breakfast, and
- conducting waste separation practices in the classroom.

The first field test of environmental education also provided insights. Accordingly, the following issues should be taken into consideration when developing the teaching contents, especially when using the English language:

- presentation of important and essential information, like texts and tasks, in written form,
- use of simple vocabulary and contents with wording that is easy to understand,
- placing important information at the beginning of the teaching unit due to reasons of concentration,
- defining the scope of tasks exactly and in written form, and
- use of pictures and graphs for illustration and better understanding.

4.3.2 Content development of the modules

The key aspects of the teaching modules are based on the goal of the environmental school project to make the improved or rather new waste separation system understandable to the students. Thus, these key aspects look like the following:

1. Presenting the waste production and disposal at ACT
2. Imparting background knowledge on the term of waste and the impacts on the environment
3. Analysis and presentation of the current waste collection system at ACT
4. Imparting background knowledge on the topic of waste avoidance
5. Imparting background knowledge on the reuse and reutilization (recycling) of wastes in general and of exemplary materials

Based on these key aspects individual topics for the teaching modules and the additional modules for elementary school and lower secondary level were formulated.

Table 4-3 and Table 4-4 summarize these topics and the suitable subject areas.

Table 4-3: Topic overview of teaching modules for the elementary school at ACT

Elementary school		
Module No.	Topic title	Suitable subject area
E1	Wastes at ACT	Thai
E2	Wastes, their composition and disposal	Thai, History, English
E3	Waste memory game	Thai
E4	Waste avoidance	Thai, Scout
E5	Crafting lesson – Art made of waste materials	Scout (Arts)
E6	Fundamentals of composting	Science, Scout
E7	Paper and recycled paper	Thai, Science
E8	Production of recycled paper	Science, Scout
E9	The new collection system	Thai
E10	Low-waste breakfast	Thai
A. E1	Crafting lesson– Musical instruments made of waste materials	Scout (Music)

Table 4-4: Topic overview of teaching modules for the lower secondary level at ACT

Lower secondary level		
Module No.	Topic title	Suitable subject area
S1	Wastes at ACT	Social studies
S2	What is waste and what do waste materials consist of?	Social studies, History, English
S3	Waste composition and disposal and the current collection system	Mathematics, Social studies
S4	Waste avoidance	Scout, Social studies
S5	Composting	Science, Scout
S6	Paper and recycled paper	Science
S7	Production of recycled paper	Science, Scout
S8	Recycling of plastics	Science
S9	Does waste has a value and what is the purpose of the separate collection of wastes?	Mathematics, Social studies
S10	Students newspaper article	Thai
Z. S1	Visit of a transfer station or landfill	Social studies
Z. S2	Art made of waste materials	Scout (Arts)

The content-related and methodical development of the individual teaching modules is based on the gained insights. For example, during action-oriented lessons the students are expected to form their own opinion on the waste production at ACT through several tours around the school grounds. The students are given tasks and background information which support this process. In elementary school the students are to engage in the topic of waste through playing games, e.g. by playing the waste memory game, see chapter 5, section 5.1.

As waste avoidance is the first step towards the decrease of the waste amount this topic is also a part of environmental education. Students are taught background knowledge on this topic in common or interdisciplinary lessons, especially on the generation of wastes. Possibilities of avoiding waste generation are named. The use of reusable tableware in the school canteen is presented as an example, see

Figure 4-2. During a practical lesson, the class breakfast, students are supposed to recognize themselves how much waste is generated. Subsequently, ways of producing less waste are sought. So the students deal with the subject of waste avoidance in a realistic way.

Figure 4-2: Reusable tableware in ACT school canteen

Unavoidable wastes can in part be reused or reutilized (recycled). The principle of recycling is explained to the students through simple and well-known cycles, namely composting and the recycling of paper. Due to the evaluation results of the first teaching units more information on the subject of the recycling of wastes and further practical lessons to enliven the teaching and to improve demonstration were integrated. For realistic representation, calculations are performed in the secondary level that are supposed to plainly show the recyclable waste amount to the students. These lessons offer the opportunity to integrate the topic of waste in the subject Mathematics, as proposed by other school projects, see Table 4-2. The topic of recycling should make the students become aware of the fact that wastes have a value. These are on the one hand the ideological (non-financial) value and on the other hand the financial one. The students should become aware of both values through background knowledge and tasks in class. The crafting and art lessons also serve this purpose and the further sensitizing for the topic of waste. Thus it becomes possible to integrate a part of environmental education in the subject area of Arts.

In the case of some modules, the tasks are not completely predefined in terms of content but are rather paraphrased. The resulting vacancies are to be filled by the teachers of ACT with current country-specific contents.

5 The pilot concept of environmental education

5.1 Elementary school modules

In this section the modules of environmental education at the elementary school that were developed from the structural and content-related insights are explained further. The goals and contents of the individual modules are explained. The fully developed documents as they are given to the teachers as teaching materials in the form of handouts are filed in Appendix D. These contain formulated tasks and contents on environmental lessons.

Module E1 – Wastes at ACT

Part	Title	Duration [min]	Contents	Tools	Subject area
A	Wastes at ACT	15	Introduction of the environmental school project • management, cooperation, and goals	Transparencies	Thai
		20	Wastes in classroom and surroundings • tour and collection of data on waste types	Worksheet	
		15	Data evaluation • Evaluation of results on blackboard	Blackboard	
B	Wastes at ACT	30	Tour around school grounds • tour and collection of data on waste types	Worksheet	Thai
		20	Data evaluation • Evaluation of results on blackboard	Blackboard	

Module E1 introduces the students to the environmental school project and is intended to teach the students about the waste fractions that are existent at the school. During a tour around the school the students are expected to consciously take note of the wastes. In Part A this tour is limited to the classroom and the areas in front of it. In Part B the students go on a tour around the whole school grounds. The task is to look into the individual waste containers and record location and waste fraction (plastic cups, paper etc.) on a worksheet handed out by the teacher. At the end of the lesson these data are jointly collected on the blackboard, evaluated and discussed.

In case of double periods the tours can be combined and the data can be evaluated at the end of module part B.

Module E2 – Wastes, their composition and disposal

Part	Title	Duration [min]	Contents	Tools	Subject area
A	What is waste?	35	Historical development of wastes • teacher presents interesting facts of the history of wastes – country-specific • optionally using English vocabulary	Worksheet E2	Thai, History, English
		15	Definitions of waste	Transparency	
A	Composition and disposal path of waste	25	Composition of the waste at the school • presentation of own illustration	Transparency	Thai
		25	Disposal path of waste • explaining to students what happens to the waste → disposal paths	Transparency	

Part A of module G2 imparts historical information on waste to the elementary school students. The teacher is expected to also use his/her own data and independently gathered knowledge. The students should understand that waste was produced by humans at all times. However, due to the human consumption behavior of recent decades the waste production has increased enormously. But humans are capable of stopping this process [DOHMANN et al., 1999].

The students are presented with definitions of waste from different perspectives and it is explained to them what waste represents in the present time. The following knowledge is imparted here:

- Waste is noticed when it becomes a problem and negatively influences daily life; then waste is matter in the wrong place [BIDLINGMAIER]
- From the subjective perspective of the waste producer, a product becomes waste when there is no possible use for it anymore and the product is declared to be worthless [BIDLINGMAIER et al.]

In order to address the problem with the foreign language English this module can be taught with English vocabulary on the topic of waste. For this purpose the students are given teaching materials with English-Thai vocabulary by the teacher. These can be used in class.

In Part B the students are to learn about waste amounts, their composition and disposal at ACT. The teacher explains this to the students with the help of graphic representations. These show the amounts of individual waste fractions, the total amount of waste and the distribution in percentages. Subsequently, the teacher explains the disposal path of waste at ACT. Again a graphic representation of this is available to the teacher. The data used in this module part are taken from the waste management concept [Klauß-Vorreiter, 2003].

Module E3 – Waste memory game

Part	Title	Duration [min]	Contents	Tools	Subject area
A / B	Waste memory game	2x50	Preparation by the teacher Pictures of all types of waste and containers • Cutting out symbols and explaining	Work-sheets	Thai

With the help of the waste memory game [PUSCH, 2000] the elementary school students should occupy themselves with the individual waste materials through playing games. Using the game the teacher can explain the waste separation system and demonstrate again the disposal path emblematically to the students. The teachers can practice with the students which type of waste belongs into which container. As preparation small cards are made on which the types of waste and containers are shown. These templates subsequently allow different variations of the game to be played.

Module E4 – Waste avoidance

Part	Title	Duration [min]	Contents	Tools	Subject area
A	Class breakfast	50	Organization of a class breakfast • Analysis of accruing wastes	Worksheet	Thai, Scout
B	Waste avoidance	50	Avoidance of wastes • Explaining about manufacturing costs and life cycles of products • avoidance as first step towards “disposal”	Transparency	Thai

The teaching materials of German projects mention a class breakfast as didactic learning method [DOHMANN et al., 1999]. The students of ACT elementary school already have the class breakfast in class, see Figure 5-1.

Module E4 suggests the class breakfast as part of the environmental education. Thus, the students are able to see how much waste is generated and of what materials it is composed. Additionally, after the breakfast students can voice opinions about how this waste could have been avoided and how it should be separated [DOHMANN et al., 1999]. Thus, a reference to daily life is established.

Figure 5-1: Elementary school students during class breakfast at ACT

In Part B, stories are used to make the students aware of the fact that there is always an energy input behind every product that is not always visible. This already burdens the environment, e.g. due to the extraction of raw materials, and also leads to waste generation. The life cycle of products, their recycling and disposal are to be addressed. Furthermore, the term “avoidance” is discussed. Waste avoidance is the first step to reduce the waste amount. The students should understand that waste that is not generated does not have to be disposed of. Subsequently, possibilities of avoiding wastes are discussed together with the students. These are collected from different literature sources. For example, possible ways of avoidance include:

- using a returnable system [BIDLINGMAIER et al.],
- using your own containers when shopping, like a rucksack or similar, and
- preferably buying products with long service life [BIDLINGMAIER et al., PUSCH, 2000]

Module E5 – Crafting lesson – Art made of waste materials

Part	Title	Duration [min]	Contents	Tools	Subject area
A / B	Crafting lesson – Art made of waste materials	2x50	Making crafts with waste materials • task (possibly by teacher) • teacher is to provide basic materials and tools		Scout (Arts)

By crafting with waste materials this module is supposed to symbolically demonstrate to the students that wastes have a certain value and can be re-used. At Assumption College

Thonburi this type of artistic expression is already practiced as part of the Arts lessons. That is why it is easily possible to integrate such a crafting lesson in environmental education. The students display their creativity and craft various things from collected waste materials following the teacher's instructions. The teacher and the students should collect re-usable waste materials in advance that are suitable for crafting.

Module E6 – Fundamentals of Composting

Part	Title	Duration [min]	Contents	Tools	Subject area
A	Fundamentals of composting	10	The riddle • Description of the earthworm		Science
		25	Composting – the most natural way of "recycling" • Teacher imparts composting fundamentals • Composting rules	Transparency	
		15	What is permitted on the composting heap and what is not? • Discussion and explanation	Transparency	
B	Visit of the composting plant at ACT	30 20	Visit of the composting plant at ACT and game of questions • Done by the teacher • What is permitted on the composting heap?	Worksheet	Science, Scout

Module E6 "Fundamentals of Composting" teaches the students about the easiest and most natural way of complete recycling using the example of nature. Composting is well-known to all students, and the cycle of reutilization is explained using the model of biological waste. A riddle is used to introduce the elementary school students to the topic. Subsequently, the teacher explains the composting cycle by means of the rotting of organic materials in the natural environment, e.g. the foliage of trees. Afterwards the basic rules of home composting are discussed with the students. The students learn from the teacher which types of waste are suitable for composting and which types do not belong on the composting heap.

Part B includes the visit of the composting plant of the school. During the tour the teacher again explains the composting fundamentals and lists the waste types that belong on the composting heap. The students are given a worksheet that lists some waste fractions. Based on their acquired knowledge the students are supposed to decide whether the waste fractions are permitted on the composting heap or not.

Module E7 – Paper and recycled paper

Part	Title	Duration [min]	Contents	Tools	Subject area
A	Basic knowledge on paper	10	The riddle • Description of paper		Thai
		25	The history of paper • What is paper and how was it invented?		
		15	The differences between types of paper • How do types of paper differ from each other?	Worksheet VI	
B	New and recycled paper	30	The production of paper • The industrial production of paper		Science
		20	Waste paper at the school • Listing things that can be done with waste paper	Transparencies	

Paper is the most often used raw material world-wide and also one of the most employed products at the school [DOHMANN, 1999]. That is why paper recycling also offers the opportunity to easily demonstrate reutilization to the students. Module E7 teaches the students basic knowledge on the development and origin of the material of paper.

In Part A the students are again introduced to the subject of paper through a riddle. As the lesson progresses the students deal with the history of paper and address the issues of where paper comes from and who invented it. Subsequently, the students should become aware of the fact that there are many different types of paper. For this purpose every students selects a random piece of paper. The teacher gives the students a worksheet with several questions about the piece's characteristics. The students answer these questions based on the selected piece of paper. If the worksheet is completed the characteristics of the piece of paper have been gathered. These are subsequently compared within the class.

In Part B the teacher explains to the students the production of paper and tells them from which countries the raw material of wood is obtained. In doing so the teacher should also address the situation of forest stands in Thailand. Afterwards the teacher explains the production of recycled paper. As waste paper cannot be recycled endlessly the students are taught further reutilization possibilities. Here, the useable types of paper are named. The students should understand that it is always beneficial to collect paper separately. Finally, it is demonstrated to the students how much waste paper accrues at Assumption College Thonburi each week.

Module E8 – Manual production of recycled paper

Part	Title	Duration [min]	Contents	Tools	Subject area
A / B	Production of recycled paper	2x50	Papermaking following instructions • Preparation done by responsible person together with students • Conduction together with students	Worksheet	Science, Scout

Modules E8 serves the solidifying of the acquired knowledge on the topic of paper and the enlivening of the lessons. During this action-oriented lesson the students make recycled paper from waste paper on their own. Thus, they become familiar with the individual steps of recycling paper through autonomous action. What is extremely important in this module is a good preparation done by the teacher or another responsible person, like the collection of the necessary materials. In doing this the responsible person can be assisted by the students.

Module E9 – The new collection system

Part	Title	Duration [min]	Contents	Tools	Subject area
A / B	Waste memory game	2x50	The new collection system with the aid of the waste memory game • Use of the existent “waste memory game” to explain the improved or rather new waste collection system	Waste memory game	Thai

Module E9 is intended to make the students understand the improved or rather new waste collection system. During the previous teaching modules the students were taught knowledge on the wastes existent at ACT and on the possible reutilization of these wastes. The reutilization possibilities are explained to the students using the examples of composting and paper recycling. The students are expected to learn how the wastes have to be collected in order to employ these reutilization possibilities. With the help of the waste memory game the students should assign the wastes to the corresponding new or re-functioned waste containers. The teacher provides explanatory assistance in that.

Module E10 – Low-waste breakfast

Part	Title	Duration [min]	Contents	Tools	Subject area
A/B	Low-waste Breakfast	2x50	Organization of a low-waste breakfast with little waste • Analysis of the accruing waste • Comparison with first class breakfast	Worksheet	Thai

In module E10 the class breakfast is repeated. But this time it is the goal to have a breakfast that produces as little waste as possible. For this purpose the teacher collects the basics, such as food and tableware, together with the students at the beginning of the lesson. That is why a double period is scheduled for this module. Based on the knowledge gained from module E4 attention should be paid to the fact that the basics are selected based on the aspect of being “low in waste”. Thus, for example no disposable tableware should be used. During the breakfast the accruing wastes are again to be collected. These are analyzed with the help of a worksheet. The results are compared to the data from the first class breakfast. The students are expected to notice whether waste was avoided or not. At the end of module E10 the students dispose of the wastes according to the new waste collection system.

Additional module E1 – Crafting lesson II – Music from waste materials

Part	Title	Duration [min]	Contents	Tools	Subject area
A / B	Crafting lesson II – Music from waste materials	2x50	Crafting of musical instrument made of waste materials • Teachers should provide basic materials and tools	Task sheet	Music

This additional module 1 is supposed to make the students again recognize that wastes have a certain value and can be used further or reutilized. This time the students display their creativity and craft various musical instruments made from waste materials following the instructions of the teacher. That is why the teacher in turn should collect reusable wastes or instruct the students to collect these in advance.

5.2 Lower secondary level modules

After the elementary school modules the following section explains more comprehensively the goals and contents of the individual modules for the lower secondary level. Some of these modules are identical to the elementary school modules and are listed for the sake of completeness. Goals and contents are briefly explained again. Furthermore, there are modules whose contents slightly differ from those of the elementary school. These are explained in full. The fully formulated versions of these modules are also listed in Appendix D.

Module S1 – Wastes at ACT

Part	Title	Duration [min]	Contents	Tools	Subject area
A	Wastes at ACT	15	Introduction of the environmental school project • Management, cooperation and goals	Transparencies	Social Studies
		20	Wastes in classroom and the surroundings • Tour and collection of data on waste types	Worksheets	
		15	Data evaluation • Evaluation of results on blackboard	Blackboard	
B	Wastes at ACT	30	Tour around school grounds • Tour and collection of data on waste types	Worksheets	Social Studies
		20	Data evaluation • Evaluation of results on blackboard	Blackboard	

The module S1 “Wastes at ACT” for lower secondary level is identical to module E1 of elementary school. The goal of this module is to introduce the students to the environmental school project and raise awareness of the waste fractions that accrue at ACT. This is not only done through explanations by the teacher. During a tour the students conduct a visual analysis on their own. The results are recorded on a worksheet and evaluated. Contrary to module E1, module S1 is assigned to the subject area of Social Studies.

Module S2 – What is waste and what do waste materials consist of?

Part	Title	Duration [min]	Contents	Tools	Subject area
A	What is waste?	35	Historical development of wastes • Teacher presents interesting facts of the history of wastes – country-specific • Optionally using English vocabulary	Worksheet 2	Social Studies, History, English
		15	Definitions of waste	Transparency	
B	What does waste consist of?	35	Waste fractions and associated raw materials • plastics, metal, paper, … letting students list them and fill in a table • Information on the raw materials	Blackboard	Social Studies
		15	Stories around the topic • Impulses for reflection	-	

Part A of module S2 matches Part A of module E2. The students are expected to realize that there has been waste since the beginning of time. But the amount increases with advancing progress. Furthermore, definitions of waste are given in Part A. The secondary level students, too, can be given hand-outs with English-Thai vocabulary in this module.

In module S1 the students became familiar with the individual waste fractions. In Part B of module S2 the students should deal with the raw materials that make up the different waste fractions. For this purpose the teacher gives basic knowledge on deposits and the extraction of these raw materials to the students. Using the example of a tin can, the students are to recognize which raw materials are used to make a product, what energy is necessary in the production, and during which stages the environment is burdened. Thus, an overlapping area between wastes and environment is created. Part B is best realized as part of the subject of Geography in the subject area of Social Studies, see chapter 2 section 2.3.3. This subject area comprehensively addresses raw materials and their use and resulting environmental impacts.

Module S3 – Waste composition and disposal and the current collection system

Part	Title	Duration [min]	Contents	Tools	Subject area
A	Waste composition and disposal	40	Waste composition at the school • Providing students with current figures to represent them as distribution in percentages, amount per capita etc. • Show own graph	Transparency Transparency	Mathematics
		10	Disposal path of waste • Explain to students what happens to the waste → disposal paths	Transparency	
B	The current waste collection system at ACT	30	Tour around school grounds • Students write down which wastes they see in the collection containers	Worksheet	Social Studies
		20	Evaluation of the tour • Evaluation of the results on the blackboard	Blackboard	

The goal of Part A of module S3 is the integration of the topic of waste in the Mathematics lessons. Having become familiar with the individual waste fractions the students are taught about the amounts accruing per week. Based on this information the students should calculate the mass distribution in percentages of the individual waste fractions. The results are to be shown in different diagrams. Finally, the teacher explains again the composition of waste at ACT using his/her own graphs. After the calculation the teacher explains the disposal path of these wastes to the students. For this purpose the teacher is provided with graphic representations as teaching aid.

In Part B the students should analyze the current collection system through visual inspection. In doing so they should determine if the wastes at ACT are separately collected and how this is done. They should note on a worksheet which waste materials can be seen and are collected in which container (color and type). The students learn how wastes are disposed of in “their” reality. During the tour the teacher can again explain the disposal path of wastes.

Module S4 – Waste avoidance

Part	Title	Dura-tion [min]	Contents	Tools	Subject area
A	Cooking	50	Organization of a shared meal • Analysis of the accruing wastes	Worksheet	Scout
B	Waste avoid-ance	50	Avoidance of wastes • Explanation of production costs and life cycles of products • Avoidance as a first step towards “disposal”	Transpar-ency	Social Studies

In terms of content and objective this module S4 is identical to module E4 of elementary school. But in the lower secondary level the students do not have a class breakfast but cook together as part of Scout lessons, see Figure 5-2.

Figure 5-2: Students of secondary level are cooking at ACT

This activity can be related to environmental education. Like the elementary school students, the secondary level students collect the wastes accruing during cooking and subsequently analyze them with the help of a worksheet. Looking at Figure 5-2 it becomes obvious that the students are in need of further knowledge on waste avoidance.
This knowledge is imparted to the students in Part B of module S4. They should understand that waste avoidance is the first step towards a reduction of waste amounts. Like the elementary school students, the secondary level students should become aware of the fact that waste that is not produced does not have to be disposed of.

Module S5 – Composting

Part	Title	Duration [min]	Contents	Tools	Subject area
A	Fundamentals of composting	35	Compost – the most natural way of "recycling" • Functioning of composting • Processes during composting • Composting rules	Transparencies	Science
		15	What is permitted on the compost heap and what is not? • Discussion and explanation	Transparency	
B	Visit of the composting plant at ACT	50	Visit of the composting plant at ACT • Led by the teacher • What is permitted on the compost heap? • Temperature measurement	Worksheet	Science, Scout

Like module E6, module S5 is concerned with the fundamentals of composting. Again, the goal is to demonstrate to the students the simplest and most natural way of complete recycling using the example of natural rotting. The secondary level students address the functioning of and the processes during composting more thoroughly. For example, the students study the temperature development. Furthermore, the basic rules of home composting are addressed. To conclude Part A the teacher explains which wastes are suitable for composting.

In part B the students engage realistically with this topic through the visit of the ACT composting plant. The students are also given a worksheet on which they have to identify the materials suitable for composting. As part of the fundamentals the students are concerned with the temperature development. During the visit the current temperature of the compost heap is measured by some students. The results are evaluated in discussions with the teacher. It can be determined in which rotting stage the compost heap is. Thus, the students are expected to solidify what they have learned.

Module S6 – Paper and recycled paper

Part	Title	Duration [min]	Contents	Tools	Subject area
A	Basic knowledge on paper	10	Paper • Description of paper	-	Science
		25	The history of paper • What is paper and how was it invented?	Reading out	
		15	Differences between types of paper • How do types of paper differ from each other?	-	
B	New and recycled paper	15	Paper production • Industrial production of paper	Reading out	Science
		25	Comparison of the production of new and recycled paper • Comparing the raw material, water and energy requirements	Transparency	
		10	Possible uses of waste paper • Listing of what can be done with waste paper	Transparency	

The goal of module S6 is to show the students another reutilization cycle, the existent reutilization possibilities of paper, and the benefit for the environment. Based on these experiences the students should become aware of the purpose of the separate collection of paper.

Part A corresponds to Part A of module E7 of the elementary school. The students learn about the historical background of paper and its characteristics. Part B is more comprehensive. Material balances of the production of new and recycled paper respectively are compared to each other. The students are to recognize that the energy and raw material requirements can be decreased in the production of recycled paper. Additionally, landfill space can be saved. Thus, the environment is less burdened. At the end of the teaching unit the school's waste paper production is illustrated in sheets of A4 to give the students an idea of the amount.

Module S7 – Manual production of recycled paper

Part	Title	Duration [min]	Contents	Tools	Subject area
A / B	Production of recycled paper	2x50	Papermaking following instructions • Preparation done by the responsible person together with the students • Conduction together with the students	Worksheet	Science, Scout

Module S7 corresponds to module E8 of the elementary school and also serves to solidify the learned subject matter and to enliven the lessons.

Module S8 – Recycling of plastics

Part	Title	Duration [min]	Contents	Tools	Subject area
A	Background knowledge on plastics	10	Naming of reutilization possibilities of food and garden wastes		Science
		40	Background knowledge on plastics • Source material, production, characteristics		
B	Recycling of plastics	25	Recycling of plastics • Basic and raw material recycling and incineration		Science
		25	Experiment • Flotation test (float-sink method)		

Module S8 is a concession to the results of question 5 of the "Questionnaire of the school environment day" that requested the integration of further information on the topic of recycling in the lessons. Along with food residuals and garden waste, plastics are, according to weight, the third most common waste at the school. Plastics also play a huge role in daily life in Thailand, especially in packaging. By learning about recycling opportunities for plastics the students should become aware of the fact that the materials can be reutilized and that it is worthwhile to separately collect them.

The module teaches the students basic knowledge about plastics. It covers the raw materials or original materials from which plastics are made, as well as the course of the production process and the existent different types of plastics. Furthermore, the processes for separating different plastic wastes and the available recycling possibilities are explained. With the help of an experiment the students can understand on their own the separation of plastics based on density.

Module S9 – Does waste has a value and what is the purpose of the separate collection of waste?

Part	Title	Duration [min]	Contents	Tools	Subject area
A	Waste has value	10	Does waste has a value? • Put this question up for discussion and let the student gather answers.		Social Studies, Mathematics
		20	The non-financial value of wastes • Calculating the savings in volume through recycling	Transparency	
		20	The financial value of wastes • Calculating the savings through sales	Transparency	
B	Separate waste collection	30	Revisiting of the analyzed collection system • Summary of the current collection system from module 3		Social Studies

		20	A modified collection system • Recycling possibilities were listed, wastes have a value → separate collection is better • Listing of suggestions and ideas		

Module 9 is supposed to explain again to the students why it is worthwhile to collect wastes separately. The students should recognize two kinds of value in the wastes:

- the non-material (non-financial) value, i.e. environmental protection in case it is possible to avoid or recycle wastes, and
- the material (financial) value, i.e. the selling of wastes.

In Part A the students are asked to express their thoughts on the question “Does waste has a value?”. The insights gained from the survey on waste awareness, see chapter 2, section 2.3.2, and from the first environmental education measures, see chapter 3, section 3.3.3, showed that some students know about the financial value of wastes. The results have to be interpreted by the teacher and directed to the non-material and material value of wastes. Module part A is developed in such a way that it can be integrated in Mathematics lessons. The students should calculate the waste amounts and volumes that can be saved at a landfill if 50% of recyclable wastes at ACT could be reutilized as well. The volume is to be represented as a cube. Subsequently, the students are asked to visualize the volume by comparing the cube edge length to the height of a human. Some waste fractions can be sold, for example paper for 4 Baht per kilogram. The purchase prices of sellable wastes are collected. The students are asked to calculate the amount of money that accrues when all sellable waste fractions could be sold. The teacher interprets the results.

In Part B of module S9 the insights gained during the previous lessons are gathered. Based on modules S1 and S3 the current collection system is worked out. Some modules taught basic knowledge on the reutilization possibilities of garden waste, paper and plastics. With reference to the collection system the question is asked whether the wastes are collected separately. The results are explained by the teacher. Based on this level of knowledge the improved or rather new collection system is introduced. It is explained which waste fraction will be collected into which container in future. Afterwards, the waste collections with and without the separation of the different waste fraction are contrasted with each other and evaluated. In order to be able to reutilize and sell wastes these have to be collected separately. The goal is to make the students understand this fact.

Module S10 – Student newspaper article

Part	Title	Duration [min]	Contents	Tools	Subject area
A / B	Summary of course contents	2x50	Writing essays or an article for the monthly student newspaper • Current waste data • Current collection system • Possibly activities of the course • Environmental education at ACT		Thai

During module S10 the students should again summarize and solidify the gained insights. Furthermore, this module offers an opportunity to integrate environmental education in the Thai lessons. The students are asked to write a report for the student newspaper or essays on the topics of “Waste at Assumption College Thonburi” or “Environmental education at ACT”. Through the student newspaper other students can be made aware of environmental education and informed about it.

Additional module S1 – Visit of a transfer station or a landfill

Part	Title	Duration [d]	Contents	Tools	Subject area
A	Visit of a landfill or a transfer station	1	Visiting a nearby landfill or transfer station with the class • Teacher gives instructions and explanations	Worksheets	Social Studies

The visit of a transfer station of a landfill would be a suitable activity to complement environmental education in the topic of waste. Additional module S1 is supposed to give the students a realistic idea of the topic of waste. The accruing heaps of waste are supposed to give the students food for thought and to create dismay. The students will also be in a position to see and possibly smell up close the huge amounts of wastes among which their own wastes are as well.

Additional module S2 – Art made of waste materials

Part	Title	Duration [min]	Contents	Tools	Subject area
A / B	Art made of waste	2x50	Crafting of collages • Students design a collage with the topic of “Waste separation at ACT”, the used materials should consist of waste products	Waste material	Arts

This additional module S2 is supposed to enliven the theoretical parts of education. The students are asked to create a collage on the topic of “Waste separation at ACT”. In doing so they are expected to critically reflect on the task and apply the insights gained from the previous modules. The used materials should be reusable waste fractions, selected from the students themselves. Subsequently, the best collages are selected and displayed at the school.

5.3 Further measures

Within the scope of environmental education not only the lessons but the complete school area are regarded as effective places of learning, i.e. environmental education has to be integrated in the official and unofficial curriculum, see section **Fehler! Verweisquelle konnte nicht gefunden werden.**. However, this demand does not influence the development of the environmental education modules but has to be realized mainly by the school administration and all involved people through projects that are conducted simultaneously with the modules, for example the environmental school project of German Transfer Centre Environmental Technology KNOTEN WEIMAR that implements a separate waste collection. In order to realize the idea of including the school as a whole in environmental education the following suggestions on the topic of waste are made in the ACEID project that can be transferred to ACT [FIEN et al., 1994]:

- Reduction of paper consumption through the use of reusable information sheets, using paper on both sides etc.
- Collecting and recycling of paper in every classroom and office
- Reusing or recycling of cardboard boxes
- Composting of organic waste
- Use of reusable or refillable materials, like printer cartridges, pens etc.
- Avoiding or minimizing disposable materials, like plastic tableware, paper towels etc.
- Promotion of the use of recycled paper in copiers etc.
- Use of environmentally friendly cleaning supplies

These suggestions in terms of material management are complemented with organizational and structural suggestions that stem from the author's own experiences. These include the following points:

- Speech by the school principal,
- Posters containing short significant messages, and
- Mottos, see Figure 5-3.

Due to the distinct hierarchical thinking, the implementation and adherence to new rules, e.g. the resourceful use of materials or an improved waste separation, can be reinforced through a speech by the school principal. Additionally, posters might be put up, similar to the project "Magic Eye" conducted in Bangkok [FRITSCHE, 2001]. These are intended to remind students, teachers and staff members of the adherence to new behaviors, like the separation of wastes. At the school the motto might be: "Everyone separates waste into paper, plastics etc. - what about YOU?"

It is also feasible to expand the aphorisms that can be found at various locations at the school, with mottoes about environmental topics, see Figure 5-3.

Figure 5-3: Motto at ACT

6 Summary

6.1 Conclusion

In the present time environmental problems are not limited to one region. In the wake of globalization these problems occur globally. International trade leads to an increase in consumption also in the countries of the Asia-Pacific region, e.g. Thailand. Especially the young generation embodies the characteristic features of a consumer society. Increasing population figures, especially in conurbations, also entail environmental problems. In order to solve these problems each and everyone has to contribute. But this requires basic knowledge in the field of environment. That is why environmental education should be integrated in all areas of life, especially in school education, because today's children are tomorrow's adults and decision-makers. At German schools environmental education is realized in the form of environmental school projects. These projects are conducted directly at the schools by external experts in cooperation with the teachers. For this purpose the teachers are provided with teaching material on environmental education.

The following can be said on the current situation of environmental education in Thailand:

- Environmental education has been no inherent part of general school education in Thailand so far.
- But the Thai government is making an effort to orient education towards sustainable development.
- Based on the “National Education Commission”, private education is given more freedom of action, i.e. in future private schools will have more freedom in developing their curricula. This fact facilitates the integration of regionally limited projects on environmental education.

In Thailand, too, there are already concepts for the implementation of environmental education. But in contrast to the German projects, these are mainly concerned with teacher training.

Within the scope of this diploma thesis, an environmental education concept was developed for the Thai school Assumption College Thonburi. This concept is intended as a guideline for the teachers at ACT for the development of lessons. In terms of content the concept is concerned with the imparting of theoretical knowledge on the separate collection of waste in order to make reutilization possible. The concept is based on German projects but is adjusted to the cultural and social conditions in Thailand. It was developed based on a bibliographic research of existing environmental education projects, the insights gained during the author’s stay at ACT, and first environmental education measures conducted at ACT.

The following conclusions can be drawn based on the analysis of current projects on environmental education in Germany and the Asia-Pacific region:

- Environmental education should affect the whole school area, i.e. the school as a whole should become an effective place for learning.
- Environmental education should not be a separate school subject but should be integrated in the existing subject areas of a school's curriculum with the duration of a school subject.
- Environmental education should be integrated mainly in elementary schools and lower secondary levels as younger students can be motivated more easily for new things.
- Environmental education should be a combination of specialized, interdisciplinary and action-oriented lessons.

The insights gained in terms of waste collection during a stay at ACT were:

- The persons involved in the daily school routine are aware of the fact that certain waste fractions can be reutilized.
- Paper is partially collected and sold at the school.
- However, through the current waste collection system the wastes are separated according to their condition into dry/wet, making a reutilization of the waste fractions impossible.

Based on the experience from the first conducted environmental education measures, the following conclusions can be drawn for the development of teaching units of environmental education:

- Students show an interest in the practical teaching units and in the topic of recycling.
- Students should be actively involved in the lessons to improve their participation.
- Problems arose from conducting the lessons in the English language.
- Overhead transparencies improve understanding but should be structured very clearly.

On the basis of these collected insights ten teaching modules and some additional modules were developed for both elementary school and lower secondary level. These teaching modules are intended directly for educating the students. The modules serve as materials for the preparation and conduction of the lessons by the teachers.

6.2 Outlook

In case of extending the teaching modules they could be expanded to the upper secondary level. Furthermore, the attempt should be made to form environmental groups among the students that assume responsibility for certain tasks at the school. Examples of this in the upper secondary level would be the continuous analysis of the waste together with the service department with the help of provided check lists, or the analysis of the progress of composting at ACT.

Further educational measures could include a competition held at the school. Similar to German projects this would be about which team separates waste best. The waste containers are mainly situated on the school grounds and the individual grades are taught in different building. That is why the assignment to a team could be done according to grades or school buildings. Extending the environmental school project to other schools of the St. Gabriel Foundation, competitions between the schools would be feasible.

Also inspired by the mentioned German projects, the students could be given financial incentives. Due to the new separate collection the school is able to sell a part of the reusable wastes. The students might use a share of the revenues, e.g. for trips or festivals.

Appendix A Lesson topics in environmental education from ACEID project

Subject-specific lesson topics in environmental education

SUBJECT AREA	SPECIFIC WORTHWHILE ACTIVITIES
Agricultural Studies	• helping farmers plant trees to prevent soil erosion • joining or forming a Landcare group • creating and maintaining a school farm, choosing species appropriate to local conditions • researching the issues involved in farming native animals • examining the relevance of wildlife corridors to sustainable agricultural management • discussing the relationships between consumers and primary producers
The Arts	• drawing and painting to sensitise students to their environment • resolving environmental conflicts and raising awareness of the controversial nature of many environmental issues through visual and performance arts • building self-esteem, confidence and creativity as a means of empowering students to value their contributions to the environment/community • developing sensory skills and powers of observation • composing, interpreting and performing music on environmental themes • appreciating the environment within outdoor activity programmes
Commerce	• investigating 'green' consumerism • examining the Resource Security Bill and its implications for the ecologically sustainable development process • investigating the 'greening' of business and industry • comparing costs of food/tuckshop packaging, eg paper vs plastic • investigating wants vs needs (individual, family, school community, larger society) • investigating a local business to compare 'use' and 'waste' levels, then devising a management plan to reduce these levels, ie resource management • assessing operations of a local industry regarding 'costs' of pollution
First Language Studies	• using drama, role-play and problem-solving debates to express attitudes and perspectives on environmental issues • researching, writing and publishing articles for papers, children's magazines, pamphlets, newsletters, journals, diaries • discussing and debating social and environmental issues to develop language skills • enjoying stories, novels, plays and poems from around the world on environmental themes • using media studies programmes to investigate environmental films
Second Language Studies	• using material on environmental issues for practice and development of language skills • establishing environmental pen-pals • researching, talking and writing in another language about an environmental issue • conducting simple structured conservations around photographs depicting pleasing natural and built environments • studying a local environmental issue as part of a language exchange programme • investigating the variety of ways in which different cultures respond to and value the environment

SUBJECT AREA	SPECIFIC WORTHWHILE ACTIVITIES
Health and Physical Education	• implementing a waste minimisation program in the school and investigating the implications of this for human and environmental health • investigating the school tuck-shop (e.g. packaging, food additives, pesticides on food, organic products, nutritional value) and planning/implementing appropriate actions to enhance the tuck-shop • examining ozone layer and greenhouse issues and relating/connecting the relevant associated human health and natural environment issues • addressing a local environmental issue which may have consequences for human health, eg hazardous wastes, hospital waste management/incineration • investigating the chemicals in the local water supply. Are the levels safe? Is there a level at which human health may be affected?
Home Economics	• Investigating micro-climate, home design, landscape planning and development of personal environments • investigating the relationship between the health of the individual and the health of the environment • investigating chemical food additives and hazardous chemicals in the home • investigating the origin and production techniques of food, e.g. organic produce; local vs imported products - cost, quality, consequences of third world cash crop production • examining the uses and environmental implications of synthetic and natural fibres • investigating excess packaging, recycling, energy conservation and waste disposal
Mathematics	• understanding, estimating and calculating probabilities using contemporary environmental data • calculating distances, lengths and angles using the natural and social environments • collecting and representing data on water use for water conservation purposes • developing basic mathematical skills through case study work on the local environment • developing species-area curves • conducting water quality testing • auditing energy use rating appliances, reading matters, calculating cost and savings • calculating size of rainwater tank for school/home • examining costs/benefits of energy efficient practices • interpreting statistics on environmental trends and developments
Manual Arts/Technology	• developing guidelines for the manual arts/technology department, eg disposal of toxic substances, buying/using offsets/recycled products, not buying rainforest timber, waste minimisation techniques • investigating sources of timber, their uses and implications for environmental conservation/preservation • examining the pros and cons of renewable vs synthetic materials and resources • constructing products from reusable and recyclable resources • investigating concepts such as conservation, waste minimisation, environmental design, environmentally friendly technologies, renewable and non-renewable resources
Religious Education	• considering personal responsibility to all living things • exploring the environmental messages/ethics in the aboriginal dreamtime • investigating the perspectives of different world religions on the environment and particular environmental issues • exploring the moral and ethical implications of political, social and economic decisions affecting the environment • exploring 'green' spirituality

SUBJECT AREA	SPECIFIC WORTHWHILE ACTIVITIES
Science	• investigating chemical changes to the earth's atmosphere caused by human and industrial activity • water quality monitoring and studying the effects of oxygen levels on life forms • doing seed collecting, planting and propagating • investigating the physics of energy production from renewable and non-renewable resources and their environmental impact • studying food webs and ecosystems and the impact of inorganic fertilisers, pesticides and waste products • investigating the science of global warming • inviting community resource people to talk about environmental/science issues
Social Studies	• investigating the variety of ways in which different societies respond to and value the environment • using role play/simulation to identify the different interests in a development issue; critically appreciating the role of values in conflicts about environmental/development issues • conducting a local area study to examine the relationships between built and natural environments; investigating people's recollections of past land use by using oral history skills • implementing a marketing scheme in the school for green consumerism, recycling etc. • acquiring critical appreciation of the concepts of sustainable development, stewardship and conservation • investigating the harnessing of energy through the ages and its social, economic and environmental effects • examining the rights and obligations of individuals, social and business organisations, and governments in their environmental interrelationships

Appendix B Questionnaires

Questionnaire to the A.C.-Thonburi Environmental Project about the present waste awareness

This is a survey including some questions to the present waste awareness at A.C.T. to g realisation of the *A.C.-Thonburi Environmental School Project*. Everybody helps the creates a cleaner future that gives true answers.

Please mark a **cross** in the correct circle ⊗ (more than one answer is possible)

Questions to the present waste economy at Assumption College Th

1) Personal Statement – I'm (a)…

student O teacher O staff O female O

How old are you? I'm ……years. Nationality: …….

2) Waste collection system

a) Do you have a separate waste collection at A.C.T.?

no O (go on to Quest. **3)**) I don't know. O (go on to Quest. **3)**)

b) How do you separate waste at A.C.T.?

size (small and big) O dry and wet O material (plastic, me

3) There are *green*, *yellow* and *grey* bins at A.C.T.! Where do you drop…?

plastic cups:	green O	yellow O	or grey O
paper:	green O	yellow O	or grey O
food:	green O	yellow O	or grey O
plas. cups with ice:	green O	yellow O	or grey O
glass:	green O	yellow O	or grey O
plastic bottles:	green O	yellow O	or grey O
metal:	green O	yellow O	or grey O

4) Places of waste disposal

a) Where do you dispose waste at A.C.T.?

in the classroom / office O at the school area O in the k

b) What type of waste do you dispose in the classroom / office?

paper O plastic O glass O food O metal

Questionnaire on waste awareness in Thai

คำถามเกี่ยวกับสิ่งแวดล้อมภายในโรงเรียนอัสสัมชัญธนบุรี
โครงการประหยัดการใช้ขยะ

แบบสอบถามเกี่ยวกับขยะ เพื่อลดปริมาณของขยะภายในโรงเรียนอัสสัมชัญธนบุรี อนึ่งในแบบนี้เพื่อจ
ของผู้มีส่วนร่วมในเรื่องของสิ่งแวดล้อมภายในโรงเรียน

ให้ทำเครื่องหมายกากบาทในข้อที่ถูกต้องที่สุดลงในช่อง ☒ (ตอบได้มากกว่า 1 คำถาม)

คำถามเกี่ยวกับขยะในโรงเรียนอัสสัมชัญธนบุรี

1) สถานะภาพของผู้ตอบแบบสอบถาม

นักเรียน O ครู O ผู้ดูแล O หญิง O ชาย O

อายุ……..ปี สัญชาติ……

2) ระบบการแยกขยะ

a) คุณทราบหรือไม่ว่ามีการจัดแยกถังขยะในโรงเรียนอัสสัมชัญธนบุรี

ไม่ O (ให้ตอบข้อ. 3)) ไม่รู้ O (ให้ตอบข้อ. 3)) ใช่ O (ให้ตอบข้อ

b) คุณแยกขยะในโรงเรียนอัสสัมชัญธนบุรีอย่างไร

ขนาด (เล็กและใหญ่) O แห้งและเปียก O วัสดุ (พลาสติก , เ

3) ในโรงเรียนอัสสัมชัญธนบุรีมีถังขยะ <u>สีเขียว</u> , <u>สีเหลือง</u> , และ <u>สีเทา</u> ! คุณจะทิ้งในถังไหน……?

แก้วพลาสติก:	เขียว O	เหลือง O	เทา O
กระดาษ:	เขียว O	เหลือง O	เทา O
อาหาร:	เขียว O	เหลือง O	เทา O
แก้วพลาสติกมีน้ำ:	เขียว O	เหลือง O	เทา O
แก้ว:	เขียว O	เหลือง O	เทา O
ขวดพลาสติก:	เขียว O	เหลือง O	เทา O
เหล็ก:	เขียว O	เหลือง O	เทา O

4) สถานที่รวบรวมขยะ

a) คุณเอาขยะไปรวมไว้ที่ไหนในโรงเรียน

ในห้องเรียน/ห้องทำงาน O บริเวณโรงเรียน O ในห้องครัว O

b) ชนิดของขยะที่คุณรวมไว้ในห้องเรียน/ห้องทำงาน

กระดาษ O พลาสติก O แก้ว O อาหาร O เหล็ก O

Questionnaire on waste awareness for elementary school students

Questionnaire to the A.C.-Thonburi Environmental S
Project about the present waste awareness

This is a survey including some questions to the present waste awareness at A.C.T. to g realisation of the *A.C.-Thonburi Environmental School Project*. Everybody helps the creates a cleaner future that gives true answers.

Please mark a **cross** in the correct circle ⊗ (more than one answer is possible)

Questions to the current waste awareness at ACT

1) Personal Statement

student O teacher O staff O female O n
How old are you? ..... years Nationality: .....

2) By what kind of system do you separate the waste at the Assumption Colle

dry and wet O size (small and big) O material (plastic, paper,

3) Questions to the waste system at the Assumption College Thonburi

You have **green**, **yellow** and **grey** bins at ACT. Where do you drop:

plastic cups	green O	yellow O	or grey O
paper	green O	yellow O	or grey O
food	green O	yellow O	or grey O
plas. cups with ice:	green O	yellow O	or grey O

Questionnaire on environmental lessons

Questionnaire for the education of the A.C.-Thonburi Environmental School Proj

This is the final survey for the education of the *A.C.-Thonburi Environmental School Pro* gives truthful answers helps to improve the environmental education. With your answers more interesting lessons to send the knowledge to you.

Please mark a **cross** in the correct circle ☒ (more than one answer is possible) and/or g

Questions for the education of the A.C.T. Environmental School Proj

1) Personal Statement

I'm a Student of mathayom …… . female O
How old are you? I'm ……years. Nationality: ……T

2) General Questions to the lesson "Conservation and Environment program the subject "Social studies"

I chose this subject as extra activity because…

I was interested O somebody advise me (told me I should choose
I didn't know what subject I should take (I had no other idea) O
Others……

3) Questions to the lessons

a) Were you interested in the lessons?

no O yes O in some lessons O

b) In what lessons were you especially interested?

3 – "We make compost by ourselves" O
4 – "Waste has a value!" O
5 – "How can we use waste at A.C.T.?" O
7 – "The knowledge of paper and recycling paper" O
8 – "We make paper by ourselves" O

In no lesson O

4) What type of problems did you have during the lessons?

I had general problems to understanding the content O

Questionnaire of school environment day

Questionnaire to the A.C.-Thonburi Environmer

Day about the presentation on each informatic

This is a survey about the presentation on each of the three information stations. Er
listen and show what is presented to you. After each presentation please try to answer t

Please mark a **cross** in the correct circle ☒ (more than one answer is possible)

Questions about the presentation on each station

Personal Statement

Name:.....Surname:.....

I'm a Student of mathayom ..... . female O

How old are you? I'm .....years. Nationality: .....

Recycling station

1) What type of waste is created at A.C.T.?

Plastic:	O
Paper:	O
Chemical waste:	O
Metal:	O
Old oil:	O
Glass:	O

2) How much waste is created per week at A.C.T.?

a) 3500 kg/week O
b) 5000 kg/week O
c) 6500 kg/week O
d) 8000 kg/week O

3) How much waste is reusable and recyclable at A.C.T.?

a) 36% of waste is reusable and recyclable O
b) 64% of waste is reusable and recyclable O
c) 20% of waste is reusable and recyclable O
d) More than 50% of waste is reusable and recyclable O

4) What type of waste is recyclable – *has a value*?

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Appendix C Modules of environmental education at ACT for elementary school and lower secondary level

Module E1 / S1– Part A: Wastes at ACT

Suitable for subject area: Elementary school: Thai
Lower secondary level: Social Studies

Topic overview – Part A — Duration [min]

1.1:	Introduction of environmental school project	15
1.2:	Wastes in classroom and surrounding areas	20
1.3:	Data evaluation	15

1.1 Introduction of environmental school project — 15 min

Contributors	Tasks/ Contents/ Activities	Tools
Teacher	**Task:** Introduction of "Assumption College Thonburi environmental school project""	
	Text: The Assumption College Thonburi Environmental School Project • consulting: KNOTEN WEIMAR GmbH, Prof. Dr. Kanoksak of Kasetsart University / Thailand, • in cooperation with: Assumption College Thonburi; and hopefully all students, teachers and staff members	Transparencies 1-1
	The general goals of the project are: • a) environmental education of the young generation – the students • b) waste avoidance through separate collection of reusable wastes, recycling and the reutilization of organic wastes di-	Transparencies 1-2

	rectly at the school	
Teacher	**Task:** Own (current) supplements to the project	

1.2 Wastes in classroom and surrounding areas 20 min

<table>
<tr><th>Contributors</th><th>Tasks /Contents/ Activities</th><th>Tools</th></tr>
<tr><td>Teacher</td><td>Activity: Take a tour around the classroom and the school areas in front of the classrooms and analyze the waste fractions together with the students.

Task: Students are asked to look into the waste containers in the classroom and the school areas in front of the classrooms and record in the table on Worksheet I, see worksheets, the waste fractions they recognized (plastic cups, paper etc.)
• Show example of Worksheet I;</td><td></td></tr>
<tr><td></td><td><table><tr><th>Location</th><th>Waste fraction</th></tr><tr><td>Example: classroom</td><td>Paper</td></tr><tr><td></td><td></td></tr></table>• Subsequently hand out Worksheet I and
• Start tour</td><td>Worksheet I</td></tr>
<tr><td>Students</td><td>Task: Fill in Worksheet I during the tour</td><td></td></tr>
</table>

1.3 Data evaluation 15 min

<table>
<tr><th>Contributors</th><th>Tasks/ contents/ activities</th><th>Tools</th></tr>
<tr><td>Teacher</td><td>Task: After the tour summarize the data collected by the students on the blackboard and evaluate them.

Contents: Create the following empty table on blackboard.

<table>
<tr><th>Location

Waste fraction</th><th>Classroom</th><th>School grounds</th></tr>
<tr><td>Example: Paper</td><td>X</td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
</table>

Ask the students one after another to fill in the results of the tour in the table on the blackboard:
Ask students to fill in the waste fraction in column one; in doing so the following waste fractions should be noticed:
drink cartons, metal, glass, paper and cardboard, plastics, garden waste, food waste, “hazardous waste” such as batteries
Ask the students to mark the respective cell in columns two and three
If not all waste fractions are noticed by students, these have to be added
</td><td>Blackboard</td></tr>
<tr><td>Students</td><td>Task: Fill in the data in the table created on blackboard.</td><td></td></tr>
<tr><td>Teacher</td><td>Task: Summary of results:
Which waste fractions accrue in the classroom?
Which waste fractions accrue on the school grounds?</td><td></td></tr>
</table>

Module E1 / S1– Part B: Wastes at ACT

Suitable for subject area: Elementary school: Thai
Lower secondary level: Social Studies

Topic overview – Part B — Duration [min]

1.4: Tour around the school grounds — 30

1.5: Data evaluation — 20

1.4 Tour around the school grounds — 30 min

Contributors	Tasks/ Contents/ Activities	Tools
Teacher	**Activity:** Take a tour around the school grounds of ACT and analyze the waste fractions together with the students. **Task:** Students are asked to look into the waste containers on the school grounds and at predefined locations and record in the table on Worksheet I, see worksheets, the waste fractions they discovered or that can be seen in the containers (plastic cups, paper etc.) **Contents:** Show an example of Worksheet I. **Location** | **Waste fraction** | | | | | | • Subsequently hand out Worksheet I • Suggested route of tour: Canteen – Sports field – (possibly school garden) – Pool canteen – First aid room • Start tour	Worksheet I
Students	**Task:** Fill in Worksheet I during tour.	

1.5 Data evaluation 20 min

<table>
<tr><th>Contributors</th><th>Tasks/ Contents/ Activities</th><th>Tools</th></tr>
<tr><td>Teacher</td><td>
Task: After the tour summarize and analyze the data collected by the students on the blackboard.

Contents: Create the following empty table on the blackboard; number of columns corresponds to number of locations.
<table>
<tr><th>Location

Waste fraction</th><th>Canteen</th><th>Sports field</th><th>School garden</th><th>Pool canteen</th><th>First aid room</th></tr>
<tr><td>Example: cups</td><td>X</td><td></td><td></td><td>X</td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

Ask students one after another to fill in the results of the tour in the table on the blackboard:
Ask students to fill in the waste fraction in column one; in doing so the following waste fractions should be noticed by the students:
drink cartons, metal, glass, paper and cardboard, garden waste, food waste, “hazardous waste” such as batteries
Ask the students to mark the respective cells in the other columns
If not all waste fractions are noticed by the students, these are to add

</td><td>Blackboard</td></tr>
<tr><td>Students</td><td>Task: Fill in the data in the table created on the blackboard.</td><td></td></tr>
<tr><td>Teacher</td><td>Task: Summarize the results:
Which waste fractions accrue in the canteen etc.?</td><td></td></tr>
</table>

Module E2 – Part A: <u>What is waste?</u>

Suitable for subject area: Thai, History, English

Topic overview – Part A — Duration [min]

2.1: Historical development of wastes — 35

2.2: Definitions of waste — 15

2.1 Historical development of wastes — 35 min

Contributors	Tasks/ Contents/ Activities	Tools
Teacher	**Task:** Based on **own data** teach the students background information on the historical development of wastes in Thailand. The information can be collected from: • own literature • the ACT library • the internet, e.g. the website of DEQP: http://www.deqp.go.th/ **Contents:** The following questions are to be discussed: Since when do wastes exist, where do wastes come from, what happened to them in earlier times etc.? • Use of stories, texts, … When working on this task the students can be taught English and foreign terms on the topics of waste and recycling. • Discuss with the students parts of the table with English-Thai vocabulary on Worksheet II, see worksheets, and use them in class.	Worksheet II

2.2 Definitions of waste 15 min

Contributors	Tasks/ Contents/ Activities		Tools
Teacher	**Task:**	Question to the students: “What is the students' understanding of the term 'waste'?” Write the answers on the blackboard. **“What is waste?”** Answer 1: Answer 2: .	
Students	**Task:**	Answer the question	

Contributors	Tasks/ Contents/ Activities	Tools
Teacher	**Task:** Explain the term “waste” to the students using definitions. **Contents:** Definition 1: Perception of waste [BIDLINGMAIER] **Text:** An obvious characteristic of waste is that we only perceive it if it becomes a problem. This is the case when the amount has increased so much that the daily routine is disturbed, for example: • if BMA (Bangkok Metropolitan Administration) is on strike, • if sanitary risks occur because illegal waste dumping grounds become a breeding ground for epidemics caused by bacteria (see plague in India 1994), • if toxic wastes contaminate the ground water and thus the drinking water, making it unusable for human consumption. So waste obviously becomes a problem if it occurs in the wrong place or location. If faeces in the toilet, toxic waste in the treatment plant, the waste that is collected and delivered to an incineration plant do not pose problems of sanitation and capacity, we do not talk about them; the waste does not attract attention. Waste is matter in the wrong place. Definition 2: Subjective point of view [BIDLINGMAIER et al.] Based on the approach of a subjective or social value criterion a product does not become waste due to the possibility of disposal. Only the subjective judgment of the owner turns the product into waste if he/she declares it useless or worthless.	Transparency 2-1 Transparency 2-2

Module E2 – Part B: Composition and disposal path of waste

Suitable for subject area: Thai

Topic overview – Part B	Duration [min]
2.3: Composition of the waste at the school	25
2.4: Disposal path of the waste	25

2.3 Composition of the waste at the school 25 min

Contributors	Tasks/Contents/ Activities	Tools
Teacher	**Task:** Assuming that the students know most of the waste fractions from Module E1, present and explain the average weekly accruing waste amounts at ACT in kilograms [kg]. **Contents:** Show and explain the waste data using transparencies 3 and 4.	Transparencies 3, 4

2.4 Disposal path of the waste 25 min

Contributors	Tasks/Contents/ Activities	Tools
Teacher	**Task:** Explain the disposal path of the wastes inside and outside the school to the students. **Contents:** Waste path 1. Students, teachers, staff members dump the waste in the containers. 2. → Staff members collect the waste using a lorry. 3. → Staff members deliver the waste to the collection point next to the service department. 4. → The municipal waste collection picks up the waste and delivers it to the transfer station. 5. → Afterwards the major part of the waste is brought to a landfill.	Transparency 5

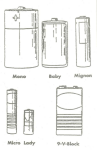
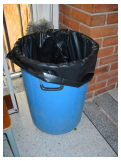
Module E3 – Parts A/B: Waste memory game

Suitable for subject area: Thai

Topic overview – Part A/B	Duration [min]
Waste memory game	2 x 50

Waste memory game **2 x 50 min**

Contributors	Tasks/ Contents/ activities	Tools
Teacher	**Task:** Play the waste memory game with the students on Worksheet III, see worksheets, [PUSCH, 2000] **Contents:** Make some preparations. • The teacher should collect some of the waste fractions depicted on the worksheet and bring them to class as demonstration materials. • The teacher can add further pictures or graphics. • Alternatively, the students can draw further pictures. • The teacher should make several copies of Worksheet III, and the students cut out the individual pictures to work with them. • The teacher explains the meaning of the individual pictures to the students. Afterwards, different game variants can be played 1. The students match the waste fractions with the respective collection containers, e.g. BII3 → A2 or Bi4 → A5. 2. The students sort the waste fractions according to the material, e.g. BII3 and BI2 or BI1 and BII4. **3.** The students can also reconstruct the disposal path by using the pictures, e.g. C1 → C2 → etc. **Further ideas should be contributed by the teachers**	

Contributors	Tasks/ Contents/ activities				Tools
		A	BI	BII	C	Worksheet III
		Collection containers	Waste fractions		Disposal paths	
	1					
	2					
	3					
	4					
	5					
	6					
	7					

Module E4 / S4– Part A: Class breakfast

Suitable for subject area: Elementary school: Thai, Scout
Lower secondary level: Scout

Topic overview – Part A — Duration [min]

4.1 Organization of a class breakfast — 50

4.1 Organization of a class breakfast — 50 min

<table>
<tr><th>Contributors</th><th>Tasks/ Contents/ Activities</th><th>Tools</th></tr>
<tr><td>Teacher</td><td>
Activity: Have a joint breakfast with the students.

Task: Teacher and students organize a joint breakfast as is already practiced in the grade levels.

Contents: Breakfast and material collection

The waste materials accruing during breakfast are collected aside on an additional table; the students are supposed to notice already now the amount of packaging.
After the breakfast the accrued packaging is jointly analyzed (e.g. according to waste fraction and amount).
The collected data is to be filled in the following table on Worksheet IV, see worksheets, by preassigned students.

<table>
<tr><th>Separation
Packaging</th><th>Paper</th><th>Plastics</th><th>...</th><th>...</th><th>...</th></tr>
<tr><td>Example: Toast</td><td></td><td>X</td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Total</td><td></td><td>1</td><td></td><td></td><td></td></tr>
</table>

Subsequently the students should discuss with the teacher how some wastes could have been avoided.
The ideas of the students should be recorded by the teacher.

</td><td>Worksheet IV</td></tr>
</table>

Students	**Task:**	Organization of the breakfast together with the teacher. • Have the class breakfast, • Analyze and sort the accruing waste, • Record the data in the table on Worksheet IV.	

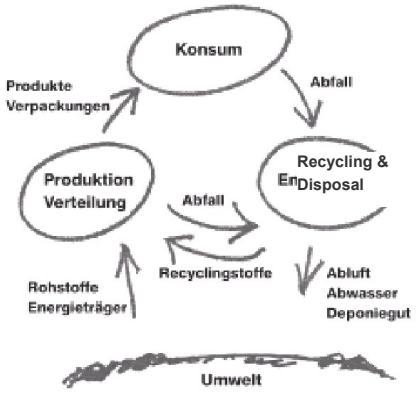
Module E4 / S4– Part B: Avoidance of Wastes

Suitable for subject area:	Elementary school:	Thai
	Lower Secondary level:	Social Studies

Topic overview – Part	Duration [min]
4.2: Avoidance of wastes	50

4.2 Avoidance of wastes 50 min

Contributors	Tasks/ Contents/ Activities	Tools

Contributors	Tasks/ Contents/ Activities	Tools
Teacher	**Task:** **W**ith the help of the illustration explain to the student that waste already accrues during the production process of goods [PUSCH, 2000 - modified]. **Contents:**  Every product has a life story. The environment (soil, water, air) is not only burdened during usage or disposal but also during the extraction of raw materials, the production of goods and the transport [PUSCH, 2000]. For example, during the production and transport of: • one A4 sheet of white paper ~ 60 W of energy are required, or • one beverage can ~ 4 hours of the energy a PC requires is used. If the sheet of paper is written on or the content of the beverage can is consumed, both turn into waste that has to be disposed of. Waste means: consumption of raw materials; consumption of energy; environmental pollution through raw material extraction, production, transport and disposal [PUSCH, 2000]. A detailed example is the “Story of a tin can”.	Transparency 6

Contributors	Tasks/ Contents/ Activities	Tools
	Text: "The story of a tin can" We are in the heartland of the South American continent and are standing on the edge of a gigantic iron ore mine. In opencast mining ferruginous rocks are extracted and loaded by huge machines, to be subsequently transported hundreds of kilometers to the iron works plants. First, the iron ore is crushed and milled, so it can be washed and separated from foreign substances. Afterwards, it is heated to 1800°C by adding coke, coal, oil and gas in a blast furnace process that requires a lot of energy. In doing so raw iron is produced, and blast furnace slag remains. In the steel works the raw iron is mixed with scrap iron and cast into big sheets. These are then rolled into thin sheet under a temperature of app. 1000°C. In order to prevent the thin sheets from corroding they first have to be tin-coated for their use in the can production. Because the tin-coated steel sheet is additionally covered with thin chromium coating the sheet acquires its characteristic bright sheen. It is also called "tin plate". The cans intended for foodstuffs have a thin lacquer coat as additional corrosion protection applied to one side of the sheet. Now the sheet is formed, punched and sealed into a can that is still open to one side. At the end of the production chain the can is filled, labeled, closed, sterilized and transported to the point of sale. We as the consumers have the opportunity to hand over the can to recycling after usage. The processes of detinning and remelting still require a high amount of energy, however, this is only half the amount required in new production. But if we dump the tin can in the residual waste container it requires unnecessarily landfill space, and all the expenses that were put into the can are thus destroyed [quoted in PUSCH, 2000].	
Students	**Task:** Explain the life cycles of products of own choice. **Contents:** The students should try to spontaneously tell the story of a selected product, e.g. paper, clothes, plastic bottle, piece of furniture etc., and describe the energy consumption and waste production.	
Teacher	**Task:** It is possible to give the task "Explain the life cycles of products of own choice" as the students' homework for the next lesson.	

Contributors	Tasks/ Contents/ Activities	Tools
Teacher	**Task:** With the help of the following graphic and text explain the basic principles and the possibilities of waste avoidance or reduction to the students. **Contents:** Waste avoidance means measures and possible courses of action that prevent the generation of wastes at the waste producer [BIDLINGMAIER et al.], because when there is no waste produced there is no waste to be disposed of. → The students should be made aware of this with the help of the following chart [LÜPKES, 1994]. **1. Avoiding waste** **2. Reutilizing waste** 3. Treating and depositing waste properly **Text:** The basic principles and possibilities of waste avoidance or reduction are [BIDLINGMAIER et al., PUSCH, 2000]: • using one's own container (backpack, …) when shopping, • buying beverages in reusable bottles, • using reusable drinking bottles instead of plastic bottles, • paying attention to quality and long service life in products, • repair options should be available, • using rechargeable batteries instead of disposable batteries, and • avoiding portion packs, • avoiding over-packaged products, • using recycled products, and using the example of the canteen [BIDLINGMAIER et al.]: • the use of reusable tableware and cutlery is recommended, • paper napkins should be made of wastepaper, and • prevention of food leftovers, thus portion size should be lean and seconds possible.	Transparency 7-1 Transparency 7-2
Teacher	**Task:** Ask the students if they know further ways of avoiding waste. Evaluate the students' answers.	
Students	**Task:** Reflect on and name further possibilities of waste avoidance.	

Module E5 – Parts A/B: Crafting lesson – Art made from waste

Suitable for subject area: Scout (Arts)

Topic overview – Part A/B	Duration [min]
Crafting lesson I – Art made from waste	2 x 50

Crafting lesson I – Art made from waste **2 x 50 min**

Contributors	Tasks/ Contents/ Activities	Tools
Teacher	**Task:** Make works of art or crafts out of waste materials together with the students. **Contents:** The students are asked to make works of art, crafts or toys etc. from reusable waste materials. Preparation: • collect reusable materials suitable for crafting and creating • teacher specifies a suitable theme	Collecting waste materials
Students	**Task:** Collect reusable materials suitable for crafting together with the teacher. Design and make works of art, crafts or toys.	

Module E6 – Part A: Fundamentals of composting

Suitable for subject area: Science

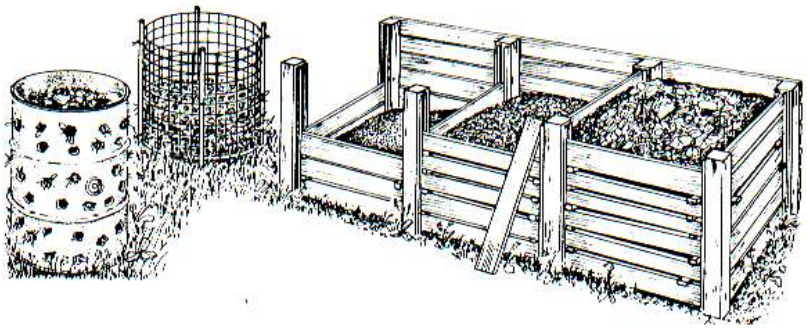
Topic overview – Part A	Duration [min]
6.1: Riddle	10
6.2: Composting – the most natural way of “recycling”	25
6.3: What is permitted on the composting heap and what is not?	15

6.1 The story of the earthworm 10 min

Contributors	Tasks/ Contents/ Activities	Tools
Teacher	Task: The following riddle is supposed to introduce the students to composting; one student reads out the riddle and the class guess the answer [DOHMANN, 1999]. **Text:** I feed on leaves, plant parts and meat. I eat my own weight in food every day. I build tunnels through the ground. My skin is slippery because it is covered with slime. My body looks like it is made of many rings. Where my mouth is my body is rounded, at the tip of my tail my body is pointed. I have bristles under my belly with which I can hold on to things. At night I come out of my tunnel and drag leaves into my dwelling. Light, especially sunlight, does not agree with me. I lay eggs (usually only one), and I am male and female at the same time. I can reach the age of about two to three years. By the way, I don't mind rain very much. I have to be cautious of birds, toads, mice and moles. I have no eyes but I can differentiate between light and dark. I can't hear anything. I am sensitive to touch. I live in the ground almost everywhere. I can crawl forward and backward. I breathe through my skin and dig over the soil all the time [DOHMANN, 1999].	
Students	**Task:** Guess the answer *Answer: the earthworm*	
Teacher	**Further ideas:** At this point the teacher can or should include further stories and the like in the lesson at his/her own discretion.	

6.2 Composting - “The most natural way of recycling” 25 min

Contributor	Tasks/ Contents/ Activities	Tools
Teacher	**Task:** The students should be taught the fundamentals of composting. **The teacher's own knowledge is also to be included.** **Contents:** **Historical facts**: Composting is the oldest form of waste utilization **F**irst records date back to the Romans app. 2000 years ago [DOHMANN, 1999] **Contents:** The cycle of nature – the perfect recycling [ZURÜCK ZUR NATUR]  1. The tree extracts nutrients from the soil for growth, fruits and leaves. 2. The leaves fall to the ground after some time. 3. The “soil specialists” turn the leaves into crumbling and nutrient-rich soil. 4. The roots absorb the nutrients, the tree grows leaves, blossoms and fruits once again [DOHMANN, 1999]. • Teacher should complement this cycle from his/her own knowledge. Composting “adopts” this cycle and proceeds as follows: • The plants absorb minerals from the soil and carbon and small amounts of nitrogen from the air. • Exposed to solar energy the plants turn these substances into	Transparency 8-1

Contributor	Tasks/ Contents/ Activities	Tools
	macromolecular organic substances. → The plants and their fruits grow. • On the compost heap these organic substances (plant debris) have to be decomposed to minerals again to be available as nutrition for other plants. • This decomposition is done by a variety of microorganisms and microbes that include bacteria, fungi, worms, mites and insects among others. • The activities of these organisms ensure the permanent disintegration of plant debris. • The more organisms are involved the faster the rotting proceeds. • Initially thermophile organisms disintegrate the plant debris. • These organisms produce heat during decomposing the substances which is why the temperature in the compost heap rises. • This heating up kills many weed seeds and germs. • The thermophile organisms are followed by the humus rotting; here fungi decompose lignin (wood substance) and cellulose. • The temperature in the compost heap decreases again. • Oxygen and a certain humidity is necessary for the organisms' activity, see composting rules. • It can take 2 to 12 months for the compost to be completed.	Transparency 8-2
	Text: Ten basic rules of composting in home composters, see figure [DOHMANN, 1999, LÜPKES et al, 1994].  Figure: Different composting containers for home composting 1. Always set up a compost heap, size h ~ 1.5 m, w ~ 2.0 m, on natural ground to attract soil biota to the compost that convert the materials. 2. Do not set up the compost heap in pits and do not close it on all sides because of lack of air → Danger of decay! 3. The compost heap should consist of a mixture of preferably varied materials, such as chopped wood, foliage, dried grass etc. 4. Before composting all coarse materials have to be comminuted. 5. The different materials have to be thoroughly mixed. 6. Pile up the lower 20 cm with coarser materials, like shrub cuttings, to achieve good ventilation. Afterwards, add the finer mate-	Transparency 9-1 Folie 9-2

Contributor	Tasks/ Contents/ Activities	Tools
	rials consisting of garden or kitchen waste in layers or mixed. 7. Cover wastes that attract animals with soil. 8. Do not let the compost heap dry out as the soil biota require humidity but do not wet excessively to avoid lack of air. The water content should be at app. 55% (in Europe). 9. Cover the finished compost with foliage, soil or straw to keep the produced heat and to protect the heap from drying out. 10. Turn the compost heap in due time (~ 6 months in Europe) to loosen up the material and mix it anew. **Contents:** Sources of information the teacher can use: • Own literature sources • ACT library • Literature of Kasetsart University (Prof. Kanoksak)	

6.3 What is permitted on the compost heap and what is not? 15 min

Contributors	Tasks/ Contents/ Activities	Tools
Teacher	**Task:** Ask the students which of the accruing wastes are permitted on the compost heap and which are not.	
Students	**Task:** The students are expected to give answers, such as catering waste, foliage etc.	
Teacher	**Task:** Explain to the students which of the accruing biological wastes are permitted on the compost heap and which are not. **The teacher's own knowledge should also be included.** **Contents:** The following materials <u>are</u> permitted on the compost heap [DOHMANN, 1999, LÜPKES et al., 1994] • kitchen wastes (dry eggshells, coffee grounds and tea leaves, fruit remains,…) • garden wastes (foliage, straw, hedge trimmings, dry lawn cuttings) • old flowers and wood ash The following materials <u>are not</u> permitted on the compost heap [DOHMANN, 1999, LÜPKES et al., 1994] a) Sick plants c) Glass, chinaware, pottery	Transparency 10

	b) Rubber, plastics d) Colored paper, catalogs, magazines	

Module E6 – Part B: Visit of the ACT composting plant

Suitable for subject area: Science, Scout

Topic overview – Part B — Duration [min]

6.4 Visit of the ACT composting plant and a game of questions — 50

6.4 Visit of the ACT composting plant and a game of questions — 50 min

<table>
<tr><th>Contributors</th><th>Tasks/ Contents/ Activities</th><th>Tools</th></tr>
<tr><td>Teacher</td><td>Activity: The teacher organizes the students' visit of the composting plant located at the service department of ACT.

Task: During the visit the teacher again gives basic instructions and information on composting to the students, see module E5 – Part A.</td><td></td></tr>
<tr><td>Teacher</td><td>Task: Worksheet V, see worksheets, is handed out to the students on which there is a game of questions on composting - “What is permitted on the compost heap?” [DOHMANN, 1999, LÜPKES et al., 1994].

Contents: The students are asked to mark in the table whether the listed material is permitted on the compost heap or not [DOHMANN, 1999, LÜPKES et al., 1994].

“What is permitted on the compost heap?”
<table><tr><th>yes</th><th>Material</th><th>no</th></tr><tr><td></td><td>Hazardous waste</td><td>X</td></tr><tr><td>X</td><td>Coffee grounds and tea leaves</td><td></td></tr><tr><td></td><td>Metal</td><td>X</td></tr><tr><td></td><td>Glass</td><td>X</td></tr><tr><td>X</td><td>Dry eggshells</td><td></td></tr><tr><td>X</td><td>Fruit remains</td><td></td></tr><tr><td></td><td>Plastics</td><td>X</td></tr><tr><td>X</td><td>Garden waste</td><td></td></tr><tr><td>X</td><td>Food and kitchen waste</td><td></td></tr></table></td><td>Worksheet V</td></tr>
</table>

		X	Foliage, straw, hedge trimmings
			Drink cartons *X*
		X	Flowers
			Colored paper, catalogs *X*
Students	**Task:** Fill in Worksheet V.		
Teacher	**Task:** Evaluate the completed Worksheet V together with the students.		

Module E7 – Part A: Basic knowledge on paper

Suitable for subject area: Thai

Topic overview – Part A	Duration [min]
7.1: Paper	10
7.2: The history of paper	25
7.3: Differences between types of paper	15

7.1 Paper 10 min

Contributors	Tasks/ Contents/ Activities	Tools
Teacher	Task: The following riddle is meant to introduce the students to the topic of paper; one student reads out the riddle and the class guess the answer [DOHMANN, 1999]. **Text:** It is a valuable material. Our daily lives are influenced strongly by it. Newspapers, books, bills, teabags, photos, identity documents, city maps and much more are made of this material. It can have a color, be rough, smooth or shiny. When touched it can rustle more or less. It is lightweight and can soak up water. Most students put down information on it on a daily basis [DOHMANN, 1999].	
Students	**Task:** Guess the answer *Answer: paper*	
Teacher	**Task:** Ask the students: “Which humans were the first to use paper?”	
Students	**Task:** Answer the question *Answer: the Egyptians*	

7.2 The history and production of paper 25 min

Contributor	Tasks/Contents/ Activities	Tools
Teacher	**Task:** Impart basic knowledge on the material of paper to the students. **The teacher's own knowledge is also to be included,** e.g. the traditional paper production in Thailand. **Text:** Historical facts: • 3000 years ago the Egyptians, Greeks and Romans produced papyrus by hammering or compacting bast fibers, from which the present term 'paper' derives. • 2000 years ago paper was also known in China where it was made of Chinese grass, flax or hemp. • Chinese minister Tsai Lun invented paper production from textile fibers in 105 AD. • In the 13th century paper production from textile fibers was brought to Europe. • In 1846 the first paper made of wood fiber was manufactured; the procedure was adopted from wasps that turn wood into a substance that is similar to paper. • Today paper is an indispensable carrier of information and communication. • This is why a huge amount is required, industrial forestry is practiced, and many forests are uprooted. **Task:** Give the students background information on the country's forest stands (Thailand), use of maps.	

7.3 Differences between types of paper 15 min

<table>
<tr><th>Contributors</th><th>Tasks/ Contents/ Activities</th><th>Tools</th></tr>
<tr><td>Teacher</td><td>
Task: Study the following different properties of paper together with the students.

Contents: Answering the questions the students should realize that there is a huge variety of different types of paper.
• every students should select a sheet of paper at will, and
• every students is given a copy of Worksheet VI, see work-sheets,
• the students study the selected sheet of paper according to the properties listed in the table on Worksheet VI.

Different properties of paper

<table>
<tr><th>Property</th><th>Answer</th></tr>
<tr><td>What is your sheet of paper called?</td><td></td></tr>
<tr><td>What color does your sheet of paper have?</td><td></td></tr>
<tr><td>What purpose does your sheet of paper serve?</td><td></td></tr>
<tr><td>Run your finger over the paper. Is the surface rough, smooth or very shiny?</td><td></td></tr>
<tr><td>Is your sheet of paper recycled paper or is it made of new fibers?</td><td></td></tr>
<tr><td>Hold your sheet of paper at one corner and shake it. Is the rustling strong, medium or weak?</td><td></td></tr>
<tr><td>Blow against the sheet of paper. Is it perme-able to air or not?</td><td></td></tr>
<tr><td>Hold your sheet of paper against the light. Is it translucent or not?</td><td></td></tr>
<tr><td>Compare your sheet of paper to other types of paper. Is your sheet thick, medium or thin?</td><td></td></tr>
<tr><td>Dip one corner of your sheet of paper into water. Does it soak up the water strongly or barely?</td><td></td></tr>
</table>
</td><td>Transparency 11 /

Worksheet VI</td></tr>
</table>

Module E7 – Part B: New and recycled paper

Suitable for subject area: Science

Topic overview – Part B	Duration [min]
7.4: The production of paper	30
7.5: Wastepaper at the school	20

7.4 The production of paper 30 min

Contributors	Task/ Contents/ Activities	Tools
Teacher	**Task:** Teach the students basic knowledge on the production of paper. **The teacher's own knowledge is also to be included.** **Text:** Production [LÜPKES et al., 1994]: • Paper consists of cellulose. • Wood consists of ~45% cellulose, ~35% lignin and ~20% hemicellulose, resins and oils. • Wood is mechanically and chemically digested, i.e. broken down into its components to extract cellulose. • The extracted cellulose is mixed with water and milled. • Filler materials such as kaolin, chalk etc. are added to improve the surface and achieve a higher degree in whiteness. • Adding glue to increase resistance. • The mixture is diluted with water (app. 220 – 500 liters per 1 kg of paper) and subsequently led through several sieves; the paper is dried between felt-covered rollers - all of this happens in big machines. • Finally the paper is cut into different sizes. • Paper is the most widely used raw material world-wide. • The wood used for papermaking in Europe predominantly comes from Russia, Scandinavia and North America. → And what about Thailand?	
Teacher	**Task:** Teach the students basic knowledge on the production of recycled paper. **Text:** Production of recycled paper • The wastepaper is digested, too; this is done through pulping and stirring.	

	• The fibers of the wastepaper should separate again; in doing so they are in part destroyed and shortened. • The paper pulp is again diluted, dried and cut. • Due to fiber shortening paper can be processed into recycled paper only 5 - 7 times.	

7.5 Wastepaper at the school 20 min

Contributors	Tasks/ Contents/ Activities	Tools
Teacher	**Task:** Introduce the students to further possible uses of wastepaper beside recycled paper. **Text:** Possible uses of wastepaper • Use of fiber properties to produce: pallets, chipboards etc. • Use of thermal properties: incineration to generate electricity • Use in composting: fertilizer and compost **Text:** According to these examples of possible uses the following types of wastepaper can be collected and utilized: • newspapers and books, • catalogs and magazines, • writing, copying and computer paper, • cardboard and packaging paper. The precondition for using wastepaper is its separate collection!	Transparency 13
Teacher	**Task:** Illustrate to the students how high paper consumption and thus the generation of wastepaper is at the school. **The teacher's own knowledge is also to be included.** **Contents:** The following amount of paper accrues at the school and is disposed of: app. 325 kg of paper per week at ACT	Transparency 14

If this paper is completely delivered to a landfill this will be:

~ 32,500 A4 sheets / week!

The landfill becomes bigger and bigger!

If the paper is collected and recycled raw materials such as wood are saved and less waste is produced!

Goal: The students should become aware of the fact that it is sensible to collect paper separately!

Module E8 / S7– Parts A/B: Manual making of recycled paper

Suitable for subject area: Elementary school: Science, Scout

Lower Secondary level: Science, Scout

Topic overview – Part A/B	Duration [min]
Guided manual papermaking	2 x 50

Guided manual papermaking **2 x 50 min**

Contributors	Tasks/ Contents/ Activities	Tools
Teacher	**Activity:** Make paper together with students. **Task:** Have the following materials ready and make the following preparations, in which the students can assist [DOHMANN, 1999, LÜPKES et al., 1994]: • materials: old newspapers, a blender, bucket, a flat water tub, deckle, smooth dish cloths, and a rolling pin, • preparation: tear the newspaper in small pieces and put into bucket, add app. 1 liter of water and let soak for at least one to two days, subsequently blend the soaked paper in the blender into a gray paper fiber pulp; build a deckle frame that fits the tub and that is covered with insect screen or a fine wire mesh; collect and lay out all materials before the lesson.	
Students and Teacher	**Task:** The students can make paper on their own by following these steps: • dilute the already soaked paper with water, • pour the water pulp into the flat tub and stir it well, • dip the deckle frame vertically in the tub, • slowly lift the deckle frame horizontally out of the tub so the screen is covered with paper pulp, • slightly shake the deckle frame and dab it from below so the water drains off and the fibers are spread evenly, • turn the deckle frame on the felt mat and loosen the paper by slight tapping [DOHMANN, 1999, LÜPKES et al., 1994].	Transparencies 15-1 15-2

Module E9 – Parts A/B: The new collection system

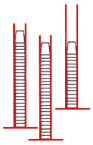
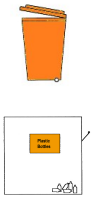
Suitable for subject area: Thai

Topic overview – Parts A/B	Duration [min]
The new collection system with the help of the waste memory game	2 x 50

The new collection system with the help of the waste memory game 2 x 50 min

<table>
<tr><th>Contributors</th><th>Tasks/ Contents/ Activities</th><th>Tools</th></tr>
<tr><td>Teacher</td><td>
Task: Play again the waste memory game on Worksheet III, see worksheets, with the students [PUSCH, 2000].

Contents: The game is supposed to make the improved or rather new collection system comprehensible to the students.
• In the previous modules the students learned that wastes that cannot be avoided can be in part recycled.
• With the help of the waste memory game the improved or rather new collection system is explained to the students.

<table>
<tr><td>Waste fraction</td><td>Plastic cups</td><td>Plastic bottles</td><td>Paper</td><td>Catering waste</td><td>Garden waste</td><td>Residual waste</td></tr>
<tr><td>Container color</td><td>Red</td><td>Orange</td><td>Blue</td><td>-</td><td>Green</td><td>Yellow</td></tr>
<tr><td>Container type</td><td>Cup collector</td><td>260-l container / Metal boxes</td><td>260-l container</td><td>Stainless steel container</td><td>260-l container</td><td>260-l container</td></tr>
<tr><td>Illustration</td><td>  </td><td>  </td><td>  </td><td>  </td><td>  </td><td>  </td></tr>
<tr><td>Purpose</td><td>Recycling</td><td>Recycling</td><td>Recycling</td><td>In part composting</td><td>Composting</td><td>Landfill</td></tr>
</table>
• The teacher should collect some of the waste fractions on Worksheet III and
</td><td>Worksheet III</td></tr>
</table>

	bring them to class as demonstration materials. • By assigning the waste fractions to the respective containers the students are expected to understand the collection system. **Further game ideas by the teacher can be incorporated.**	

Module E10 – Parts A/B: Low-waste class breakfast

Suitable for subject area: Thai

Topic overview – Parts A/B	Duration [min]
Organization of a low-waste class breakfast	2 x 50

Organization of a low-waste class breakfast **2 x 50 min**

Contributors	Tasks/ Contents/ Activities	Tools

<table>
<tr><th>Contributors</th><th>Tasks/ Contents/ Activities</th><th>Tools</th></tr>
<tr><td>Teacher</td><td>
Activity: The students have another joint class breakfast, but this time the motto is “low in waste”.

Task: Organization of the joint low-waste breakfast by teacher and students.
• Prepare the breakfast together with the students with groceries from the market, the shop or the school canteen.
• The teacher should pay attention to the fact that little waste accrues during this breakfast, i.e. that groceries are bought or tools are provided that cause less waste, e.g. in the form of packaging or disposable tableware.
• Discuss and reflect on the topics of waste generation, avoidance and reutilization during and after the breakfast, see Module E4 – Part B.

Contents: Breakfast and material collection
• Again collect the waste materials that unavoidably accrue during the breakfast aside on an extra table.
• Jointly analyze the accrued packaging after the breakfast (e.g. according to waste fraction and amount).
• Preassigned students should fill in the collected data in the following table on Worksheet IV, see worksheets.
• The improved or rather new waste separation is discussed and the individual waste fractions (e.g. paper, plastics, catering waste etc) are separated according to this waste collection system.

<table>
<tr><th>Separation / Packaging</th><th>Paper</th><th>Plastics</th><th>Catering waste</th><th>...</th><th>...</th></tr>
<tr><td>Example: Toast</td><td></td><td>X</td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Total</td><td></td><td>1</td><td></td><td></td><td></td></tr>
</table>
</td><td>Worksheet IV</td></tr>
<tr><td></td><td>
• The teacher compares waste amount and fractions with that of the class breakfast conducted in Module E4 – Part A.
• Afterwards the students should discuss together with the teacher which waste types were avoided and which of the accrued wastes could be still avoided, see Module E4 – Part B.
</td><td></td></tr>
</table>

Contributors	Tasks/ Contents/ Activities	Tools
Students	**Task:** Organization of a low-waste breakfast together with the teacher. • Have the low-waste class breakfast. • Analyze and separate the accruing waste. • Record the data in the table on Worksheet IV. • Compare the data to the breakfast of Module E4. • Reflect on the waste separation according to the improved or rather new waste collection system and think of further ways of waste avoidance.	

Additional module E1 Crafting lesson II – Music from waste

Suitable for subject area: Scout (Arts)

Topic overview – Parts A/B	Duration [min]
Crafting lesson II – Music from waste	2 x 50

Crafting Lesson II – Music from waste **2 x 50 min**

Contributors	Tasks/ Contents/ Activities	Tools
Teacher	**Task:** Make musical instruments out of waste materials together with the students. **Contents:** The students should make simple musical instruments out of reusable waste materials • Collect reusable materials. • Make instruments.	Collecting waste materials
Students	**Task:** Collect reusable materials suitable for crafting together with the teacher. Design and make the instruments.	

Module S2 – Part A: What is waste?

Suitable for subject area: Social Studies, History, English

Topic overview – Part A	Duration [min]
2.1: Historical development of wastes	35
2.2: Definitions of waste	15

2.1 Historical development of wastes 35 min

Contributors	Tasks/ Contents/ Activities	Tools
Teacher	**Task:** Based on the teacher's data, background information on the historical development of wastes in Thailand and possibly other countries is imparted. Information can be collected from: • own literature, • ACT library, • from the internet, e.g. the DEQP website: http://www.deqp.go.th/ **Contents:** Regarding this topic the following questions are to be discussed: Since when do wastes exist, where do they come from, what happened with them in earlier times etc.? • Use of stories, texts, … When working on this task the students can be taught English and foreign terms of the topics of waste and recycling. • Discuss with the students parts of the table with English-Thai vocabulary on Worksheet II, see worksheets, and use them in class.	Worksheet II

2.2 Definitions of waste 15 min

Contributors	Tasks/ Contents/ Activities	Tools
Teacher	**Task:** Question to the students: “What is the students' understanding of the term 'waste'?”	

Contributors	Tasks/ Contents/ Activities	Tools
	Write the answers on the blackboard. **"What is waste?"** Answer 1: Answer 2:	
Students	**Task:** Answer the question.	
Teacher	**Task:** Explain the term "waste" to the students with the help of definitions. **Contents:** Definition 1: Perception of waste [BIDLINGMAIER] **Text:** An obvious characteristic of waste is that we only perceive it if it becomes a problem. This is the case when the amount has increased so much that the daily routine is disturbed, for example: • if BMA (Bangkok Metropolitan Administration) is on strike, • if sanitary risks occur because illegal waste dumping grounds become a breeding ground for epidemics caused by bacteria (see plague in India 1994), • if toxic wastes contaminate the ground water and thus the drinking water, making it unusable for human consumption. So waste obviously becomes a problem if it occurs in the wrong place or location. If faeces in the toilet, toxic waste in the treatment plant, the waste that is collected and delivered to an incineration plant do not pose problems of sanitation and capacity, we do not talk about it; the waste does not attract attention. Waste is matter in the wrong place. Definition 2: Subjective point of view [BIDLINGMAIER et al.] Based on the approach of a subjective or social value criterion a product does not become waste due to the possibility of disposal. Only the subjective judgment of the owner turns the product into waste if he/she declares it useless or worthless.	Transparency 2-1 Transparency 2-2

Module S2 – Part B: What does waste consist of?

Suitable for subject area: Social Studies

Topic overview – Part B — Duration [min]

- 2.3: Waste fractions and associated raw materials — 15
- 2.4: Stories about the topic — 35

2.3 Waste fractions and associated raw materials — 15 min

<table>
<tr><th>Contributors</th><th>Tasks/ Contents/ Activities</th><th>Tools</th></tr>
<tr><td>Teacher</td><td>Task: The students should list the waste fractions and name the associated raw materials.

Contents: Create the following table for this task.

<table>
<tr><th>Waste fraction</th><th>Raw material</th></tr>
<tr><td>Example: Paper</td><td>Wood</td></tr>
<tr><td>Plastics, synthetics</td><td>Natural oil</td></tr>
<tr><td>Glass</td><td>Sand</td></tr>
<tr><td>Metal</td><td>Ores</td></tr>
<tr><td></td><td></td></tr>
</table>
1) Ask the students to fill in the waste fractions known from Module S1 in the table.
2) Subsequently ask the students to name and fill in the associated raw materials.</td><td>Blackboard</td></tr>
<tr><td>Students</td><td>Task: Fill in the waste fractions and associated raw materials in the table on the blackboard.</td><td>Blackboard</td></tr>
<tr><td>Teacher</td><td>Task: Teach the students background knowledge on the raw materials listed in the table, e.g. in the subject Geography from subject area Social Studies, see chapter 3, section 3.2.2.</td><td></td></tr>
</table>

2.4 Stories about the topic 10 min

Contributors	Tasks/ Contents/ Activities	Tools
Teacher	**Task:** Ask a student to read out the narrative “The story of a tin can” [PUSCH, 2000] and afterwards discuss it with the students. **Text:** We are in the heartland of the *South American continent* and are standing on the edge of a gigantic *iron ore mine*. In *opencast mining* ferruginous rocks are extracted and loaded by huge machines, to be subsequently transported hundreds of kilometers to the iron works plants. First, the iron ore is crushed and milled, so it can be washed and separated from foreign substances. Afterwards, it is heated to 1800°C by adding coke, coal, oil and gas in a blast furnace process that requires a lot of energy. In doing so raw iron is produced, and blast furnace slag remains. In the steel works the raw iron is mixed with scrap iron and cast into big sheets. These are then rolled into thin sheet under a temperature of app. 1000°C. In order to prevent the thin sheets from corroding they first have to be tin-coated for their use in the can production. Because the tin-coated steel sheet is additionally covered with thin chromium coating the sheet acquires its characteristic bright sheen. It is also called “tin plate”. The cans intended for foodstuffs have a thin lacquer coat as additional corrosion protection applied to one side of the sheet. Now the sheet is formed, punched and sealed into a can that is still open to one side. At the end of the production chain the can is filled, labeled, closed, sterilized and transported to the point of sale. We as the consumers have the opportunity to hand over the can to recycling after usage. The processes of detinning and remelting still require a high amount of energy, however, this is only half the amount required in new. But if we dump the tin can in the residual waste container it requires unnecessarily landfill space, and all the expenses that were put into the can are thus destroyed [quoted in PUSCH, 2000].	
Students	**Task:** Listen and afterwards discuss the text and answer the following questions. **Contents**: 1. “In which stages is energy required?” The underlined passages in the text form the answers. 2. “In which stage is the *environment* burdened?” Here, the passages in italics are possible answers.	
Teacher	**Task:** Ask the questions 1 and 2 and collect answers from the students. **Contents**: The students should understand in which process steps energy is required and the environment is burdened.	

Module S3 – Part A: Waste composition and disposal

Suitable for subject area: Mathematics

Topic overview – Part A	Duration [min]
3.1: Composition of the waste at the school	40
3.2: Disposal path of the waste	10

3.1 Composition of the waste at the school 40 min

Contributors	Tasks/ Contents/ Activities	Tools

Contributors	Tasks/ Contents/ Activities	Tools
Teacher	**Task:** Assuming that the students know most of the waste fractions presented in Module E1/S1, Worksheet III, see worksheets, is handed out that shows the average weekly accruing waste amounts in kilograms [kg]. **Contents:** Present the data by means of Transparency 3-2.	Transparency 3-2 Worksheet III

Waste fraction	**amount [kg/week]**	**Proportion [%]**
Hazardous waste	20.46	
Drink cartons	35.51	
Metal	41.95	
Glass	131.18	
Paper, cardboard	326.85	
Fat	304.35	
Material < 40 mm	535.55	
Residual waste	831.05	
Plastics	1,109.12	
Garden waste	1,146.30	
Catering waste/ kitchen waste	1,806.85	
Total	6,289.17	

- The waste fractions of fat, material < 40 mm, and residual waste are new to the students at this point and have to be explained:
  - Fat: Fat residuals accruing in the kitchen during cooking
  - Material < 40 mm: Part of waste that is not analyzed in the waste analysis and mainly consists of organic waste and residual waste
  - Residual waste: Wastes that cannot be reutilized or recycled

Task: The students should calculate the mass distribution in percentages of the individual waste fractions, represent this distribution in different types of diagrams and present these diagrams on the blackboard.

Contributors	Tasks/ Contents/ Activities	Tools
Students	**Task:** Solve the calculation and present the results. • Calculate the percentage portions • Present the results in diagrams on the blackboard	
Teacher	**Task:** Present own results.	Transparency 4
Teacher	**Task:** Further possible arithmetic problems **at the teacher's discretion:** • Calculation of the waste amount per capita and day at ACT • Calculation of the annually accruing waste (based on 40 weeks of school)	

3.2 Disposal path of the waste 10 min

Contributors	Tasks/ Contents/ Activities	Tools
Teacher	**Task:** Explain the disposal path of the wastes inside and outside the school to the students. **Contents:** Waste path 1. Students, teachers, staff members dump the waste in the containers. 2. → Staff members collect the waste using a lorry. 3. → Staff members deliver the waste to the collection point next to the service department. 4. → The municipal waste collection picks up the waste and delivers it to the transfer station. 5. → Afterwards the major part of the waste is brought to a landfill.	Transparency 5

Module S3 – Part B: The waste collection system at ACT

Suitable for subject area: Social Studies

Topic overview – Part B — Duration [min]

- 3.3: Tour around the school grounds — 30
- 3.4: Worksheet evaluation — 20

3.3 Tour around the school grounds — 30 min

<table>
<tr><th>Contributors</th><th>Tasks/ Contents/ Activities</th><th>Tools</th></tr>
<tr><td>Teacher</td><td>Activity: Make a tour around the school grounds of ACT together with the students and analyze the current collection system.

Task: The students should explore which waste fractions (plastic cups, paper etc.) can be seen in which container and fill in the table on Worksheet III, see worksheets.

Contents: Show examples of Worksheet III.

<table><tr><th>Waste fraction</th><th>Container color/ type</th></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr></table>
• Subsequently hand out Worksheet III
• Suggested route of tour:
Canteen – Sports field – (possibly school garden) – Pool canteen – First aid room
• Start tour</td><td>Worksheet III</td></tr>
<tr><td>Students</td><td>Task: Fill in Worksheet III during the tour.</td><td></td></tr>
</table>

3.4 Worksheet evaluation 20 min

<table>
<tr><th>Contributors</th><th>Tasks/ Contents/ Activities</th><th>Tools</th></tr>
<tr><td>Teacher</td><td>Task: After the tour evaluate the data collected by the students on the blackboard.

Contents: Create the following empty table on the blackboard; number of columns equals number of containers.

<table>
<tr><th>Container
Waste fraction</th><th>yellow</th><th>green</th><th>blue</th><th>red</th><th>orange</th></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

• Ask the students one after another to fill in the results of the tour in the table on the blackboard:
• Ask students to fill in the waste fractions in column one; in doing so the following waste fractions should be noticed by the students:
hazardous waste, drink cartons, metal, glass, paper and cardboard, plastics, garden waste, catering waste
• Ask the students to mark the respective cells in the other columns.</td><td>Blackboard</td></tr>
<tr><td>Students</td><td>Task: Fill in the data in the table created on the blackboard.</td><td></td></tr>
<tr><td>Teacher</td><td>Task: Interpret the results together with the students under the following aspects:

3) Which waste fractions are collected in containers of which color?
4) Are the individual waste fractions (paper, plastics etc.) collected separately or are they distributed among all containers?
5) Can we refer to the current system as a separate waste collection or not?</td><td></td></tr>
</table>

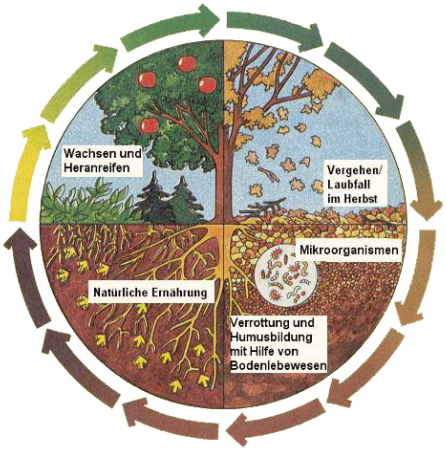
Module S5 – Part A: Fundamentals of composting

Suitable for subject area: Science

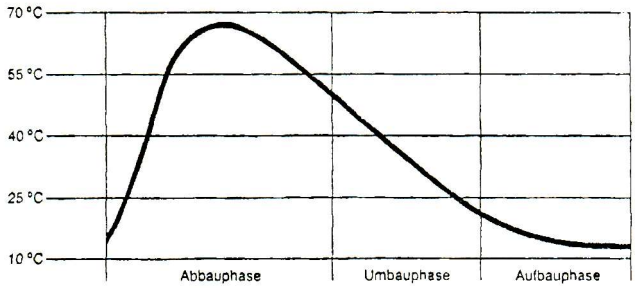
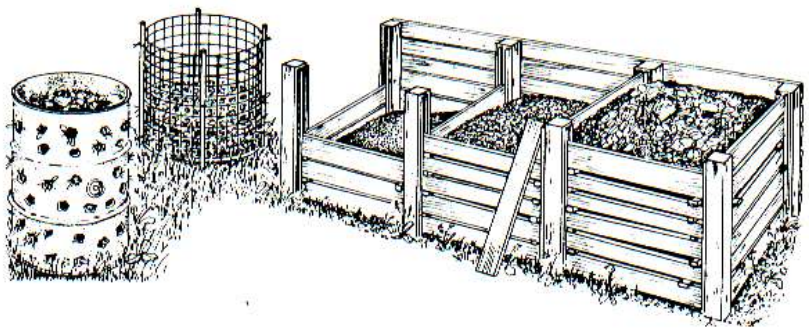
Topic overview – Part A	Duration [min]
5.1: Composting – the most natural way of “recycling”	10
5.2: What is permitted on the compost heap and what is not?	10

5.1 Composting – the most natural way of “recycling” 40 min

Contributors	Tasks/ Contents/ Activities	Tools

Contributors	Tasks/ Contents/ Activities	Tools
Teacher	**Task:** Introduce the students to composting with the help of the natural cycle of rotting. **The teacher's own knowledge is also to be included.** **Contents:** **Historical facts**: Composting is the oldest form of reutilizing waste First records date back to the Romans app. 2000 years ago [DOHMANN, 1999] Composting • Uses the natural process of decomposition (rotting) to produce valuable humus purposefully and fast. • The produced humus has a soil-improving and fertilizing effect. **Contents:** The cycle of nature – the perfect recycling [www - 13]  1. The tree extracts nutrients from the soil for growth, fruits and leaves. 2. The leaves fall to the ground after some time. 3. The “soil specialists” turn the leaves into crumbling and nutrient-rich soil. 4. The roots absorb the nutrients, the tree grows leaves, blossoms and fruits once again [DOHMANN, 1999].	Transparency 8-3

Contributors	Tasks/ Contents/ Activities	Tools
Teacher	**Task:** Teach the students the backgrounds of composting. **Contents:** Backgrounds of composting – nutrients and savings in landfill space • When growing plants extract nutrients from the soil. • When used by the plants and their fruits nutrients are extracted from the soil as food. • The plant debris is mostly delivered to a landfill, and the soil has to be provided with nutrients artificially through fertilizers. • If the plant debris is composted it can partially return the nutrients to the soil as compost. • Composting not only r**eturns valuable nutrients to the soil but also saves landfill space.**	
Teacher	**Task:** The technical fundamentals of composting should be imparted to the students. **Contents:** Functioning of the composting process • Nutrients (minerals) exist in the plants in the form of macromolecular organic substances. • These macromolecular organic substances have to be decomposed again into minerals on the compost heap. • This decomposition is called reduction and is done by microorganisms and microbes. • During composting these microorganisms require oxygen to be able to decompose the plant debris into humus. • If no oxygen is available rotting sets in, which generates poisonous products that are undesirable in composting.	

Contributors	Tasks/ Contents/ Activities	Tools
	 • This curve is divided into three phases, the decomposition phase, the conversion phase and the building phase. • The duration of composting can be 2 to 12 months. • Humidity is also important for the organisms. • If the compost is too dry the organisms stop their activities. • If the compost is too moist the pores are clogged with water and the organisms have no oxygen anymore for breathing. • The optimal moisture content is at ~55 %. **Contents:** Compost • After the completion of the composting process the finished compost is available; it is called mature compost. • The compost has a dark-brown to black color. • Now it can be spread on the soil for fertilizing and returns the nutrients to the soil.	
Teacher	**Task:** Afterwards the students are introduced to the containers of home composting and taught about the basic rules of composting. **Contents:** **C**omposting containers for home composting • In these containers compost can be produced, see figure.  Figure: Different composting containers for home composting	Transparency 9-1

Contributors	Tasks/ Contents/ Activities	Tools
	Text: Ten basic rules of home composting [DOHMANN, 1999, LÜPKES et al., 1994] 1. Always set up a compost heap, size h ~ 1.5 m, w ~ 2.0 m, on natural ground to attract soil biota to the compost that convert the materials. 2. Do not set up the compost heap in pits and do not close it on all sides because of lack of air → danger of decay! 3. The compost heap should consist of a mixture of preferably varied materials, such as chopped wood, foliage, dried grass etc. 4. Before composting all coarse materials have to be comminuted. 5. The different materials have to be thoroughly mixed. 6. Pile up the lower 20 cm with coarser materials, like shrub cuttings, to achieve good ventilation. Afterwards, add the finer materials consisting of garden or kitchen waste in layers or mixed. 7. Cover wastes that attract animals with soil. 8. Do not let the compost heap dry out as the soil biota require humidity but do not wet excessively to avoid lack of air. The water content should be at app. 55% (in Europe). 9. Cover the finished compost with foliage, soil or straw to keep the produced heat and to protect the heap from drying out. 10. Turn the compost heap in due time (~ 6 months in Europe) to loosen up the material and mix it anew. **Contents:** Sources of information the teacher can use: • own literature sources • ACT library • literature of Kasetsart University (Prof. Kanoksak)	Transparency 9-2

5.2 What is permitted on the compost heap and what is not? 15 min

Contributors	Tasks/ Contents/ Activities	Tools
Teacher	**Task:** Ask the students which of the accruing biological wastes are permitted on the compost heap and which are not.	
Students	**Task:** The students are expected to give answers, such as catering waste, foliage etc.	
Teacher	**Task:** Explain to the students which of the accruing biological wastes are permitted on the compost heap and which are not. **The teacher's own knowledge should also be included.** **Contents:** The following materials <u>are</u> permitted on the compost heap [DOHMANN, 1999, LÜPKES et al., 1994] • kitchen wastes (dry eggshells, coffee grounds and tea leaves, fruit remains, …) • garden wastes (foliage, straw, hedge trimmings, dry lawn cuttings) • old flowers and wood ash The following materials <u>are not</u> permitted on the compost heap [DOHMANN, 1999, LÜPKES et al., 1994] e) Sick plants f) Rubber, plastics g) Glass, chinaware, pottery h) Colored paper, catalogs, magazines	Transparency 10

Module S5 – Part B: Visit of the ACT composting plant

Suitable for subject area: Science, Scout

Topic overview – Part B — Duration [min]

5.3 Visit of the ACT composting plant and a game of questions — 50

5.3 Visit of the ACT composting plant and a game of questions — 50 min

Contributors	Tasks/ Contents/ Activities	Tools
Teacher	**Activity:** Organization of the students' visit of the composting located at the service department of ACT. **Task:** During the visit the teacher again gives basic instructions and information on composting to the students, see module S5 – Part A.	
Teacher	**Task:** **D**uring the visit the students should measure the temperature inside the compost heaps with the help of a thermometer. **Contents:** Determine the temperature and interpret the results. • Where is the temperature taken – inside • During which phase is the composting process – initial phase, conversion phase, building phase	Thermo-meter
Students	**Task:** Measure the temperature inside the compost heap and evaluate the results together with the teacher.	

<table>
<tr><th>Contributors</th><th>Tasks/ Contents/ Activities</th><th>Tools</th></tr>
<tr><td>Teacher</td><td>Task: Worksheet V, see worksheets, is handed out to the students on which there is a game of questions on composting - “What is permitted on the compost heap?” [DOHMANN, 1999, LÜPKES et al., 1994].

Contents: The students are asked to mark in the table whether the listed material is permitted on the compost heap or not [DOHMANN, 1999, LÜPKES et al., 1994].

<table>
<tr><th colspan="3">Suitable for composting</th></tr>
<tr><th>yes</th><th>Material</th><th>no</th></tr>
<tr><td></td><td>Hazardous waste</td><td>X</td></tr>
<tr><td>X</td><td>Coffee grounds and tea leaves</td><td></td></tr>
<tr><td></td><td>Metal</td><td>X</td></tr>
<tr><td></td><td>Glass</td><td>X</td></tr>
<tr><td>X</td><td>Dry eggshells</td><td></td></tr>
<tr><td>X</td><td>Fruit remains</td><td></td></tr>
<tr><td></td><td>Plastics</td><td>X</td></tr>
<tr><td>X</td><td>Garden waste</td><td></td></tr>
<tr><td>X</td><td>Food and kitchen waste</td><td></td></tr>
<tr><td>X</td><td>Foliage, straw, hedge trimmings</td><td></td></tr>
<tr><td></td><td>Drink cartons</td><td>X</td></tr>
<tr><td>X</td><td>Flowers</td><td></td></tr>
<tr><td></td><td>Colored paper, catalogs</td><td>X</td></tr>
</table></td><td>Worksheet V</td></tr>
<tr><td>Students</td><td>Task: Fill in Worksheet V.</td><td></td></tr>
<tr><td>Teacher</td><td>Task: Evaluate the question sheet together with the students.</td><td></td></tr>
</table>

Module S6 – Part A: Basic knowledge on paper

Suitable for subject area: Science

Topic overview – Part A Duration [min]

6.1:	Paper	10
6.2:	The history of paper	25
6.3:	Differences between types of paper	15

6.1 Paper 10 min

Contributors	Tasks/ Contents/ Activities	Tools
Teacher	**Task:** The following riddle is meant to introduce the students to the topic of the material of paper; one student reads out the riddle and the class guess the answer [DOHMANN, 1999]. **Text:** It is a valuable material. Our daily lives are influenced strongly by it. Newspapers, books, bills, teabags, photos, identity documents, city maps and much more are made of this material. It can have a color, be rough, smooth or shiny. When touched it can rustle more or less. It is lightweight and can soak up water. Most students put down information on it on a daily basis [DOHMANN, 1999].	
Students	**Task :** Guess the answer *Answer: paper*	
Teacher	**Task:** Ask the students: “Which humans were the first to use paper?”	
Students	**Task:** Answer the question *Answer: the Egyptians*	
Teacher	**Further variants:** Here the teacher can include other or further stories etc. in the lesson **at his/her own discretion.**	

6.2 The history and production of paper 25 min

Contributors	Tasks/Contents/ Activities	Tools
Teacher	**Task:** Impart basic knowledge on the material of paper to the students. **The teacher's own knowledge is also to be included.**	
	Text: Historical facts: • 3000 years ago the Egyptians, Greeks and Romans produced papyrus by hammering or compacting bast fibers, from which the present term 'paper' derives. • 2000 years ago paper was also known in China where it was made of Chinese grass, flax or hemp. • Chinese minister Tsai Lun invented paper production from textile fibers in 105 AD. • In the 13th century paper production from textile fibers was brought to Europe. • In 1846 the first paper made of wood fiber was manufactured, the procedure was adopted from wasps that turn wood into a substance that is similar to paper. • Today paper is an indispensable carrier of information and communication. • This is why a huge amount is required, industrial forestry is practiced, and many forests are uprooted. **Task:** Give the students background information on the country's forest stands (Thailand), use of maps.	

6.3 Differences between types of paper 15 min

<table>
<tr><th>Contributors</th><th>Tasks/ Contents/ Activities</th><th>Tools</th></tr>
<tr><td>Teacher</td><td>
Task: Study the following different properties of paper together with the students.

Contents: Answering the questions the students should realize that there is a huge variety of different types of paper.
• Every students should select a sheet of paper at will, and
• Every students is given a copy of Worksheet VI, see worksheets,
• The students study the selected sheet of paper according to the properties listed in the table on Worksheet V.

Different properties of paper

<table>
<tr><th>Property</th><th>Answer</th></tr>
<tr><td>What is your sheet of paper called?</td><td></td></tr>
<tr><td>What color does your sheet of paper have?</td><td></td></tr>
<tr><td>What purpose does your sheet of paper serve?</td><td></td></tr>
<tr><td>Run your finger over the paper. Is the surface rough, smooth or very shiny?</td><td></td></tr>
<tr><td>Is your sheet of paper recycled paper or is it made of new fibers?</td><td></td></tr>
<tr><td>Hold your sheet of paper at one corner and shake it. Is the rustling strong, medium or weak?</td><td></td></tr>
<tr><td>Blow against the sheet of paper. Is it permeable to air or not?</td><td></td></tr>
<tr><td>Hold your sheet of paper against the light. Is it translucent or not?</td><td></td></tr>
<tr><td>Compare your sheet of paper to other types of paper. Is your sheet thick, medium or thin?</td><td></td></tr>
<tr><td>Dip one corner of your sheet of paper into water. Does it soak up the water strongly or barely?</td><td></td></tr>
</table>
</td><td>Transparency 11 /

Worksheet VI</td></tr>
<tr><td>Students</td><td>Task: Every student selects on sheet of paper - if possible there should be a variety of different types - and studies the listed properties</td><td></td></tr>
</table>

	and records them in the table on Worksheet E6.	

Module S6 – Part B: New and recycled paper

Suitable for subject area: Science

Topic overview – Part B	Duration [min]
6.4: The production of paper	15
6.5: Comparison of the production of new/recycled paper	25
6.6: Insights and paper accrual at the school	10

6.4 The production of paper 15 min

Contributors	Tasks/ contents/ Activities	Tools
Teacher	**Task:** Teach the students basic knowledge on the production of paper. **The teacher's own knowledge is also to be included.** **Text:** Production [LÜPKES et al., 1994]: • Paper consists of cellulose. • Wood consists of ~45% cellulose, ~35% lignin and ~20% hemicellulose, resins and oils. • Wood is mechanically and chemically digested, i.e. broken down into its components to extract cellulose. • The extracted cellulose is mixed with water and milled. • Filler materials such as kaolin, chalk etc. are added to improve the surface and achieve a higher degree in whiteness. • Adding glue to increase resistance. • The mixture is diluted with water (app. 220 – 500 liters per 1 kg of paper) and subsequently led through several sieves; the paper is dried between felt-covered rollers - all of this happens in big machines. • Finally the paper is cut into different sizes. • Paper is the most widely used raw material world-wide. • The wood used for papermaking in Europe predominantly comes from Russia, Scandinavia and North America. → And what about Thailand?	

6.5 Comparison of the production of new/ recycled paper 25 min

<table>
<tr><th>Contributors</th><th>Tasks/ Contents/ Activities</th><th>Tools</th></tr>
<tr><td>Teacher</td><td>
Task: The students should become aware of the differences in raw material amount and energy required in the production of new and recycled paper based on the following overview.

The teacher's own knowledge is also to be included.

Contents: Comparison of raw material and energy consumption in the production of new and recycled paper.

<table>
<tr><th colspan="4">Raw material demand for:</th></tr>
<tr><th colspan="2">1 kg of new paper</th><th colspan="2">1 kg of recycled paper</th></tr>
<tr><td>2.3 kg wood</td><td>(image)</td><td>1.1 kg waste paper</td><td>(image)</td></tr>
<tr><td>220 l water</td><td>(image)</td><td>20 l water</td><td>(image)</td></tr>
<tr><td>7.4 kWh electricity</td><td>(image)</td><td>0.8 kWh electricity</td><td>(image)</td></tr>
</table>

Paper can be recycled app. 5 – 7 times, after that the paper fibers have become too short to produce recycled paper.
But there are other reutilization possibilities for wastepaper.

</td><td>Transparency 12</td></tr>
<tr><td>Teacher</td><td>
Task: Introduce the students to further possible uses of wastepaper beside recycled paper.

Text: Further reutilization possibilities for waste paper:

Use of fiber properties to produce:
pallets, chipboards etc.
Use of thermal properties:
incineration to generate electricity
Use of biological decomposition in composting
fertilizer and compost

</td><td>Transparency 13</td></tr>
</table>

6.6 Paper accrual at the school 10 min

<table>
<tr><th>Contributors</th><th>Tasks/ Contents/ Activities</th><th>Tools</th></tr>
<tr><td>Teacher</td><td>
Task: Explain to the students which paper type can be used for the possibilities listed in section 6.5 and illustrate the extent of the waste paper production at the school.

Text: According to examples of possible uses mentioned above the following types of wastepaper can be collected and utilized:
• newspapers and books,
• catalogs and magazines,
• writing, copying and computer paper,
• cardboard and packaging paper.

The precondition for using wastepaper is its separate collection!

Contents: The following amount of paper accrues at the school and is disposed of:

app. 325 kg of paper per week at ACT


If this paper is completely delivered to a landfill this will be:
~ 32,500 A4 sheets / week!

The landfill becomes bigger and bigger!

If the paper is collected and recycled raw materials such as wood are saved and less waste is produced!

Goal: The students should become aware of the fact that it is sensible to collect paper separately!
</td><td>Transparency 13

Transparency 14</td></tr>
</table>

Module S8 – Part A: Background knowledge on plastics

Suitable for subject area: Science

Topic overview – Part A	Duration [min]
8.1: Repetition of reutilization possibilities of food and garden wastes	10
8.2: Background knowledge on plastics	40

8.1 Repetition of reutilization possibilities of food and garden wastes 10 min

Contributors	Tasks/ Contents/ Activities	Tools
Teacher	**Task:** **L**ist again briefly the reutilization possibilities of garden and food wastes as materials for composting. **Contents:** The following food and garden wastes are permitted on the compost heap [DOHMANN, 1999, LÜPKES et al., 1994]: • food wastes (dry eggshells, coffee grounds and tea leaves, fruit remains…) • garden wastes (foliage, straw, hedge trimmings, dry lawn cuttings) • old flowers and wood ash	Transparency 10

8.2 Background knowledge on plastics 40 min

Contributors	Contents/ Texts/ Activities	Tools

<table>
<tr><th>Contributors</th><th>Contents/ Texts/ Activities</th><th>Tools</th></tr>
<tr><td>Teacher</td><td>Task: Explain to the students that there are also reutilization possibilities for plastics beside those for food and garden wastes.

Contents: To create a personal connection the students should collect in a table where synthetics and plastics are found in their daily life [PUSCH, 2000].
• Create the following empty table on the blackboard; number of columns equals number of location.

<table>
<tr><th>At home</th><th>Stores</th><th>Classroom</th><th>Canteen</th><th>Other locations</th></tr>
<tr><td></td><td>e.g. plastic bags</td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
</table>

• Ask the students one after the other to fill in ideas in the table on the blackboard.</td><td></td></tr>
<tr><td>Students</td><td>Task: Fill in ideas in the created table.</td><td></td></tr>
<tr><td>Teacher</td><td>Task: Interpret and summarize the contents.</td><td></td></tr>
</table>

Contributors	Contents/ Texts/ Activities	Tools
Teacher	**Task:** Teach the students background knowledge on source materials, production and properties of plastics. **A chemistry teacher should assist in the explanations about the production of plastics.** **Text:** Source materials for synthetics and plastics [LÜPKES et al., 1994]: • Plastics are materials that consist of macromolecular organic compositions. • Source materials are: a) natural products like natural rubber, and b) primary raw materials, like natural oil, natural gas or coal. • The major part of plastics is produced from primary raw materials *Production of plastics* • Production is done through polymerization, polycondensation and polyaddition. • Macromolecules are produced from individual molecules, i.e. individual molecules are combined to form molecule chains (polymers). *Properties of plastics* • The properties depend on the structure and the degree of cross-linking of the macromolecules. • Three main groups of plastics are distinguished, namely thermoplastics, duroplastics and elastomers. • *Thermoplastics* can be glass-like, transparent and relatively soft or opaque, brittle and heat-resistant up to a certain temperature, which is dependent from the different molecular structures (completely disordered or in parts parallel) of the monomers under high temperatures. Thermoplastics can be repeatedly deformed and constitute app. 90% of the plastics in households. • *Duroplastics* consist of a three-dimensional, close-meshed net and cannot be softened due to the chemical bond but start to decompose at a certain temperature. • *Elastomers* are built of wide-meshed, cross-linked polymers, stretchable and soft and elastic under room temperature, e.g. rubber, car tires. • Examples of *shared properties* are: low density of 0,84 – 2,2 g/cm³ inexpensive production insulating effect due to low electric conductivity high durability against rotting → no composting The overview in the table on Transparency 16 shows the abbreviations, chemical formulas and the area of application of various plastics.	

Module S8 – Part B: Recycling of plastics

Suitable for subject area: Science

Topic overview – Part B	Duration [min]
8.3: Recycling of plastics	25
8.4: Small experiment	25

8.3 Recycling of plastics 25 min

Contributors	Tasks/ Contents/ Activities	Tools
Teacher	**Task:** Explain possibilities of recycling plastics but also associated problems to the students. **Contents:** Problems in the recycling of plastics [LÜPKES et al., 1994] • Basic problems are contaminations, such as labels, metal closures and remains of contents. • A further problem is the separation of different types of plastics according to their properties. • **BUT** at least plastic cups and bottles at ACT can be collected unmixed with other types of plastics and only slightly contaminated with food residuals!	Transparency 17

Mixed and contaminated plastic wastes	unmixed plastic bottles	unmixed, slightly contaminated plastic cups
		

Separation methods

- The most often employed method is the separation of plastics according to their density.
- Two methods are distinguished for this purpose: the sink-float method, that uses a parting liquid, and the separation by means of a hydrocyclone.
- Common household plastics have a density between 0.98 g/cm^3 and 1.07 g/cm^3

<table>
<tr><th>Contributors</th><th>Tasks/ Contents/ Activities</th><th>Tools</th></tr>
<tr><td></td><td>

These differences in the density of plastics is used in the sink-float method; a parting liquid is adjusted to a respective density between 0.98 g/cm^3 and 1.07 g/cm^3
The heavy plastics sink to the bottom and the light plastics float on top.
The hydrocyclone separates by means of a vertical air current.
The lighter plastics are transported upwards with the air current and the heavier plastics sink downwards.
The weaker the air current the lower the density of the upwards transported plastics.

Recycling

The recycling is subdivided into the recycling of basic and raw materials and the incineration of plastics.

<table>
<tr><th>Basic material recycling</th><th>Raw material recycling</th><th>Incineration of plastics</th></tr>
<tr><td>Description:

• Thermoplastics can be reutilized (reshaped) into other products through melting
• The melting is done at 150 and 230 °C</td><td>Description:

• Polymeric basic materials are decomposed into low-molecular raw materials, i.e. long-chained plastics are separated into short-chained starting materials
• The chemical conversion closes the cycle of raw material – plastics – raw material</td><td>Description:

• The plastics are incinerated in incineration plants and used for the generation of energy</td></tr>
<tr><td>Advantages:

• Well applicable in facilities that process plastics as the wastes are unmixed</td><td>Advantages:

• No sorting and cleaning necessary
• Production of high-quality plastics</td><td>Advantages:

• Plastics have a high heating value</td></tr>
<tr><td>Disadvantages:

• Sorting and cleaning necessary in case of mixed wastes
• Material deterioration occurs, therefore endless recycling is not possible
• Production of goods</td><td>Disadvantages:

• High expenses of energy and machines are necessary that can seldom be justified
• Not all plastics can be recycled using this method</td><td>Disadvantages:

• Only advantageous if separation and sorting of plastic wastes require energy-intensive methods
• During incineration pollutants are discharged that are collect-</td></tr>
</table>
</td><td>Transparencies
18-1
18-2
18-3</td></tr>
</table>

Contributors	Tasks/ Contents/ Activities			Tools
	of inferior quality that are eventually landfilled • Recycling into products of superior quality is currently not economic		ed in filters but have to be landfilled	
	Goals: However, the students **have to become aware** of the fact that recycling is no universal remedy for the waste problem as environmental burdens are generated here as well, like further energy consumption and discharge of pollutants, see Module S4 Avoidance [LÜPKES et al., 1994].			

8.4 Small experiment 25 min

Contributors	Tasks/ Contents/ Activities	Tools
Teacher	**Task:** By means of a small experiment, see Worksheet VII, the students should solidify and expand their knowledge on plastics. **Contents:** Experiment – Flotation test (Sink-float method) [LÜPKES et al., 1994] This experiment is meant to divide plastics into individual groups sorted according to their density, i.e. to separate them using the sink-float method. Required devices and chemicals: • Plastics samples • 200 ml saturated sodium chloride solution ($NaCl_2$) • 200 ml saturated magnesium chloride solution ($MgCl_2$) • Spoon, scissors, possibly pliers, 250-ml beaker Procedure • Comminute plastics into small pieces with scissors or pliers and mix in the beaker. • Add water (ρ = 1.0 g/cm³) to beaker, stir and skim the floating pieces. • Decant water, replace with saturated sodium chloride solution (ρ = 1.18 g/cm³) and skim the floating pieces. • Decant sodium chloride solution, replace with saturated magnesium chloride solution (ρ = 1.33 g/cm³) and skim the floating pieces. Observation and evaluation • Polyethylene and polypropylene, among others, float on water, • Polystyrol and polyamide float on NaCl2 solution,	Worksheet VII

	• Polymethylmethacrylat floats on MgCl2 solution, • Not floating: polyvinylchloride, polyester, phenoplastics and most types of aminoplastic as their densities are each > ρ = 1,33 g/cm³ • Density < ρ = 1.0 g/cm³: Polyethylene and polypropylene • Density < ρ = 1.22 g/cm³: Polystyrol and polyamide • Density < ρ = 1.33 g/cm³: Polymethylmethacrylat • Density > ρ = 1.33 g/cm³: Polyvinylchloride, polyester, phenoplastics, and most types of aminoplastics	
Students	**Task:** Conduct the experiment with the assistance of the teacher.	

Module S9 – Part A: Waste has a value!

Suitable for subject area: Social Studies, Mathematics

Topic overview – Part A — Duration [min]

9.1: Does waste has a value?	10
9.2: The non-financial value of wastes	20
9.3: The financial value of wastes	20

9.1 Does waste has a value? 10 min

Contributors	Tasks/ Contents/ Activities	Tools
Teacher	**Task:** Write the following question on the blackboard and pose it to the students: **"Does waste has a value?"** Collect answers to this question from the students. **Contents:** Pose this question to the students and ask them to write answers on the blackboard, as follow : **"Does waste has a value? "** Answer 1: Answer 2: **Goals: T**he students are expected to come forward with ideas such as: • Wastes can be sold (monetary values). • Wastes can be reutilized (composting, paper recycling). • Wastes can be used for crafting etc.	Blackboard
Students	**Task:** Collect ideas as answers to the question and write them on the blackboard.	

9.2 The non-financial value of wastes 20 min

Contributors	Tasks/ Contents/ Activities	Tools

Teacher

Task: Explain the non-financial (non-material) value of waste to the students and make them understand it.

Contents: Through the possibility to **reutilize wastes (recycling)** raw materials can be saved and less space is necessary for the disposal of these wastes, i.e. the environment can be preserved.

Task: The students are asked to calculate the weight and volume of the wastes accruing most often at ACT that can be saved at the landfill if half of the wastes (50%) are reutilized.

Contents: Present the following table and ask the students to calculate (the data in italics are to be calculated).

Transparency 19

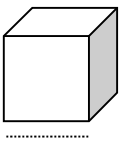
Waste fraction	**Amounts [kg/week]***	**50% of amount [kg]**	**Density [Mg/m³]***	**Volume [m³/week]**
Paper, cardboard	326.85	*163.43*	0.25	*0.65*
Plastics	1,109.12	*554.56*	0.03	*18.49*
Garden waste	1,146.30	*573.15*	0.11	*5.21*
Food and kitchen waste	1,806.85	*903.43*	0.80	*1.13*
Total	4,389.12	*2,194.57*	-	*25.48*

* Data from waste management concept [Klauß-Vorreiter, 2003]

- Ask the students to come to the blackboard and fill in the results.

Depict the calculated volume of ~ 25.5 m^3 as a cube.

Subsequently calculate the edge length of this cube.



2.94 m edge length

(human ~ 1.75 m)

Transparency 20

Goal: The students should picture this amount in their heads and realize the landfill space that could be saved.

But this is only feasible if the wastes are collected separately!

Students

Task: Use the data and calculate the results.

Teacher

Task: Interpretation of the results.

9.3 The financial value of wastes 20 min

Contributors	Tasks/ Contents/ Activities	Tools

Teacher

Task: Discuss with the students the financial (material) value of the wastes.

Contents: Collect with the students the purchase values of wastes, e.g. how many Baht are paid for 1 kg of wastepaper etc.

- Create the following table on the blackboard and fill in the values.

Blackboard

Waste fraction	Price per kilogram
Example: *paper*	*4 Baht/kg*
Glass	*2 Baht/kg*
Plastic bottles	*7 Baht/kg*
Plastic cups	*4 Baht/kg*
...	

Task: Calculate with the students the financial value of the sellable wastes.

- Present the following table and ask the students to calculate (the data in italics are to be calculated).

Transparency 21

Waste fraction	Amount [kg/week]	Baht / week
Glass	131.18	*262.36*
Paper, cardboard	326.85	*1307.40*
Plastic bottles	78.90	*552.3*
Plastic cups	232.90	*931.60*
...		
Total	*769.83*	*3053.66*

- Ask the students to come to the blackboard and fill in the results.
  - The *3,056.66 Baht* can by multiplied with the *40 weeks of school* to result in a value of *122,146.40 Baht/school* year.
  - This roughly corresponds to 3,053.66 €/school year or in Thailand:

1 h of internet game	~ 30	Baht;
One movie ticket	~ 100	Baht;
One domestic flight	~ 2800	Baht

Goals: The students should realize the financial value that can be saved.

But this is only feasible if the wastes are collected separately!

Module S9 – Part B: The separate waste collection

Suitable for subject area: Social Studies

Topic overview – Part B	Duration [min]
9.4: Revisiting the analyzed collection system	30
9.5: An improved or rather new collection system	20

9.4 Revisiting the analyzed collection system 30 min

Contributors	Tasks/ Contents/ Activities	Tools

<table>
<tr><th>Contributors</th><th>Tasks/ Contents/ Activities</th><th>Tools</th></tr>
<tr><td>Teacher</td><td>
Task: Present the current collection system together with the students.

The teacher assesses the result in terms of whether the wastes at the school are separately collected and thus can be reutilized, or whether the wastes are completely landfilled.

Contents: the students should bring together the following insights:
a) the waste fractions at ACT from Module S1,
b) the waste system from Module S3 – Part B,
c) the reutilization possibilities through composting and the recycling of paper and plastics,
and thus realize the characteristics of the current collection system.

a) and b) bring together the insights – which waste fraction is collected in which container.

<table>
<tr><th>Container type
Waste fraction</th><th>(color & type)</th><th>...</th><th>...</th><th>...</th><th>...</th><th>...</th></tr>
<tr><td>Hazardous waste</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Drink cartons</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Metal</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Glass</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Paper, cardboard</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Residual waste</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Plastic cups</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Plastic bottles</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Other types of plastics</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Garden waste</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Food residuals and kitchen wastes</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
</td><td>Transparency 22</td></tr>
</table>

Contributors	Tasks/ Contents/ Activities	Tools
	c) Are the following waste fractions collected separately?	Transparency 23

Paper		Garden and food wastes
Yes	**No**	Yes
Good → Recycled paper	**Bad → Landfill**	Good → Composting

Plastic cups		Plastic bottles
Yes	**No**	Yes
Good → Recycling	**Bad → Landfill**	Good → Recycling

- If the waste fractions are not collected separately they will be landfilled, which increases landfill space and burdens the environment.
- If the waste fractions are not collected separately they cannot be sold or reutilized.
- If the waste fractions are collected separately they can be reutilized, i.e. raw materials, energy and landfill space can be saved, which preserves the environment.
- If the waste fractions are collected separately they can be sold.

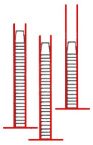
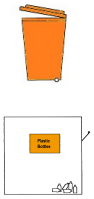
9.5 An improved or rather new collection system 20 min

<table>
<tr><th>Contributors</th><th>Tasks/ Contents/ Activities</th><th>Tools</th></tr>
<tr><td>Teacher</td><td>
Task: Ask the students to collect ideas for an improved or rather new collection system and

Subsequently explain the improved or rather new collection system to the students.

Contents: In order to be able to reutilize the reusable materials they have to be collected separately.

Based on the waste management concept this separate collection is implemented as follows:

<table>
<tr><td>Waste fraction</td><td>Plastic cups</td><td>Plastic bottles</td><td>Paper</td><td>Catering waste</td><td>Garden waste</td><td>Residual waste</td></tr>
<tr><td>Container color</td><td>Red</td><td>Orange</td><td>Blue</td><td>-</td><td>Green</td><td>Yellow</td></tr>
<tr><td>Container type</td><td>Cup collector</td><td>260 l Container / metal boxes</td><td>260 l Container</td><td>Stainless steel container</td><td>260 l Container</td><td>260 l Container</td></tr>
<tr><td>Illustration</td><td>  </td><td>  </td><td>  </td><td>  </td><td>  </td><td>  </td></tr>
<tr><td>Purpose</td><td>Recycling</td><td>Recycling</td><td>Recycling</td><td>In part composting</td><td>Composting</td><td>Landfill</td></tr>
</table>
Explain to the students the improved or rather new way of collecting.
</td><td>Transparency 24-1</td></tr>
</table>

Contributors	Tasks/ Contents/ Activities	Tools
	Task: Using the following two graphics explain the purpose of the separate waste collection on the basis of the individual steps. **Contents:** In order to be able to reutilize the reusable materials they have to be collected separately, for example as follows:	Transparency 24-2

Without separate collection

(4 steps)

1.) Disposal of all wastes in one container

⇓

2.) The waste is collected

⇓

3.) The waste has to be separated to be reutilized

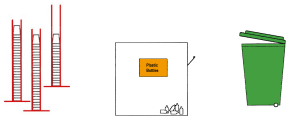
⇓

4.) Reutilization of the wastes is possible **in part**.

With separate collection

(3 steps)

1.) Disposal of all wastes in different containers



⇓

2.) The waste is collected with different vehicles

⇓

3.) The different waste fractions can be reutilized without separation of the waste fractions

Module S10 – Parts A/B: Summary

Suitable for subject area: Thai

Topic overview – Parts A/B	Duration [min]
Summary of course contents	2 x 50

Summary of course contents **2 x 50 min**

Contributors	Tasks/ Contents/ Activities	Tools
Teacher	**Task:** The students should write essays or an article for the monthly student newspaper, possibly the activities of the whole course. **Contents:** Exemplary topics of the essays • Information about the current waste data at ACT • What possibilities do exist for every individual to avoid wastes? • What are the students learning in environmental education? • Etc.	

Additional module S1 Visit of a landfill or transfer station

Suitable for subject area: Social Studies

Topic overview	Duration [d]
Visit of a landfill or transfer station	1

Visit of a landfill or transfer station **1 d**

Contributors	Tasks/ Contents/ Activities	Tools
Teacher	**Task:** Organize the visit of a landfill or transfer station with the students. **Task:** Prepare background knowledge on the visit and impart it to the students. **Contents:** For example the following questions should be addressed: • Since when does this transfer station/landfill exist? • How many waste trucks arrive daily at the station? • What task do the individual persons have? • Which waste fractions are delivered and which can be seen? Etc.	

Additional module S2 Art made from waste

Suitable for subject area: Scout (Arts)

Topic overview	Duration [min]
Art made from waste	2 x 50

Art made from waste **2 x 50 min**

Contributors	Tasks/ Contents/ Activities	Tools
Teacher	**Task:** Make collages from waste materials together with the students. **Contents:** The students should make a collage from waste materials. • Collect usable waste fractions. Select a suitable theme from the field of waste, e.g. “Waste separation at ACT”.	Collecting waste materials
Students	**Task:** Design and make a collage.	

7 Worksheets

Worksheet I – Table of waste analysis

Location	Waste fraction

(Cutting line)

Worksheet I – Table of waste analysis

Location	Waste fraction

Worksheet II – Vocabulary related to the topic of waste [www – 12]

English	Thai
Ability	ความสามารถ
Ability to comprehend	ความสามารถที่จะเข้าใจ / ส
Ability to solve problems	ความสามารถในการแก้ปัญ
Academic	ในทางวิชาการ/สถาบัน/สถา
Accomplish	เป็นผลสำเร็จ / มีความสำเร็จ
Accomplishment	ความสำเร็จ / สัมฤทธิ์ผล
Achieve	บรรลุ / สำเร็จ
Achievement	ความสำเร็จ / ผลสัมฤทธิ์ / ส
Acid rain	ฝนกรด
Action	การกระทำ / ลงมือทำ
Action competence	ความสามารถกระทำการ
Action research	การวิจัยเชิงปฏิบัติการ
Action research format	รูปแบบการวิจัยเชิงปฏิบัติก
Action research system	ระบบการวิจัยเชิงปฏิบัติการ
Activity	กิจกรรม
Adapt	ปรับตัว / ปรับให้เข้ากัน
Adaptation	การปรับตัว / การปรับให้เข้
Adult education	การศึกษาผู้ใหญ่
Advise (v)	แนะนำ/ให้คำปรึกษา
Advice (n)	การแนะนำ / การให้คำปรึก
Advisory	ซึ่งให้คำปรึกษา
Advisory group	คณะที่ปรึกษา
Age group	กลุ่มอายุ
Agenda 21	แผนปฏิบัติการ 21

English	Thai
Assets	สินทรัพย์
Attention	ความเอาใจใส่
Attentive	อย่างสนใจ / อย่างเอาใจใส่
Attitudes	ท่าที / กริยาท่าทาง / การวางตัว / เจตคติ
Aware	รู้ / ทราบ / ตระหนัก
Awareness	การรับทราบ / ความตระหนัก
Baseline study	การศึกษาข้อมูลพื้นฐานเบื้องต้น
Basic education	การศึกษาขั้นพื้นฐาน
Basic knowledge	ความรู้พื้นฐาน
Basic skill	ทักษะ / ความชำนาญพื้นฐาน
Behavior	ความประพฤติ / พฤติกรรม
Biodiversity	ความหลากหลายทางชีวภาพ
Break (=recess)	การหยุดพักระหว่างประชุม
Business	ธุรกิจ
Business community	ชุมชนธุรกิจ
Capacity constraint	ข้อจำกัดด้านสมรรถนะ / เงื่อนไขบังคับ
Carry out	ดำเนินการ
Case study	การศึกษารายกรณี / กรณีศึกษา
Central level	ระดับกลาง
Centralized curriculum	หลักสูตรแบบศูนย์รวมอำนาจ / หลักสูตรรวมศูนย์

English	Thai
Analytical thinking	การคิดวิเคราะห์
Application	การประยุกต์ / การนำไปใช้
Application of knowledge	การประยุกต์ความรู้ / การนำความรู้ไปใช้
Applied knowledge	ความรู้ประยุกต์ (เช่น วิทยาศาสตร์ประยุกต์)
Apply	ประยุกต์ / ใช้
Approach	วิธีการ / แนวการสอน
Art/drawing	ศิลปะ / การวาด
Artist/draughtsman	ศิลปิน/ช่างเขียนแบบ
Assess	ประเมินค่า / ประเมิน
Assessment	การประเมินค่า / การประเมิน

English	Thai
Certificate	ใบสำคัญ / วุฒิบัตร / ใบแสด เอกสารแสดงข้อเท็จจริง
Change (n)	ความเปลี่ยนแปลง / การเปลี่
Change (v)	เปลี่ยน / เปลี่ยนแปลง
Change in attitude	เปลี่ยนเจนคติ
Chief Technical Advisor	หัวหน้าที่ปรึกษาทางวิชาการ
Circulate for comment	ส่งเวียนไป(เอกสาร)เพื่อขอ
Circulation	การหมุนเวียน / การเวียนเรื่อ
Citizen	พลเมือง
Citizenship	ความเป็นพลเมือง / สภาพพ
Civil society	สังคมพลเรือน
Class hour	ชั่วโมงเรียน
Class size	จำนวนนักเรียนในห้องเรียน
Classmate	เพื่อนร่วมชั้นเรียน
Classroom	ห้องเรียน
Classroom behavior	การปฏิบัติในห้องเรียน

English	Thai
Classroom teaching	การสอนในห้องเรียน
Coherent	อย่างต่อเนื่อง / อย่างมีนัยสัม สอดคล้อง / มีความสัมพันธ์
Collaborate	ทำด้วยกัน / ร่วมกันทำ
Collaboration	ความร่วมมือ
Collect	เก็บ / รวบรวม
College	วิทยาลัย
Communication	การสื่อสาร / ติดต่อ
Commit	มอบหมาย / ผูกมัด
Commitment	การผูกมัด
Completed course	วิชาเบ็ดเสร็จ
Complex	ซับซ้อน/ยากที่จะจำแนกได้
Complexity	ความซับซ้อน
Component	ส่วนประกอบ
Comprehension	ความเข้าใจ
Computerize	ทำให้เป็นระบบคอมพิวเตอร์
Concept	ความคิดรวบยอด /สังกัป / ม มโนคติ
Concept development	การพัฒนาแนวคิด / ความคิด
Concept formation	การกำหนดแนวคิด
Concept paper	เอกสารแนวคิด
Conception	การสร้างแนวคิด
Conception of reality	การสร้างแนวคิดที่เป็นจริง
Conflict management	การจัดการความขัดแย้ง
Conflicting interests	ผลประโยชน์ขัดแย้ง
Conflicts	ความขัดแย้ง
Coherence n.	ความสอดคล้องต่อเนื่อง
Constraint	ข้อจำกัด / เงื่อนไขบังคับ
Consult	ปรึกษา / ขอความเห็น
Consultation	การปรึกษา / ขอความเห็น
Consultative	เชิงปรึกษาหารือ
Content (in terms of knowledge)	สารบัญ / เนื้อหาสาระ
Continuing education	การศึกษาต่อเนื่อง
Continuous assessment	การประเมินอย่างต่อเนื่อง

English	Thai
Core curriculum	หลักสูตรแกนกลาง
Core subject	วิชาแกน
Counseling	การแนะ / การให้คำปรึกษา
Course content	เนื้อหาวิชา
Course evaluation	การประเมินผลวิชา
Course literature	คำอธิบายวิชา
Course of action	สิ่งที่ต้องปฏิบัติ
Course period	ระยะเวลาเรียนของวิชา
Create	สร้างสรรค์ / รังสรรค์
Creation	การสร้างสรรค์
Creative thinking	การคิดเชิงสร้างสรรค์
Criterion (pluralism: criteria)	เกณฑ์ / บรรทัดฐาน
Critical thinking	การคิดเชิงวิจารณญาณ
Cross-circular	ตลอดหลักสูตร
Crosscutting	ตัดผ่าน
Culture	วัฒนธรรม
Curriculum	หลักสูตร
Curriculum development	การพัฒนาหลักสูตร
Curriculum formation	การกำหนดหลักสูตร
Curriculum framework	การอบรมหลักสูตร
Curriculum review	การปรับ (ปรุง) หลักสูตร
Data collection	การรวบรวมข้อมูล
Decentralize	กระจายอำนาจ
Decision-making	การตัดสินใจ
Define	นิยาม / กำหนดนิยาม / ให้คำ
Instruction Development (DCID)	
Demonstration project	โครงการสาธิต
Department of General Education (DGE)	กรมสามัญศึกษา
Description of aims	คำอธิบายจุดหมาย
Depletion of natural resources	การทำลายทรัพยากรธรรมช
Design (n)	การออกแบบ / แบบ
Design (v)	ออกแบบ

English	Thai
Development	พัฒนาการ / ก้าวหน้า / เจริญ
Development needs	ความจำเป็นในการพัฒนา
Development objective	จุดประสงค์ของการพัฒนา
Development of education/learning materials	พัฒนาการทางการศึกษา / สื่
Discovery learning	การเรียนรู้แบบค้นพบ
Discussion	การอภิปราย
Dissemination	การเผยแพร่
Dissemination of information	การเผยแพร่ข้อมูล
Distance learning	การศึกษาทางไกล
Distribute	กระจาย / แจก / แพร่
Distribution	การแจกแจง / การเผยแพร่
District	อำเภอ
District level	ระดับอำเภอ
District supervisor	ศึกษานิเทศก์อำเภอ
Diversity	ความหลากหลาย

English	Thai
Environment	สิ่งแวดล้อม
Environmental disaster	หายนะทางสิ่งแวดล้อม
Environmental Education (EE)	สิ่งแวดล้อมศึกษา
Environment education handbook	คู่มือสิ่งแวดล้อมศึกษา
Environmental research	การวิจัยสิ่งแวดล้อม
Environmental studies	การศึกษาสิ่งแวดล้อม
Equality	เสมอภาค
Equipment	อุปกรณ์
Evaluate	ประเมิน
Evaluation	การประเมิน / การประเมินผ
Evolution	วิวัฒนาการ
Excursion	การเดินทางท่องเที่ยว
Executing agency	องค์กร
Exercise (n)	แบบฝึกหัด
Experience (n)	ประสบการณ์
Facilitate	อำนวยความสะดวก
Field study	การศึกษาภาคสนาม
Field trip	การศึกษานอกสถานที่
Financial resources	แหล่งงบประมาณ
Flip chart	แผนภูมิพลิก / แผนภูมิชุด
Focus	จุดเน้น
Follow-up study	ติดตามผล
Forecast	พยากรณ์ / ทำนาย/คาดคะเน
Formal education	การศึกษาในระบบ / การศึก ทางการ
Formative evaluation	ประเมินผลระหว่างเรียน / ร การ
Frame of reference	กรอบอ้างอิง
Funds	ทุน / กองทุน
Garbage	ขยะ / สิ่งเหลือใช้

English	Thai
Ecological agriculture	เกษตรกรรมเชิงนิเวศ
Ecologist	นักนิเวศวิทยา
Education	การศึกษา
Education service area	พื้นที่ให้บริการการศึกษา
Education development	พัฒนาการทางการศึกษา
Education development work	งานการพัฒนาการศึกษา
Educational material	สื่อการศึกษา
Educational objective	วัตถุประสงค์ของการศึกษา
Educational policy	นโยบายการศึกษา
Educational psychology	จิตวิทยาการศึกษา
Educational supply	วัสดุสิ้นเปลืองที่ใช้ในการศึ
Educational theory	ทฤษฎีการศึกษา
Educator	นักวิชาการศึกษา
Empower	สร้างพลัง / ความเข้มแข็ง
Empowerment	การสร้างพลัง / การสร้างคว
Energy	พลังงาน
Energy conservation	การอนุรักษ์พลังงาน
Energy resources	แหล่งพลังงาน
Environmental education policy	นโยบายสิ่งแวดล้อมศึกษา

English	Thai
Grass house effect	ปฏิกิริยาเรือนกระจก
Group	กลุ่ม / พวก
Group size	ขนาดของกลุ่ม
Group work	งานกลุ่ม
Guidance	การแนะแนว
Guidelines	แนวทาง

English	Thai
Guidelines	แนวทาง
Headmaster	อาจารย์ใหญ่
Health education	สุขศึกษา
Hidden curriculum	หลักสูตรซ่อนเร้น
High priority	ความสำคัญลำดับต้น
Holistic approach	แนวคิดแบบองค์รวม
Homework	การบ้าน
Housing environment	สิ่งแวดล้อมเคหะ
Human resources	ทรัพยากรมนุษย์
Idea	ความคิด
Identification	การระบุ / ชี้เฉพาะ / การเทีย
Identify	ระบุ / ชี้เฉพาะ / เทียบเคียง
Imagery	ภาพลักษณ์
Immediate objective	วัตถุประสงค์ระยะสั้น
Impact	ผลกระทบ
Implement	ใช้ / ดำเนินการ
Implementation	การใช้ / การดำเนินการ
Implementing agency	หน่วยงานดำเนินการ
Improvisation in teaching	การสอนที่นึกขึ้นโดยปัจจุบั ไม่ได้เตรียมการ
Information campaign	การเผยแพร่ข่าวสาร / ข้อมูล
Information exchange	การแลกเปลี่ยนข่าวสาร / ข้อ
Information program	รายการข้อมูล
Innovative	ที่เป็นนวัตกรรม
Input	ปัจจัยนำเข้า
In-service training	การฝึกอบรมบุคลากรประจำ
Institutional EE capacity	ความสามารถด้านสิ่งแวดล้อ สถาบัน
Instruction	การสอน
Integrate	การรวมเข้าด้วยกัน / บูรณาก
Integration	การบูรณาการ
Intensive course	รายวิชาเร่งรัด
Interaction	ปฏิสัมพันธ์ / อันตรกิริยา / ก ระหว่างกัน
Interdisciplinary	สหวิทยาการ / สหวิชาการ
Interests	ผลประโยชน์ / ส่วนได้ส่วน
Internalize	ทำให้เป็นการภายใน

English	Thai
Interplay	ความเกี่ยวเนื่องกัน / สัมพันธ์
Intervene	เข้าแทรก / อยู่ระหว่าง
Intervention	การแทรกแซง
Introductory course	วิชาเบื้องต้น
Issue	ประเด็นปัญหา
Key concept	แนวคิดหลัก
Key word	คำหลัก
Kit	ส่วนต่างๆที่ทำขึ้นสำหรับชุด /ชุดประกอบพร้อมใช้
Learning by doing	การเรียนโดยการกระทำ
Learning materials	สื่อการเรียนรู้
Learning outcome	ผลการเรียนรู้
Learning package	ชุดการเรียนรู้
Learning process	กระบวนการเรียนรู้
Learning situation	สถานการณ์การเรียนรู้
Learning theory	ทฤษฎีการเรียนรู้
Lesson	บทเรียน
Lesson learnt	บทเรียนที่ได้เรียนรู้
Level of knowledge	ระดับความรู้
Liaise	สร้างการติดต่อ
Life experience	ประสบการณ์ชีวิต
Lifelong learning	การเรียนรู้ตลอดชีวิต
Link (n)	สอด / ประสาน/เชื่อมเข้าด้ว
Link (v)	เชื่อมต่อ / เชื่อมโยง
Link theory and practice	การเชื่อมโยงทฤษฎีสู่การปฏิ
Linkage	ที่เชื่อมโยง
Local consultant	ที่ปรึกษาในประเทศ / ท้องถิ่
Local curriculum	หลักสูตรท้องถิ่น
Local work plan	แผนปฏิบัติงานระดับท้องถิ่น
Long-term	ระยะยาว
Low priority	ความสำคัญลำดับหลัง
Marine/aquatic	ทางทะเล / เกี่ยวกับทะเล / เก
Mathematics	คณิตศาสตร์
Mobilization	การเกณฑ์ / ระดมพล / ชุมนุ

English	Thai
Municipality	เทศบาลนคร
Natural resources	ทรัพยากรธรรมชาติ
Nature	ธรรมชาติ
Nature study	การศึกษาธรรมชาติ
Network (n)	เครือข่าย
Network (v)	เครือข่าย / แผนติดต่อ
Non governmental organization (NGO)	องค์กรเอกชน
Objective	วัตถุประสงค์
Office of the National Primary Education Commission (ONPEC)	คณะกรรมการการประถมศึ
Official	เป็นทางการ
Option	ตัวเลือก / ทางเลือก
Optional course	(ราย) วิชาเลือก
Organization	องค์การ/ การจัดการองค์การ
Organization chart	ผังองค์การ
Organize	การจัดการ
Organizer	ผู้จัดการ / ผู้จัด
Outcome	ผลที่ได้รับ / ผลลัพธ์
Outcome of teaching	ผลการสอน
Overall perspective	มุมมองรวม
Overview	ภาพรวม
Ownership	ความเป็นเจ้าของ
Package (learning)	ชุด (การเรียน)

English	Thai
Planning the work environment	การ
Plant cultivation	การเพาะปลูกพืช
Plenary session	การประชุมครบองค์
Pluralism	พหุนิยม
Policy framework	กรอบนโยบาย
Pollution	มลพิษ
Practice (n)	การปฏิบัติ / การฝึกหัด
Practice (v)	ฝึกฝน / ปฏิบัติ
Precondition	เงื่อนไขที่กำหนดล่วงหน้า
Prepare	เตรียม
Presentation of a problem/issue	การนำเสนอปัญหา / ประเด็
Primary school	โรงเรียนประถมศึกษา
Principal	อาจารย์ใหญ่ / ทุน/เป็นตัวก
Prioritize (=sort in order of	จัดอันดับความสำคัญ
education/learning materials	เรียนรู้
Prognosis	การคาดคะเน / การพยากรณ์
Progress	ความก้าวหน้า
Project	โครงการ
Project area group	คณะทำงานในพื้นที่
Project Director	ผู้อำนวยการโครงการ
Project group	กลุ่มผู้ร่วมโครงการ
Project implementation plan	แผนดำเนินงานโครงการ
Project management group	คณะผู้บริหารโครงการ
Project manager	ผู้จัดการโครงการ
Project matrix	เครื่องเชื่อมโครงการ
Project purpose	เป้าหมาย / วัตถุประสงค์ของ
Project steering committee	คณะกรรมการอำนวยการโค
Project work	งานโครงการ
Promote	ส่งเสริม
Promotion	การส่งเสริม
Provide	จัดหา / เตรียมการ
Province	จังหวัด
Provincial level	ระดับจังหวัด
Provincial supervisor	ศึกษานิเทศก์จังหวัด

English	Thai
Perception	การรับรู้
Period (lesson period)	คาบเรียน
Perspective	ภาพสองมิติ, ทิวทัศน์
Pictorial perception	การรับรู้จากรูปภาพ
Pilot phase	ระยะการนำร่อง
Pilot project	โครงการนำร่อง
Pilot study	การศึกษานำร่อง
Place-base education	การศึกษาตามสถานที่
Planning	การวางแผน
Planning the work	การวางแผนสภาพแวดล้อมฯ
Provision	การจัดหา / การเตรียม / ข้อก
Public	สาธารณะ
Public awareness	การตื่นตัว / ความตระหนักข
Public sector	ภาคประชาชน
Pupil	นักเรียน

English	Thai
School administrator	ผู้บริหาร โรงเรียน
School board	คณะกรรมการบริหารของโ
School broadcasting	การกระจายเสียงของโรงเรี
School building	ตึก / สิ่งก่อสร้างของโรงเรี
School committee	คณะกรรมการ โรงเรียน
School environment	สิ่งแวดล้อมในโรงเรียน
School radio program	รายการวิทยุของโรงเรียน
School subject	วิชาของโรงเรียน
School-base curriculum	หลักสูตรสถานศึกษา / โรง
School-base management	การจัดการสถานศึกษา / โร
Schoolmate	เพื่อนร่วมโรงเรียน
Science	วิทยาศาสตร์
Sea	ทะเล
Secondary school	โรงเรียนมัธยมศึกษา
Self-instructional	บทเรียนด้วยตนเอง
Self-knowledge	ความรู้ในตนเอง
Self-respect	นับถือตนเอง
Seminar	สัมมนา
Share ideas	แลกเปลี่ยนความคิดเห็น

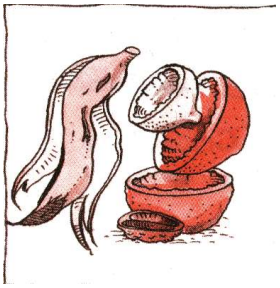
English	Thai
Questionnaire	แบบสอบถาม
Reporters	ความปรองดองกัน/ความสา ไมตรี
Read	อ่าน
Recurrent education	การกลับไปเรียนใหม่
Recycle	นำกลับมาใช้
Recycling	การนำกลับมาใช้
Reflect	สะท้อน
Reflection	ภาพสะท้อน
Reform	ปฏิรูป
Region	ภาค / แคว้น
Relevance	ตรงกับปัญหา / อยู่ในประเด็
Relevant	เกี่ยวข้อง / สัมพันธ์
Reorganization	ปรับองค์กร
Replete	กล่าวซ้ำ /ย้ำ / ทำซ้ำ
Repetition	การทำซ้ำ
Replicate	จำลอง
Replication	การถอดแบบ
Report (n)	รายงาน
Report (v)	การรายงาน
Research	วิจัย
Resource institution	สถาบันค้นคว้า
Resource person	วิทยากร
Resources	แหล่งทรัพยากร
Responsibility	ความรับผิดชอบ
Role conception	บทบาทที่เข้าใจ
Role-play	บทบาทสมมติ
Room	ห้อง
Rote learning	การเรียนแบบท่องจำ
Schedule	หมายกำหนดการ
School	โรงเรียน
[illegible]	[illegible]

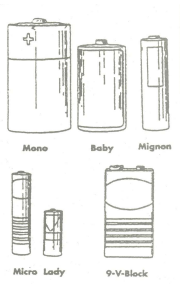
English	Thai
Social science	สังคมศาสตร์
Social study	สังคมศึกษา
Society	สมาคม
Socio-economy	เศรษฐกิจและสังคม
Soil	ดิน
Soil use	การใช้ผืนดิน
Solid waste	ขยะแห้ง
Special knowledge	ความรู้พิเศษ
Stake holder	ผู้มีส่วน / ผู้ได้รับประโยชน์
Standard	มาตรฐาน
Starting point	จุดเริ่ม
Story-line method	เทคนิคการสอนแบบเส้นทา
Strategic option	ทางเลือกยุทธวิธี
Strategy	ยุทธศาสตร์
Student	นักเรียน / นักศึกษา
Student democracy	ประชาธิปไตยของนักเรียน /
Study	เรียน / ศึกษา

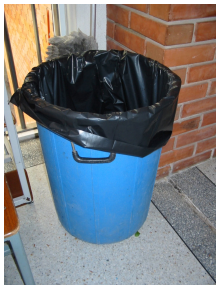
English	Thai
Study kit	ชุดการเรียน
Study program	โปรแกรมการเรียน
Study tour	การศึกษาดูงาน
Study visit	การเยี่ยมชมงาน
Subject	วิชา
Subject area	สาขาวิชา
Subject matter	เนื้อหาวิชา
Subject teaching	สอนตามวิชา
Sustainable	ยั่งยืน
Sustainable development	การพัฒนาอย่างยั่งยืน
Sustainable use	การใช้อย่างยั่งยืน
Sustainable use of resources	การใช้ทรัพยากรอย่างยั่งยืน
Syllabus	ประมวลการสอน / การเรียน
System	ระบบ
Systematic	อย่างมีระบบ
Tailor-made	จัดทำโดยเฉพาะ
Target (n)	เป้า / เป้าหมาย / จุดมุ่งหมาย
Target (v)	มุ่งสู่เป้าหมาย
Target achievement	บรรลุเป้าหมาย
Target area	พื้นที่เป้าหมาย
Target group	กลุ่มเป้าหมาย
Target school	โรงเรียนเป้าหมาย
Training needs	ความจำเป็นที่ต้องฝึกอบรม
Task	ภาระงาน
Task Force	คณะทำงาน
Teach	สอน
Teacher	ครู
Teacher attitude	เจตคติของครู
Teacher exchange	การแลกเปลี่ยนครู
Teacher role	บทบาทของครู
Teacher trainer	ผู้ฝึกครู
Teacher training	ฝึกหัดครู
Teacher training college	วิทยาลัยฝึกหัดครู
Teaching experiment	การทดลองการสอน
Teaching kit	ชุดการสอน

English	Thai
Teaching material requirements	ความต้องการด้านสื่อการสอ
Teaching media	สื่อการสอน
Teaching methods	วิธีการสอน
Teaching practice	การฝึกการสอน
Teaching premise	อาคารที่สอน
Teaching resources	ทรัพยากรการสอน
Teaching staff	คณะผู้สอน
Teaching staff meeting	การประชุมคณะผู้สอน
Teaching subject matter	การสอนเนื้อหาวิชา
Team	คณะ
Team teaching	สอนเป็นทีม
Teamwork	การร่วมมือกันเป็นคณะ
Test (n)	แบบทดสอบ / การทดสอบ
Test (v)	ทดสอบ
Textbook	ตำราเรียน
Thematic	เป็นหัวข้อเรื่อง
Theme	หัวข้อ / ใจความ / แก่นสาร
Time devoted to teaching	เวลาที่ทุ่มเทให้กับการสอน
Time horizon	ขอบเขตเวลา
Timetable	ตารางเวลา
Timetabling	การจัดทำตารางเวลา
Tool	เครื่องมือ
Understand	เข้าใจ
Understanding	ความเข้าใจ
University	มหาวิทยาลัย
Update	ทำให้ทันสมัย
User-friendly	เป็นมิตรกับผู้ใช้ / ใช้ง่าย
Utilization of natural resources	การใช้ทรัพยากรธรรมชาติ
Vision	วิสัยทัศน์
Visual perception	การรับรู้ / เข้าใจจากการเห็น
Visualization technique	เทคนิคการนึกภาพ
Vocabulary	คำศัพท์
Waste	ของเหลือใช้ / ขยะ

Worksheet III – Waste memory game





Worksheet IV– Separation of packaging wastes

Packaging for ...	Paper	Catering waste	Plastics	Glass	Metal	Other
Total						

(Cutting line)

Worksheet IV – Separation of packaging wastes

Packaging for ...	Paper	Catering waste	Plastics	Glass	Metal	Other

Total						

Worksheet V – Game of questions about composting

“What is permitted on the compost heap?”

yes	Material	no
	Hazardous waste	
	Coffee grounds and tea leaves	
	Metal	
	Glass	
	Dry eggshells	
	Fruit remains	
	Plastics	
	Garden waste	
	Food and kitchen waste	
	Foliage, straw hedge trimmings	
	Drink cartons	
	Flowers	
	Colored paper, catalogs	

(Cutting line)

Worksheet V – Game of questions about composting

“What is permitted on the compost heap?”

yes	Material	no
	Hazardous waste	
	Coffee grounds and tea leaves	
	Metal	
	Glass	
	Dry eggshells	
	Fruit remains	

	Plastics	
	Garden waste	
	Food and kitchen waste	
	Foliage, straw, hedge trimmings	
	Drink cartons	
	Flowers	
	Colored paper, catalogs	

Worksheet VI – Properties of paper

Property	Answer
What is your sheet of paper called?	
What color does your sheet of paper have?	
What purpose does your sheet of paper serve?	
Run your finger over the paper. Is the surface rough, smooth or very shiny?	
Is your sheet of paper recycled paper or is it made of new fibers?	
Hold your sheet of paper at one corner and shake it. Is the rustling strong, medium or weak?	
Blow against the sheet of paper. Is it permeable to air or not?	
Hold your sheet of paper against the light. Is it translucent or not?	
Compare your sheet of paper to other types of paper. Is your sheet thick, medium or thin?	
Dip one corner of your sheet of paper into water. Does it soak up the water strongly or barely?	

Worksheet VII – Experiment – Floating test [LÜPKES et al., 1994]

The purpose of this experiment is the separation of plastics in distinct groups sorted according to their density.

Devices and chemicals:

- Plastics samples
- 200 ml saturated sodium chloride solution ($NaCl_2$)
- 200 ml saturated magnesium chloride solution ($MgCl_2$)
- Spoon, scissors, possible pliers, 250 ml beaker

Procedure

- Comminute plastics into small pieces with scissors or pliers and mix in the beaker.
- Add water (ρ = 1.0 g/cm³) to beaker, stir and skim the floating pieces.
- Decant water, replace with saturated sodium chloride solution (ρ = 1.18 g/cm³) and skim the floating pieces.
- Decant sodium chloride solution, replace with saturated magnesium chloride solution (ρ = 1.33 g/cm³) and skim the floating pieces.

Observation and evaluation

- Polyethylene and polypropylene, among others, float on water,
- Polystyrol and polyamide float on NaCl2 solution,
- Polymethylmethacrylat floats on MgCl2 solution,
- Not floating: polyvinylchloride, polyester, phenoplastics and most types of aminoplastic as their densities are each > ρ = 1,33 g/cm³

- Density < ρ = 1.0 g/cm³ : Polyethylene and polypropylene
- Density < ρ = 1.22 g/cm³: Polystyrol and polyamide
- Density < ρ = 1.33 g/cm³: Polymethylmethacrylat
- Density > □ = 1.33 g/cm³: Polyvinylchloride, polyester, phenoplastics, and most types of aminoplastics

8 Teaching transparencies for the modules

Separate file!