Aspects of Learning Foreign Languages and Learning WITH Foreign Languages: Language Immersion and CLIL

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Development Project Report
July 2006

JYVÄSKYLÄ UNIVERSITY OF APPLIED SCIENCES
Teacher Education College

JYVÄSKYLÄ UNIVERSITY OF APPLIED SCIENCES

DESCRIPTION
Date
_____

Author(s)
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Type of Publication
Development project report

Pages
37

Language
English

Confidential
☐ Until_____

Title

Aspects of Learning Foreign Languages and WITH Foreign Languages:
Language Immersion and CLIL

Degree Programme
Teacher Education College

Tutor(s)
MURTOSAARI, Kirsi

Assigned by

Abstract

The aim of my development project was to get acquainted with two language learning methods that differ from formal language education at our school system. These methods are language immersion and CLIL (Contents and Language Integrated Learning). I wanted to research how language immersion is implied in Finland and in other countries. I wanted to find out how using of CLIL changes teacher´s methods of working. The research problem was based on books, articles in educational magazines, personal experiences and opinions of interviewed persons.

In my research I studied firstly basic information of these methods via internet articles. I continued by searching related articles in EBSCO HOST Research Database. A big part of the contents came by reviewing real-life occasions. I chose the qualitative method and interviewed a person who has experienced language immersion. I told about my personal experiences with both language immersion and CLIL. I interviewed a representative of my own institute about the using of CLIL and about its benefits for language learning.

Research showed that the children who had started learning another language in the childhood reached equal or better results in tests of cognitive functioning compared to other children. They were also more receptive to learning about the people coming from other cultures and more likely to develop positive cross-cultural attitudes. The results proved that using of these two methods improve significantly students´ language skills, increase their self-esteem and readiness for international and multicultural communication.

Keywords
Language immersion, CLIL, Contents and Language Integrated Learning

Miscellaneous

Appendix: Teaching practice lesson documents, 20 pages

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1. INTRODUCTION

I wanted to learn about new innovative methods that could support my teaching work. The aim of this report is to gain my personal knowledge about two **not** so usual ways to learn languages:

1) Learning through language immersion
2) CLIL – Contents and Language Integrated Learning

In this text I mean with concepts ´traditional´ or ´formal´ language teaching the compulsary, guided language teaching which takes place in classroom lessons in our comprehensive school.

We will have a continously growing need for communicating in foreign languages in European Union and in its future enlargements. We travel more both in business and on our free time. We receive immigrants and we want to/must go abroad for working projects and to get vacancies.

Traditionally foreign languages have been taught to us solely by the language teachers. Especially with us Finns there has been a frustrating problem with learning the language: the main emphasis has been on knowing the grammar perfectly and being able to produce written text without errors. Understanding of spoken language and producing speech have not been as important.

I have always been interested in languages – and they have been easy for me. I even applied for language studies in several universities after the senior secondary school but was not accepted. Instead of that I became an engineer. This profession, however, has not prevented me being interested in languages. Linguisticly talented engineers are wanted people – and a minority.

Learning languages is a natural thing. You can ´suck knowledge´ from the breast of your mother, you may be totally immersed inside a foreign language

or you might be voluntarily willing to learn it through certain subject that interests you.

2. LANGUAGE IMMERSION

I was discussing the topic CLIL with one of my native English speaking colleagues, John. He said to me: “CLIL has its roots in **language immersion**, CLIL is its ´grandchild´. Find out about language immersion and thus you know much about CLIL.”.

2.1 What Is It?

I refer in chapters 2.1-2.3 to an internet article from source http://lipas.uwasa.fi/hut/svenska/centret/kieli.html. The Centre for Immersion and Multilingualism of Vaasa University says that language immersion means a voluntary teaching programme which is aimed for all those who speak the majority language as their mother tongue and are not naturally in any contact with the immersion language.

In language immersion it is assumed to adopt the second language most efficiently in true meaningful communication situations. Teaching is given mostly in different than pupils´ own language in the beginning. Students are also taught some subjects partly in the immersion language. The immersion language is not only a target but it is a means of learning. It is adopted through experiences like we adopt our native tongue. Children´s parents do not need to speak the immersion language. They are supposed to communicate with the children in their mother tongue and thus support their lingual and cultural progress.

The article continues that when the pupils are at grades 5-6, half of the teaching is given in the immersion language and the other half in their first language and other languages. The teachers that teach in immersion language use ONLY that language when they communicate with students. The reason for this is that in that way the pupils hear and use the language in different occasions. Teacher also acts as a model for students.

The pupils are encouraged to use the language and they are expected to use it when talking with the teacher and their companions in the same group right from the beginning. Because immersion teacher only teaches in immersion language, those lessons that are not given in immersion language need different teachers.

The author of the article writes that the aim of language immersion is that pupils gain functional skills in both written and spoken immersion language while their first language is progressing at the same time.

Language immersion programme is ruled by the national curriculum and the immersion pupils get the knowledge which is assumed in the curriculum. The pupils adopt second functional language in addition to this and learn to know the culture that this language represents. This also strengthens their first language and the knowledge of their own culture.

2.2 Language Immersion in Finland

The web article (http://lipas.uwasa.fi/hut/svenska/centret/kieli.html) tells that the first initiative of starting the languge immersion in Finland was done in Vaasa 1986. The city council made the decision and the program was launched after negotiations between local and state authorities in 1987. In Vaasa they give so called early stage total immersion. This is started for Finnish speaking children in the day nursery at the age of five years.

The language immersion teacher speaks to pupils Swedish but undertands also Finnish. The meanings of words and expressions are completed with non-linguistic communications like pictures, expressions and gestures.

Author continues that after two years in the day nursery the language immersion continues in the comprehensive school. The immersion groups are taken to the Finnish language school so that they will not loose their culture identity. They are after all Finns.

Teaching is mostly given in Swedish at first but it is increasingly held in Finnish during the coming years. The use of two languages is split half anf half at the highest grades. The immersion pupils are taught also in English, German and French.

Because Vaasa is a bi-lingual city they put much weight on creating a bi-lingual environment and natural communication in two languages. The research-workers of Vaasa University can offer great advantages to the teachers and also learn from them. This way they all work for the progress of language immersion. Using of language immersion is possible also for adult students in Vaasa University.

The web article says that the language immersion approach was created in Canada and was brought from there to Finland when Christer and Ulla Laurén of Vaasa University became acquainted with it in late 1970´s there. The initiative for starting language immersion was made by a group of politically active women in Vaasa. The program has spread out to other parts of Finland since, mainly by parents of the the pupils.

In Finland language immersion in mainly targeted for the children of majority group i.e. Finnish speaking pupils. For minorities teaching is given in international languages, too. The most often used language immersion

program is early stage total immersion but they also use early stage partial immersion in the south of Finland.

By us language immersion starts at the age of 3-6 years and it continues from the day nursery up the end of the 9th grade. Language immersion is applied all over the country and the pupils/students are of various ages including adult learners, too.

The research is made mainly in Vaasa University but people from many other universities also work with language immersion and multi-lingual projects. In the autumn of 2001 there were 1151 language immersion children in the day nurseries, 2808 pupils in grades 1-6 and 433 boys/girls in grades 7-9. (Lyhyesti kielikylvystä / Vaasan yliopisto 2004.)

2.3 Language Immersion Abroad

Canada

According to the web article (http://lipas.uwasa.fi/hut/svenska/centret/kieli.html) the language immersion was first started in Canada in 1965. This happened when English speaking parents started to claim efficient language teaching in their schools. They knew about the lingual demands for their children in the future but were not satisfied with the level of education. Because of the active working of those parents nowadays every child of all the provinces of Canada can take part in language immersion. There were about 300 000 pupils that joined it in late 1990´s.

There are various language immersion programs In Canada that are devided after these criteria:

TABLE 1. Division of immersion programs in Canada (Lyhyesti kielikylvystä 2004.)

According to child´s/pupil´s age:	According to amount of language immersion
1) early stage language immersion 2) delayed language immersion 3) late language immersion	1) total language immersion 2) partial language immersion

The most popular method is the early stage total language immersion.

Catalonia

The internet source tells that language immersion started in Catalonia in 1983. The program is there for pupils that speak Spanish but live at the areas where Catalan language is not much used.

The purpose of language immersion is to maintain and make stronger the Catalan language as a functional language in their society. The Catalan language was not allowed to be used in schools during Franco´s regime and this weakened the language. Thus the goal of immersion is different from for instance that in Finland. The language immersion method has been dominant in Catalonia since 1995.

Other countries

Language immersion is widely used in many countries in their multi-lingual territories, for instance:

- Schlesswig-Holstein area in the north of Germany (teaching in German and English)
- Italy (teaching in German)
- Esthonia (teaching in Estonian and Russia)

(Lyhyesti kielikylvystä / Vaasan yliopisto 2004.)

According to an article in an educational magazine numerous states and schools in USA have recognized that early foreign language instruction benefits students cognitively and academically, contributes to the achievement of schools´ multicultural goals and can help to meet the needs of the nation. Many recent studies show that the children who have started learning another language in the childhood reach equal or better results in tests of cognitive functioning compared to other children. They are also more receptive to learning about the people coming from other cultures and more likely to develop positive cross-cultural attitudes. (Myriam 1991.)

2.4 Experiences in Language Immersion

2.41 Interview of a Canadian Friend

In this chapter 2.41 I refer to an interview made by myself via e-mail.

I ´bumped´ into my Canadian friend Robert in June 1982 when I was visiting a lovely small town of Giethoorn in the Netherlands. I was there as an IEASTE student (see chapter 2.42) for two months. I took part in several excursions arranged for foreign students and thus made many loyal friends. We became pen pals with Robert for 18 years and finally in 2000 I travelled to Cologne, Germany and saw his face again. He lives there with her lovely French wife

Christiné and three very energetic little sons. Here are the results of my interview.

Question 1. Who, what, from where, how old are you?

“Robert HAM, Canadian, from Huntsville, Ontario, CANADA, 46 years old, mother tongue English.”

Question 2. You come from Canada. According to the Finnish sources language immersion was first started in your country (I e-mailed the contents of chapters 2.1-2.3 to Robert). How would you comment the facts of this text (in the file)?

“I am not too well acquainted with the various language immersion programs in Canada at present because I have been living outside of Canada for almost twenty years now! But having read the following in the attached file “Because of the active working of those parents nowadays, every child of all the provinces of Canada can take part in language immersion”, I am not too sure that every child (especially those in rural areas) in <u>all</u> provinces can take part in language immersion.

Question 3. As a native Canadian could you tell more detailed information about language immersion in your country.

“As I indicated above, I have been out of the country for almost twenty years now, so my knowledge is limited. I know, however, that in my small hometown of about 15,000 inhabitants there are schools where the children starting at age five or six can take part in (at least) partial language immersion. I believe language immersion is even more common in the province of Quebec, where French as the mother tongue predominates, i.e. in this province the immersion language is English.”

Question 3. I suppose that both English and French are official languages in your country like we Finns have Finnish and Swedish. How many percent of population speaks each language and what is a short history behind the languages?

"English and French are the two official languages of Canada. I believe the percentages of them would be about 20 % French, 60 % English and 20 % rest, but this must be checked! (About 29 % are of French origin, 43 % of British origin, but this does not necessarily indicate the percentages of the spoken languages!) The history in Canada between the French- and English-speaking peoples is a very turbulent one! The French arrived in Canada before the British. The British, however, won the Seven Years War in the 18th century and thus took the lands that - up until then – had belonged to France. The only province where French was / is the predominant language was / is Quebec*. Up until the 1960's this province was somewhat isolated from the rest of Canada. After a "liberalization" of the province in these years under the provincial Liberal Party, the Separatist Party ("Le Parti Quebecois") came to power in 1976. This government and other separatist governments of Quebec every since have organized referenda in which the voters of Quebec were asked whether they wished to separate from Canada. Up until now, the vote of the separatists has not been sufficient!
* The province of New Brunswick is the only province, I believe, that is officially bilingual."

Question 4. You yourself speak at least English, French and German as far as I know. What kind of language learning history do you have?

"I began learning a bit of French at the age of about eight years, but I really believe I made progress with French in high school from the age of seventeen years on.

In the summer before my last year of high school, I took part in an immersion program funded by the Government of Canada. I spent six weeks in Quebec

with a French-speaking family that lived in a village. During these six weeks I took French courses and also took part in many excursions. I made a great deal of progress with the French language, so much so that I greeted my parents with “Bonjour” when they arrived to pick me up at the end of the six weeks!

After high school I went to McGill University in Montreal in the province of Quebec, one of the reasons being the French language there. I took a number of French courses at university and tried to keep up my French by talking to some of the French-speaking (Quebecois) students there. But most of them could speak better English that I could French!

During all my university years I attempted many times to obtain a bursary or scholarship that would allow me to study in France and allow me to become bilingual. For my doctorate I finally went to France, spending five years in Lyon. This was what one would call total immersion … and allowed me to become bilingual. My finding and marrying a French woman allowed me to keep and improve the French language, even though I am now in Germany.

After a short stay in Canada between living in France and Germany, I acquired the German language on-the-job in Leverkusen/Cologne. At the same time I took a number of language courses, in groups and in private, paid for by the company. (I told my work colleagues to “come back in a year” if they wanted to practise their English with me since I wanted to first learn German! There was to be “no talking English” with me!) The beginning of the language-learning period was a difficult because I was just “thrown into” the language, but I think this was the best solution, i.e. the most efficient, since it allowed me to speak the language with relatively good facility after a very short period of time. My wife and I have now been here more than fourteen years, so that I speak German fluently. Learning German for my wife was however more difficult at the beginning since she had no job to go to and thus no chance to be fully immersed in the language. But after going to German language courses at The University of Cologne and after getting to know people,

especially after our children began going to kindergarten and then primary school, her German improved to the point that she is now fluent in the language as well."

Question 5. You are married to a French lady and your 3 sons were all born in Germany (were they?). Can you tell/comment about any language immersion happening in this context?

"Please see above! Our three sons (10, 8 and 4 years old) were all born in Germany. All of them go / have gone / will go to regular kindergarten and primary schools where the language of instruction is German. Thus they are more or less similar to German children as far as their language capabilities in German are concerned. Their first language is indeed German, but at the moment only the two elder children speak it fluently. All children have been spoken to from birth and are now spoken to - to a greater or lesser degree - in French and English by their mother and father respectively, but they usually answer in German. The oldest however answers more or less often in the parent's language and can engage a conversation in both. All three get along in English and, to a lesser extent, in French. For me it is quite simply a practical matter: they have to be able to speak to the families of their mother (French) and father (English)!"

Conclusions

Robert doubts a little about the facts told in the internet article (http://lipas.uwasa.fi/hut/svenska/centret/kieli.html). Article says that every child of all provinces in Canada can take part in language immersion. He thinks that this may be officially possible but it does not happen in practice. Robert confirms that there are two official languages in Canada like we Finns have ours, too. English dominates with about 60 % and French language comes next with 20 %. My friend Robert is really a cosmopolitan with good skills of three languages: English, French and German. His language

immersion development in French and German has happened in many stages. At first at the age of 17 he spent six weeks in a French-speaking family while taking French courses in the university. Partial immersion continued during his university studies and turned into total immersion when he moved to France for his doctorate. Five years in Lyon and marriage with French woman finally made him totally bilingual in English/French.

Robert has been ´flooded´ partially with German language because of living and working in Germany now for 14 years. His wife also has achieved a good skill of German through partial language immersion. Each parent speaks to their three sons in his/her own mother tongue, English and French. The language of the children´s every day neighbourhood, however, is German. I think that German will become their strongest language but they control well English and French, too. What a treasure! They get skilled in three different languages by just living their normal life. This is one of gifts that multicultural families offer to their children. The languge immersion works with them in a very natural and convenient way.

2.42 My Personal Experiences as an IAESTE Student

I studied civil engineering in Kuopio during years 1980-1982. The institute was called “Kuopion teknillinen oppilaitos” at that time. I graduated as civil engineer in December 1982. Before that there was a possibility in spring 1982 to apply for a training period of two months abroad. This training was organized by IAESTE (**T**he **I**nternational **A**ssociation for the **E**xchange of **S**tudents for **T**echnical **E**xperience). I chose to apply for a position in the Netherlands and I was accepted.

I had met a dutch student in Finland in previous summer and contacted him by phone. He was very helpful and offered to pick me up from Amsterdam Schiphol airport and to take me with his car to my new location.

Right now, when I am writing this development project and finding out about language immersion, I understand that my flight to Holland in May 26th 1982 started a period of language immersion lasting for eight weeks. The journey was virtually my first one abroad, I had visited only Nordic countries before that.

I met my friend with a sign (my name on it) at Schiphol airport and from that moment I was on my own by speaking just English with him. My school English seemed to work well enough when we drove towards little town of Franeker in the province of Friesland. He took me to my host family. I was going to stay there like in a boarding-school during my non-working time. I thanked my friend for the lift and started to become acquainted with the family members and my boss who came there, too.

I started working in the next morning. My employer was Rijkwaterstaat. It could be compared to Finland´s Tieliikelaitos. Rijwaterstaat was building up a large viaduct and tunnel for a new motorway. The construction work itself was done by contractors (private enterprises) but Rijkwaterstaat as developer was supervising it. My task was to work in the supervising group by making various mass calculations, measurements etc.

Things went on very well. I remember clearly that I started thinking in English after two weeks. There were no possibilities to speak Finnish with anyone and calling home was extremely expensive (I called to Finland only once during eight weeks). I was ´flooded´ in foreign language. I was also affected by local foreign culture. Because I spent evenings and nights in my host family´s house their every day habits (frisian/dutch) became very familiar for me. Differences of our habits became obvious which was not actually a problem for me. The lady of the house instead thought that I was a “really strange boy from Finland” and I was even taken by car to their relatives to be shown like some zoo animal. That was real intercultural communication! I had not any difficulties with the language, the language immersion worked out very well.

At work I had not linguistic problems either but some misunderstandings occured. The very first of them happened with the word ´contractor´. When I was studying the detailed information about this training spot on the bulletin board in our school before the trip I picked up this word. On our lessons we had been studying about a special ´contractor casting method´ which enables to lay concrete under water which would be unpossible with normal methods. I thought that working with ´contractor´ in Holland will mean the same. No, it meant the building firm who has made a building contract with Rijkwaterstaat to build up the viaduct and the tunnel. The words ´viaduct´and ´tunnel´ as well had a totally different meaning from the words that we are used to here in Finland. But there is no point of explaining them here.

Conclusions

I would call my training period in the Netherlands total language immersion. I started soon to think in English because there was not any contact to Finnish language. I spoke it in the family, at work and with everyone. The Dutch society is very international because of its colonial history and you can use English everywhere. I joined student happenings organized by IAESTE almost every week-end and met people coming from all over the world there. I felt very confident because I managed well with my English. The close connection to ´natives´ also made the familirization to the local culture and habits totally different than would be possible for a tourist. The dutch people are very friendly and helpful. If I had not made this language immersion visit to Holland I would probably not be writing this development project now. This experience left an endless desire for intercultural communication in me. The main tool to put that into effect is the language.

I read an article from the Newsweek Magazine published in 2006. The article tells about Carol Kaminski, a researcher from Philadelphia, USA. She wanted to improve her Spanish but instead of joining a traditional language class she packed her bags and travelled to Granada, Spain. “I lived in a hostel where

the desk man couldn´t even speak English. By the end of two weeks, I was speaking Spanish.” (Weingarten 2006.)

Both Carol´s and my own experiences support well each other.

2.43 Excursion to Hungary with my Students

I visited Hungary with a student group in March 2005. The group consisted mainly of adult environmental operative students. Our host was Tata´s acricultural institute for one week. They had arranged for us a very busy yet efficient schedule among various spots of interest. We visited for instance an energy grass production plant, a bioenergy heating plant and a power station with huge environmental reforms. We also got acquainted with mushroom growing and treatment of pig manure. Visiting of main sights of Budapest, a huge fortress in Komarom and lake Balaton were very enjoyable as well.

Every professional day trip followed the same rule. Our hosts Gabi and Dezsö (teachers of the Tata Agricultural Institute) took us with mini bus to the spot and there was a representative of the company or institute to tell us about the functions. S/he was speaking either Hungarian or English. If the language was Hungarian Gabi interpreted it into English and I had to interprete it into Finnish. Our students understood English to some extent but mostly they asked me to tell them what the speaker was talking about. Sometimes it was difficult for me to interprete because the speaker did not have enough pauses. This interpreting and translating became a very hard job for me. In the evening I felt totally exhausted.

This went on day after day. Just the target was changing. Then came the last excursion day and we went to see a large farm full of pigs. The farm introduced us their system for handling the massive amounts of manure. I was a total layman with the content like this. I did not know the words and concepts typical to that field and I had to ask to clarify my interpreting. Suddenly my

students started to help me with the phrases. They were experts with the content which I was not. They even started asking questions from our host via Gabi. They had got courage to use the English language themselves during this trip. I soon felt myself almost useless in the situation. But it did not bother me at all, I just happily moved a few steps backwards and let the experts do the talking and explaining.

Conclusions

Our group spent one week in ´mild´ language immersion. The students lived and travelled together and were thus able to use their mother tongue all the time. Because the content information was interpreted to them from Hungarian/English there was no need to use English necessarily. They heard English every day but were not expected to produce it themselves. I think, however, that when they were listening to the English talk, more or less actively, the content related words, concepts and phrases remained in their memory to some extent. They did not yet have the courage to speak out in English. The ´climax´ of this excursion trip came there at the pig farm. The students started to use English actively.

3. CONTENTS AND LANGUAGE INTEGRATED LEARNING

I refer in chapters 3.1-3.3 to an internet article from source http://www.ecml.at/mtp2/clilmatrix/pdf/other_languages/9sf.pdf.

3.1 What Does CLIL Mean?

Hartiala and Harviainen tell in their internet article that abbreviation CLIL means **C**ontents and **L**anguage **I**ntegrated **L**earning. It is an old teaching method but very popular again at the moment. CLIL is in Finland called with several names. Free translations could be for instance: teaching by foreign language, language immersion or content based teaching. The authors themselves use the term “teaching by foreign language”. The method combines the learning of foreign languages and the learning of different subjects, let´s say biology, chemistry, basics of levelling in surveying etc.

CLIL offers the students possibilities to use a foreign language so that after some studies they will more and more become interested in the subject itself instead of the language they are using. In this method the students use a foreign language which they do not normally use.

The subject and the language are combined so that main emphasis is **not** on the language itself. The method thus has two aims: 1) to learn the subject 2) to learn to use the foreign language.

The authors say that practical outcomes are as various as may be the ages of the pupils/students. Children of 8 years could learn the language via singing and playing only half an hour every week. On the other hand 13-year-old pupils can spend half of their studying time in another language.
Both the foreign and the native language are used side by side in most lessons. The main lines of the topic are often clarified in both languages and after that excercises, discussions etc. are held only in foreign language. (Hartiala & Harviainen 2006.)

3.2 Why CLIL?

Hartiala and Harviainen write that we learn by doing. We learn most effectively when we get knowledge about the subject and put that in practice. It does not matter what the subject to be learned is. In CLIL the students have the possibility to try and use the language they are learning at the same time when they are learning new things about the subject.

We often assume that foreign languges can be learned best as a child or being young. It is true that small children adopt easily languages that they hear in their natural living environment. One big reason for learning is that it happens in natural circumstances.

But not only children learn by this way. Gaining age does not remove this ability. Same learning results can be achieved by teenagers and adults, too. Writers state that it is important that the pupil/student can at the same time learn the language through guidance and adopt it by using it in real practical occasions. When studying in traditional language lessons it takes a lot of time to practice pronounciation, structures and vocabulary of language. Thus there is not so much time to try and use the language in more natural ways. Traditional i.e. guided language teaching though is necessary. The basic structures of the language would not be learnt otherwise.

For some of us the language lessons at school have been inspirating and pleasant experiences. For some it has been something else; hard and difficult learning through errors. For them it has also been tough to put on practice their language skills in every day life. They do not have the courage to cross the border to use the language.

At birth every child has natural ability to learn languages. This ability is the foundation for later capacity of adopting them. The natural born talent is not enough, they have to have possibilities to use the language. The parents play

the major role in this by communicating with their child. “Learning by doing” is vital for successful learning.

Some children are naturally talented for music, mathematics, sports or artwork. Some are naturally good in languages. This does not mean that those not talented should give up with them. We have to keep in mind that talent is a relative thing. If someone is not at all interested in languages, his/her talent may stay hidden.

The article continues that knowledge of languages is not just abilities to control words and structures and form perfect sentences. We must not just pay attention to school marks because understanding and expressing oneself – even inperfectly – are expressions of language skill. We do not have to think that foreign language can be used only when we manage fluently with it. Students should be encouraged to use the new language right from the beginning like is done in CLIL. When children or older students realize that they succeed with even more modest skills their positive attitude towards themselves grows and strengthens as learners of foreign language. In CLIL we tend to utilize this attitude and enthusiasm as well as possible. (Hartiala & Harviainen 2006.)

Marsh, Marsland and Stenberg say in their book that CLIL is advantageous in professionally-oriented education. It offers development in pragmatic knowledge and skills, interpersonal skills, intercultural communication end employability. It also improves quality of learning and teaching in the content field. (Marsh, Marsland, Stenberg 2001, 17).

3.3 How CLIL Affects Teaching

Marsh, Marsland and Stenberg think that there are many aspects that have impact on teaching and learning when using CLIL. I review here some of

them. The teacher has to be as visual and illustrative as possible. S/he also has to focus on the subject and make the instructions very simple and clear. It is very important that the students really have good reading skills which is not always self-evident. The teacher has to proceed more slowly than normally. S/he has to repeat things many times and explain them from many angles. S/he also have check that the students really understood what they were told. The learning occasion should be organized so that the teaching/learning is not just teacher-centered i.e. the students also produce learning by communicating with each other. (Marsh, Marsland and Stenberg 2001, 152).

I refer in following chapters and in chapter 3.4 to an interviewing discussion with Irja Nenola. Irja Nenola is an English teacher in Savo Vocational College in Kuopio and she works also as the coordinator for international relations in Savo Consortium of Education.

I asked Irja to tell me how using of CLIL affects the teaching.

Irja started by telling about criteria that good CLIL teachers should have. Holland is a pioneer in utilizing CLIL method and they have listed these properties. A good CLIL teacher has to:

- be good in making curricula
- be able to choose proper teaching material (first/CLIL language)
- know how to test the learning
- know proper emphasis in content versus linguistic skills
- be able to confirm real understanding of content (student may know it although s/he can´t explain it in foreign language)
- teach in a practical way, content must not be too difficult

Irja continued with her own opinions. A good CLIL teacher has to have good communication skills, s/he has to be able to explain and tell about things in very concrete ways. Lessons must be student-centered so that they act and do as much as possible. The assignments and tasks must be versatile and made so that students must talk about the topic. Good examples of that are

exercises in which two students have active dialog and find out answers to questions through that.

Irja told me about attending a lecture held by Heini-Marja Järvinen. Heini-Marja works as a lecturer for didactics of foreign languages in University of Turku. Heini-Marja had stated in her lecture that using CLIL vastly improves students´ understanding of the topic. But she had continued that CLIL does not improve so much writing and speaking. Improving of these demand very cognitive exercises. Talking, explaining to others and writing develop these skills.

All these four persons (Marsh, Marsland, Stenberg and Irja Nenola) seem to have same kind of thoughts about the differences that CLIL brings into teaching.

3.4 CLIL In Our Institute

I have been working as a temporary part-time teacher in Savo Vocational College since autumn 2002. I know that languages are taught inside general subjects in our institute, too. But I had no idea about the amounts of lessons etc. I asked Irja to tell me.

Irja Nenola teaches English. Her courses consist of two credit units only. In Swedish language there is one credit unit. She continued that 60 teaching hours is not much compared to comprehensive school. The language teaching in comprehensive school is more general and long term. The pupils will utilize their learning later in their life. In vocational institute the vocabulary is limited to field-spesific words. Students exercise to manage in real world working situations. They need the language when they communicate with customers personally or in the phone and when they present their products. Studies deal

with words concerning materials, machinery and field-spesific concepts and terms. Students would benefit by using CLIL if there just were more time and other resources available.

Irja continued that although our institute is not an actual CLIL institute this method is used in many courses at least partially. It wood be very productive if language teachers and subject teachers could co-operate. The subject teacher´s job would be to choose the learning material and to decide the functions that student has to be able to control. The language teacher´s duty would then be to think of the exercises through which these aims can be achieved. This kind of co-operation presupposes that the subject teacher is ´CLIL-minded´ and s/he is interested in interactive and communicative teaching. The best subjects for CLIL are practical ones. It would be ideal to have working life also involved in this co-operation. The students think very positive about this.

Irja told also that there is a mobility project in our consortium. Teachers and other staff are able to apply for travelling abroad for some weeks. By doing this they can improve their skills in languages, multiculturalism, teaching methods and get new contacts for student exchange.

3.4 Experiences in CLIL

In chapters 3.41 and 3.42 I refer to a video consisting of interviews of persons working with CLIL.

3.41 CLIL Needs Extra Resources, Interview of a Administrator

Katrinelund Gymnasium in Sundsvall was among the first regular state upper secondary schools in Sweden to begin offering a broad range of subjects taught through the medium of English. Jan Kibe is the Director of Education with The National Agency for Education in Sundsvall. He was former Deputy Head at Katrinelund.

He tells that the project was started from the idea of their headmaster. They tried to increase the possibilities to learn languages in their school without increasing the amount of actual language studies because that was difficult. They decided to do it inside the subjects. They asked teachers in autumn 1989 if there were persons willing to take part in such a project. Those teachers were without any special background with the English. A few were ready to try it and they started in 1990.

Because they were ´pioneers´ there was no material and teachers were unsure about how to do it. A vital thing is that the headmaster of the school supports the teachers both in their work and financially. In this case all the prework was paid service.

Extra money is so needed both for material and additional salary for the teachers compared to traditional teaching. When asked about any unforeseen problems, Jan tells that some teachers had difficulties with their English but in general everything went fine. Of course these teachers could not get all the support they would have needed, and thus they did a very hard job when building up the system. Many of the students achieved great improvement in their language skills compared to expectations before the project. The CLIL students reached the same or even higher level of knowledge than those just using Swedish.

Because CLIL has now spread out all over Sweden the teaching itself has changed. More international environment has changed the curriculum and the courses are better. (Talking about CLIL.)

3.42 Teachers Tell about their CLIL Experiences

Question 1. How is teaching bilingually different from teaching in mother tongue? Have your teaching methods changed?

Gunnar comes from Umeå´s Dragonskolan in Sundsvall, Sweden. He teaches physics and mathematics in English/Swedish and says that first of all you have to check all the time that pupils understand what you mean. You have to translate a lot because students need to know the Swedish words and concepts. In the beginning Gunnar thought to make everything only in English but he has changed his mind during the years. Mixing two languages is important beacause the pupils need to learn the Swedish vocabulary also. That is done in math for instance by using formula book in Swedish. The students agree about this with their teacher.

Riitta Liisa of Kulosaaren yhteiskoulu in Helsinki (Chemistry in English/Finnish): “It means a lot of homework for me, preparations are harder.”

Bjorn´s subject is civics in Katrinelund school of Sundsvall, Sweden. He has taught bilingually in English/Swedish already for four years. So he does not find it too hard any more. Of course you have to think wider yourself to be able to express things to the students.

Bertil (also from Katrinelund) being an ethics teacher sees a little problem with his own linquistic skills, this far. He often thinks things in his head first but has then to cut parts of it because he does not know the correct words for

them. You say to yourself that for the next lesson you will find out those words and that way it gets better. But that leads to unhomogeneous lessons.

Sirpa comes from Kulosaaren yhteiskoulu and teaches civics in English/Swedish. She for instance in her history lessons uses exactly the same teaching methods as normally in Finnish only. She even uses the same material.

Question 2. How do you see your role as a subject teacher and as a language teacher?

Gunnar says that first of all he is a psysics teacher. But because he uses English, he has to concentrate in the language, too. He of course corrects the students in their expressions and spelling if he can do that. That is, however, difficult for him because when correcting you have to be sure that you correct right.

Maria, a Finnish biology teacher from Helsinki states that she does not consciously think herself as a language teacher although she uses the language to bring the content to the students. The main point for her is: if they get the message, her teaching has then been successful also linguisticly.

Riitta Liisa is teaching the content, not the language. Language is not her main concern. She is all the time worried about making mistakes.

Bjorn is trying not to tell the students all the facts right a way but instead pushes them to find ones on their own. After that the facts are summed up collectively and common knowledge is then made of them.

Maria does not correct her pupil´s English because she thinks that belongs to the English teacher. But she does teach them new special words belonging to the content.

Question 3. How suitable is your subject for teaching bilingually compared with other subjects?

Maria´s opinion is that most subjects can be taught in foreign language. If other science subjects like math, physics, geography etc. are in English, that makes her own subject biology much easier because many concepts and vocabulary in foreign language are already familiar through those subjects.

Gunnar says that mathematics itself is an international language. So that is easy to teach in foreign language because not so many words are needed. Physics is more difficult in this case.

According to Sirpa some subjects are very hard to teach in English because of numerous difficult terms, for instance psychology and philosophy. The terms in those subjects are not well understandable to students even in Finnish. Riitta Liisa thinks that chemistry is one of the best because of the limited terminology.

Bjorn says that almost every subject can be taught by CLIL. He thinks that most of his students will continue their studies in university and when now studying in English they get confidence with it. In university many studying sources are available in foreign language only. This will prepare them for that.

Question 4. Do you think that the bilingual context reduces the amount of content that can be covered?

Gunnar says that there is a risk for this in the beginning but not so much after two or three times any more. Because Sirpa teaches very fast in what ever language she is using that is not a problem for her. She even teaches more content to the children when teaching in English. Bjorn also had difficulties at first to cover the content within scheduled time but adds then that the pace mainly depends on his capability to tell about the concepts and core things in foreign language. His students seem to be quite confident with their language.

Sometimes, especially when discussing some ethic or moral topics, they however have to switch the language in order to continue forward. After all their project in bilingual, both languages can be used.

According to Maria some subjects have very tight schedules, so CLIL cuts down the time available. You have to concentrate in the core topics when using English. Riitta Liisa says that her students get along without difficulties. If there are any they at least do not say so. She thinks that pupils may suffer from her poor English but because of she being NOT a native English speaking teacher they can always ask her to re-explain in Finnish things they did not understand.

Question 5. Can your students learn to the same depth bilingually, and do they have any particular problems?

Sirpa says that it is more difficult for those whose English is not very good, but even in Finnish they probably would not acquire the content well enough. In upper secondary school 80 % of her pupils acquire the knowledge in foreign language. Gunnar says that they do not lose much or learn at just the same level. The results of exams held to them do not differ from those who study the subject only in Swedish. Bjorn´s students do all the studying in this bilingual program. According to him the results show that they gain the same level or even higher than their fellow students. Those Riitta Liisa´s pupils that fail in her chemistry tests do not do that because of language problems. They just neglect everything despite the language.

Question 6. What are the greatest challenges for you as a bilingual teacher?

For Gunnar the greatest challenge is of course to be successfull, to find out that CLIL works and students learn the same way as they do when using their mother tongue. Sirpa´s goal is to manage with the children that have various native languages which are not just Finnish. These pupils also represent many nationalities. It is as well challenging for her that she constantly has to learn

new things herself. “After 15 years of teaching you have to do something new, something hard to cope with.”, says Bjorn. That also gives teachers more training possibilities. (Talking about CLIL.)

Conclusions

Using of CLIL method in teaching is impossible or at least very difficult if there are not suffiecient resources for that. The administration and principles of the institute should give the teachers their full support. This is done best by letting the teachers to do their extra prework for CLIL during working hours that they are paid for. Money is needed for learning materials as well. Using of CLIL causes teachers a lot of extra work during the teaching and after it which should be paid for. As far as I know, the teachers in my institute can do CLIL teaching but they are not paid extra for that. According to director Kibe many students achieved great improvement in their language skills and could adopt the contents at least as well or even better than in normal teaching.

Teachers think about differences in teaching and about changed methods like this:

- you have to check all the time that pupils understand what you mean
- you have to translate a lot because students need to know the words and concepts in both languages
- preparations are harder and there is more homework
- you have to think wider yourself to be able to express things to the students
- if you have problems with your language that might lead to unhomogenous lessons

Every teacher has to solve the problem of how to emphasize the subject versus language. Most of them put the weight on the content and successful understanding of it but want to correct students´ language also. But the

corrections have to be absolutely right and this causes extra tension to the teacher. Some teacher may also think that s/he is not good enough with the language.

Some subjects suit for bilingual teaching better than others. Interviewed teachers think that mathematics and chemistry are easier because of their universal structure and limited terminology. On the other hand subjects with difficult terms like psychology, philosophy and arts are not so easy.

Using of CLIL may cause some problems, too. It may reduce the time so that part of the content must be cut. If there are students whose English is not very good this may affect the learning results. Most teachers, however, think that failures in results do not come from language problems. (Talking about CLIL.)

3.43 Trying CLIL, Giving a Teaching Practice Lesson in English

As a part of this teacher education program in Jyväskylä I had to do two actual teaching practices. The first part I held in Finnish and the second set of lessons I taught in English.

I was teaching a subject of ´Basic Land Surveying Techniques´ to adult environmental operative students in February 2005. I decided to try CLIL by teaching one part of the subject in the time period of one day (8 lessons). The plan can be seen in details in appendix 1. I have added my own comments in the text after finished lessons. Those comments are in italic font.

I had to do a lot of prework when getting ready for the lessons. I translated the basic concepts into English and gathered a glossary of surveying and environmental words which took a lot of time. I also searched a ready article telling about the topics of our lessons. These are included in appendices 3 to 5.

I decided to tell the students about our CLIL ´experiment´ on preceding lesson before the actual teaching. I told them that we would tomorrow try a multilingual method to study basics of levelling. I also handed out to them the documents I described in previous chapter and asked them to get acquainted with the contents. I said that although the material is in English the main point is to understand the content. Finnish could be used whenever that would be necessary to understand the things. After that we already started a little by looking at the handouts and the glossary.

The students´s reactions varied a lot. Most of them murmured weak protests, some were very frightened and a few became greatly interested. I heard: “My English is so poor.”, “I never succeeded in languages.” and so on.

The next morning came and I started to teach according to my plan. I was very surprised to see that some of those students that looked most frightened when I told them about this trial, were missing now. In general these students succeeded well in all subjects. I suppose they were such perfectionists that they would have had problems with possible errors with their English.

I used both languages and tried to explain as clearly as possible. I also had a lot of illustrating surveying equipment with me. We rehearsed the calculations that we had done before but this time in English. I was very surprised to see that many of those persons who yesterday had been very skeptic about their linguistic abilities succeeded now very well. They won their fears about being able to pronounce perfectly and so on. They understood the content!
I sent an interview to the participants of the lesson by e-mail afterwards. There I asked them to tell about their feelings before, during and after the CLIL lessons. Here are some gleanings from the interviewing materials.

Question. Did you have problems to understand the content because of the English language?

”We handled the topics the previous day. It made things easier and after all it was not very difficult.”

”No major problems occured.”

“Not at all! On the contrary. Maybe I even listened more carefully.”

Question. Do you think that I should had used more Finnish?

“No, it was just right.” Your teaching was clear and even I understood it.”

“No. I prefer you had not used Finnish at all.”

Question. Would you like to try CLIL another time?

“Perhaps yes. But rather about some easier subject. The surveying is not very easy even taught in Finnish. The day went just fine and I got no permanent traumas. Keep on the same way!”

“Yes, I´d like that.”

“This one time was just enough for me!”

Conclusions

I very much agree with the teachers´ opinions in chapter 3.42. CLIL meant a lot of extra work for me and some for the students but we all succeeded well. I got mainly positive feedback from them and want to try again this sometime in the future.

4. DISCUSSION

Evaluating Formal Language Teaching

Traditional language teaching that we receive in basic school forms the necessary foundation for our further language studies. It is good, strict and productive in Finland. Linguistically talented pupils benefit a lot from it. For less talented or otherwise unsure students it can be a nightmare. They are ´punished´ or at least corrected clearly if they pronounce wrong or form clauses with errors. That does not always motivate them to go on. This is a two-sided problem. Luckily there have been changes from my school times. Strict controlling of grammar, vocabulary and writing have got besides them understanding of heard language and speaking. When I was in the senior secondary school in 1977 somebody pronounced English with American accent. S/he was every time ´guided safely back to paths´ of Oxford English.

Evaluating Language Immersion

It is always easier to believe theories´ outcomes when you have experienced it yourself or there are friends that have done it. My Canadian friend Robert (see chapter 2.41) and his family members among many others are a living proof of language immersion´s power. A child of any nationality will adopt the language of his/her mother. Partial immersion gives good language learning results also but takes more time. It would be interesting to enter some distant country at my age and see if I could learn a new language that I know nothing about now. I wonder how long time it would take by just ´flooding´ myself totally in that strange society without any contacts to my home country.

My experiences in Holland in 1982 support well these thoughts. My English language improved greatly and there were no problems to adopt the technical contents of engineering. On the contrary, I learned a lot of special things that

seldom can be found in Finland. Holland is maybe the leading country in the world in the field of civil engineering. They have to be because most of the country´s area is below the sea level. I made my final engineering thesis about civil engineering in Holland by giving an oral performance with numerous slides. That was a great success. Every student should have an opportunity to experiences like this. If my children want to go abroad for student exchange I will give them my full support.

Our excursion to Hungary lasted only for one week but it gave opportunities to my students to feel that they can use their English language to express themselves and understand what foreigners are saying. Their self-esteem grew. They found out that they control their prosessional field and know about content based concepts and words. In fact they were experts in it.

Evaluating CLIL

It was fine that I had the opportunity to try CLIL in my teaching work. Because I work as a temporary part-time teacher at the moment I doubt about using it in my teaching but maybe the future will offer more possibilities for that.

My usual subjects are mostly technical and even at the moment the curricula have too few hours. If I wanted to use CLIL it should be taken account inside the curriculum. I used normal Finnish, into English translated material and totally original English learning materials in my CLIL teaching test. I think that was good policy. I assessed the success of my teaching by checking out if the students understood the main contents and how they reacted themselves. If I would do the lessons again I would not change anything.

The language immersion and the CLIL are language learning/studying methods that vastly base on cognitive and constructivist learning theories. Teacher´s task is to work as a learning facilitator who creates favourable learning circumstances for the student to receive actively perceptions from

various sources. Teacher guides his/her development and makes ´bulbs switch on´ in his/her head. Learner´s self-esteem increases and this feeds further learning. The student reflects his/her learning and finds successful outcomes. The principles of communal pedagogy come true and every one is happy.

We become international and multicultural by using these methods for language learning.

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APPENDICES

Appendix 1
Teaching Practice, Plan and Report

Appendix 2
Teaching Practice, Curriculum in Finnish

Appendix 3
Teaching Practice, Land Surveying, Basic Concepts

Appendix 4
Teaching Practice, Land Surveying and Environmental Vocabulary

Appendix 5
Teaching Practice, Basics of Levelling

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TEACHING PRACTICE 2, REPORT

10.2.2005

My own reporting comments written with blue colour italic font (like this)

Student teacher: Kari Nieminen, kari.nieminen@sakky.fi, GSM 045 670 2480

School organization: Savon ammatti- ja aikuisopisto, Kuopio / Savon koulutuskuntayhtymä

Students group: Environmental operatives SLUO04V (ympäristönhoitaja)

What do environmental operatives do?

Environmental operatives carry out executing tasks in environmental surroundings (natural and environmental protection). Below are listed some possible job tasks:

reconditioning of lake and river systems:
- assistance in getting the basic information
- exhausting fishing (tyhjennyskalastus)

reconditioning of contaminated soil areas:
- old gravel areas
- old dumping-grounds
- shooting tracks
- sawmill areas, petrol stations etc.

taking samples from water and soil for laboratory:
- municipalities
- state
- industry

improving of ecological environments:
- wet areas (kosteikot)
- swamps
- bird lakes

guidance and consulting tasks:
- waste management and recycling
- sewage of one family (or equivalent) lodgings

Supporting teacher: Irja Nenola, irja.nenola@sakky.fi, GSM 044 785 3311

Teacher educator: Kirsi Murtosaari, kirsi.murtosaari@jypoly.fi, (014) 444 6778
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Narrative friends: Jukka Väisänen, jiivee@luukku.com, GSM 0400 650 824

Time: **Thursday** 10.2.2005 klo 8-15

Place: Presidentinkatu 3, Kuopio, suurryhmätila 2, kauneudenhoitorakennus,
in addition levelling exercises outdoors (ATTENTION: warm clothing!!!)

Subject: **Land Surveying and Map technics, contact teaching 3 cu, distance learning 1 cu**

The teaching will be multilingual, but as much as possible in English. Anyhow, the main thing is: to understand the subject itself. It is allowed to use Finnish at any stage if needed. Teacher uses both languages to explain the terms and phrases.

Topics of the lessons are:

Basics of Levelling, consisting of:

1. height systems
2. position (X/Y) and height (H, Z) marks and their explanation cards
3. the levelling procedure itself
4. the principle of calculating height
5. level man´s duties
6. staff man´s duties
7. levelling sub procedures and the actual “hands on” using of level
8. how to fill up the levelling matrix
9. calculation exercises
10. actual levelling excercise outdoors

Finally the evening before I decided to to add an extra introductory lesson before the actual subject of the day (Basics of Levelling).

In the beginning of the course I had given the students a document in Finnish (Maanmittaus, peruskäsitteitä). Now I gave them the same document translated into English. There is a chapter which introduces various main land surveying instruments from a simple tape measure up to a GPS receiver. I had all these intruments with me in “live”. I told what do we do with each one of them. They could also try some of them themselves.

Students’ backgrounds, skills and special needs:

Environment field is quite new and there are NOT so called ”ready made” professions. The first students of this field graduated from Savon ammatti- ja aikuisopisto in spring 2003.

The problem in this field is that possible employers do not know about the existence of these people or what

environmental operatives in general do. The students have to "build up" concretic tasks in order to market themselves. They have to "sniff around" the field and also be updated of the changing legislation of MANY DIFFERENT fields, in order to be able "offer" themselves to the employers.

I personally would say: This education and those studying in it are a mixture of both technical and ecological know-how and interests; they want to carry out concretic tasks outdoors and to be in close contact with nature.
To sum up the essential: they want to take care of yet unspoilt nature AND improve already spoilt one."

The schooling of just this group will last for two years being multiformal. This is their first year. In a month there is on an average one distance studying week, the rest of the time is normal contact teaching. The education includes on-the-job learning in positions that the students get themselves.

The overall subject of this course (Land Surveying and Map technics) is to teach the very basic land surveying tasks and to get acquainted with different kinds of maps (both conventional paper maps and the digital ones).

I have taught to this group other topics, too:

- basics of energy and water supply
- construction of community´s basic infrastructure
- waste management and recycling
- land use planning

There are 11 adult students, their ages varying from 20 to 50 years. They are active and well motivated, in my opinion an ideal group for TRYING SOMETHING NEW, which I think this first step (in my teaching career) towards CLIL is. The students are "environmentally orientated" yet not being "too green" (purely my personal estimation! ;-D).

How the subject entity belongs to curriculum / target of teaching:

Valtakunnallisessa opetussuunnitelmassa todetaan seuraavaa:

LUONTO- JA YMPÄRISTÖALAN PERUSTUTKINTO 2001

"Ympäristönhoito, 20 ov

…keskeinen sisältö on yhdyskuntatekniikan ympäristövaikutusten vähentäminen sekä maanmittaus- ja karttatekniikan perustöiden tekeminen."

Koulukohtaisessa opetussuunnitelmassa on tämän opintojakson tavoite määritelty seuraavasti:

See the curriculum (in Finnish only) attached to this plan.

I personally summarize the curriculum like this:
"Environmental operative shall know how to carry out the

basic land survey and mapping technology tasks in community development."

Orientation basis for the learning situation:

How do the students learn (see the detailed teaching procedures in the next chapter)?

The previous day (Wednesday) I have presented to them **in Finnish** the basic concepts by using overhead projector. They have been **listening and reading**. At the same time we have got to know terms and phrases related to the subject by **reading** the English glossary. I have also **written** those words on the white board.

We have become acquainted with the level machine and how to get it levelled. Students learn by **exercising themselves**.

On Thursday the same things (as Wednesday) will be repeated but **in English/in both languages**. Everyone makes the height **calculations** and this is repeated several times. The procedures are done again after English terms. At the end the full scale continous levelling exercise is done by using the foreign language. After every task every person inside the group switches into new task and **by that learns all the essential tasks of the levelling team**.

Detailed description of the plan:

Wednesday (previous day of the teaching practice)

I will tell the students that tomorrow we will try learning the day´s subject by Contents and Language Integrated Learning (CLIL) in English. I will introduce them the CLIL concept. I´ll tell why and how it is done and what kind of benefits it can offer to students etc.

We will start closing the Thursday´s subject (Basics of Levelling) already then and I will hand them out the glossary of terms and concepts. The teaching, anyhow, is in Finnish. We navigate through the main procedures and terms, at the same time we pick up the English words for the Finnish terms. We become acquainted with the level and how to use it. At the end of the day I give them an article in English which deals with the subject. This is their homework, to some extent to understand what is happening in the article (see attached file "5 task for students, basics of levelling.doc").

Thursday, Feb 10th (The Day) ;-D

We restart the subject from zero. I speak English and encourage the students to do so as well. I very much emphasize that now there is not much to concern about how well they pronounce the words they use or how many mistakes they make with the grammar. The main thing is that they make themselves understandable and they themselves

understand the subject and what we are talking about. Might someone to feel unsure about one´s talents, he/she can always switch into Finnish. And of course everyone can help each other with the words and phrases. Our progress in the subject is very slow – but inevitable.

1. I start by telling what levelling is about. I tell what things we find out by it and in what example working tasks we need it. We get to know the height systems used in Finland and their history as well.

2. What are these and why do we need them:
   - position mark network
   - multi angle marks and lines
   - height marks
   - explanation cards attached to those

3. The levelling procedure

4. The principle of calculating height, the formula and one example

5. What does the level man do and what are his/her duties

6. What does the staff man do and what are his/her duties

7. I divide the class into four groups each one consisting of three students (one group may have only two members, or not if one extra student from Suonenjoki will join us). Every group is working together in exercises as a levelling team. Normally a levelling group only needs two persons but here in our excercise one of them can work as a clerk and at the same time observe the others.

   Every group picks up the equipment which is: a level, a tripod, a tripod star and a staff. The groups gather in the classroom around those things. I start telling them what to do and they follow by doing themselves. I skip here those details in between. By doing these procedures they get to know the using of level itself and how to aim the level towards the staff. They exercise how to do the reading from staff scale properly. The readings are written down and then we calculate the absolute height of target as well as the height difference between two spots. The members inside the group change the tasks so that every person does every task. At the end they dismount the equipment and learn how to prepare it properly for tranportation.

   We learn by doing concrete procedures ourselves and ALL DO EVERY procedure needed to learn.

8. Studying continues: we start filling up the levelling matrix and learn how to calculate the final height with it.

9. We repeat the matrix calculation with several examples.

Somewhere between these sub subjects (when it is reasonable, may be before “chapter” 9) we´ll have lunch.

10. When having had the lunch and completed all the tasks from #1 to #9 we change the classroom out to wonderful refreshing winter weather.
Before this I give to everyone a full scale CONTINOUS LEVELLING task to carry out. They have to find out the absolute height of a given spot by “running”/transporting the height to it from a fixed height mark in the starting point. One person at a time is working as the level man, one is the staff man and the third writes down to the levelling matrix the backsight anf foresight readings as a clerk. When the height has been run to the target, the clerk calculates the final height. A short “spin” around in the group and the next person takes the role of the level man. By continuing this changing of tasks every person completes every three jobs.

After completion of all 4 groups we gather again in the classroom, warm up the frozen hands and such and compare the results of levelling INSIDE the groups and BETWEEN the groups. If any differences can be found we find out the reasons for those. We get together the main causes for possible errors. If any time left we once again recapitulate the main procedures.

At Thursday morning at 8 o´clock I realized the some people did not come to the lesson because of knowing about this CLIL method (this is naturally my assumption, they might also have REALLY been ill!) They

surely felt themselves SO UNSURE about their abilities to cope with the language. So they just “ran away”! But even more happy I was about those 7 of 11 brave ones that arrived. And I found out that among these people were several people that “grinned their teeth” in Wednesday when I told them “the news”. They were not happy at all but managed during these lessons just fantastic!

The students seemed to understand TOTALLY the planned contents of the subject despite the foreign language used. At the toughest points I switched into Finnish temporarily but soon continued in English again. I got the theory lessons finished 30 minutes ahead of planned schedule and so did we depart for lunch.

After lunch we completed the planned practical levelling exercise outdoors. There were fewer groups than planned but that did not have any effects on the learning results, on the contrary: I had more time to guide individual students.

We did the full exercise and then returned into the class. We checked the levelling results and discussed the minimum errors that occured in them. Both the students and I were very happy for the day, for using CLIL and for the learning results.

My own opinion: the day and the results of this CLIL trial were a GREAT SUCCESS! I am surely going to try this again!

OPETUSSUUNNITELMA 14.1.2005

TUTKINTO: **Luonto- ja ympäristöalan perustutkinto**
KESTO: **90 ov**
OPINTOKOKONAISUUS:

Koulutusohjelmittain eriytyvät ammatilliset opinnot

Ympäristöala: ympäristönhoito tai ympäristötekniikka

MODUULI:
OPINTOJAKSO: **Maanmittaus- ja karttatekniikka**
LAAJUUS (ov): Lähiopetus 3 ov, etäopetus 1 ov

TAVOITE: **MAANMITTAUSTEKNIIKKA**

1. Mittauksen perusteet

Opiskelija tuntee mittauksen perusvälineistön, kuten mittanauhat, linjaseipäät ja kulmaprisman sekä osaa käyttää, säilyttää ja huoltaa niitä asianmukaisesti.

Opiskelija osaa mitata mittanauhan avulla tarvitsemiaan etäisyyksiä sekä määrittää mahdollisten nauhakorjausten tarpeen. Hän kykenee tekemään yksinkertaisia kartoitus- ja paikalleenmittaustehtäviä mittanauhan ja kulmaprisman avulla.

Opiskelija osaa hyödyntää ”kirvesmiehen muistikolmiota” ja/tai Pythagoraan teoreemaa merkitessään maastoon tarvitsemiaan mittoja (ristimitta) mittanauhan avulla.

2. Korkeuden mittaus/merkitseminen

Opiskelija tuntee Suomessa käytössä olevat korkeusjärjestelmät, niiden historian ja kehittymisen nykyiseen käyttömuotoonsa. Hän osaa selvittää käyttämänsä korkeusjärjestelmän suhteen nykyisin käytössä olevaan N60–korkeusjärjestelmään. Hän osaa hakea tarvittavan korkeustiedon kulloisellekin rakennus-/mittauskohteelle ja varmistaa tietojen oikeellisuuden suunnitelmissa esiintyviin korkeustietoihin.

Opiskelija tuntee ja osaa omatoimisesti rakentaa maanrakennustyömaalla yleisimmin käytössä olevat korkeuden merkitsemistavat, kuten ”sihtilaput”, portit, tasokolmiot ja linjapukit. Lisäksi hän ymmärtää em. merkintätapojen tarkkuuden.

Hän osaa suorittaa pintavaaituksia ja piirtää tulosten pohjalta tarvitsemiaan leikkauspiirustuksia ja tarvittaessa korkeuskäyriä. Hän osaa siirtää korkeuden jonovaaitusperiaatteella ja ymmärtää vaaituksen sulkemisen periaatteen ja tarkoituksen. Hän osaa vaaituskirjanpidon.

Hän osaa todeta maa-ainespaikan pohjan ja pohjavesiputken yläpään korkeuden.

Opiskelija tunnistaa ja tietää ”vanhat” korkeuden mittausmenetelmät kuten vesiletku ja vatupassi sekä tietää barometrisen korkeusmittauksen periaatteet.

3. Laseretäisyysmittarit, pointterit, taso- ja putkilaserit ja käsi-GPS

Hän tunnistaa em. laitteet ja osaa käyttää tasolaseria sekä GPS-laitetta. Hän ymmärtää GPS-paikannuksen pääperiaatteet.

4. Takymetri ja tarkkuus-GPS mittalaitteena

Opiskelija tunnistaa teodoliitin, takymetrin ja senttimetriluokan GPS-laitteen. Hän osaa keskistää ja tasata takymetrin.

Hän osaa koordinaatti- ja suuntalaskennan perusteet (geodeettinen pää- ja käänteistehtävä).

Hän osaa toimia takymetrimittauksessa prismamiehenä.

Hän tuntee takymetrin/GPS:n edut ja haitat mittaustilanteessa toisiinsa verrattuna.

TAVOITE: **KARTTATEKNIIKKA**

Opiskelija tuntee tavallisimmat karttakoordinaatistot (maantieteellinen ja suorakulmainen KKJ-koordinaatisto). Hän erottaa toisistaan eri mittakaavaiset maasto- ja kaavakartat sekä tuntee sähköisessä muodossa saatavia kartta-aineistoja. Hän osaa käyttää Maanmittauslaitoksen Karttapaikkaa.

TOTEUTUS: Luennot ja käytännön harjoitustehtävät, vierailut.

Opintojaksolla annetaan harjoitustöitä sekä siitä pidetään koe.

Mahdollisia vierailupaikkoja:

Pohjois-Savon Maanmittaustoimisto
Alueen kaupunkien/kuntien mittaustoimistot
Alan konsulttiyritykset
Alan laite- ja ohjelmistotoimittajat

ARVIOINTI: 1
Opiskelija tuntee mittauksen perusvälineistön, kuten mittanauhat, linjaseipäät ja kulmaprisman sekä osaa käyttää, säilyttää ja huoltaa niitä asianmukaisesti.

Hän osaa mitata mittanauhan avulla tarvitsemiaan etäisyyksiä sekä määrittää mahdollisten nauhakorjausten tarpeen.

Hän osaa hyödyntää ”kirvesmiehen muistikolmiota” ja/tai Pythagoraan teoreemaa merkitessään maastoon tarvitsemiaan mittoja (ristimitta) mittanauhan avulla.

Opiskelija hallitsee mittakaavakäsitteen, tuntee peruskartan sisällön sekä erottaa toisistaan eri mittakaavaiset maasto- ja kaavakartat.

2
Tason 1 lisäksi oppilas tuntee Suomessa käytössä olevat korkeusjärjestelmät, osaa saattaa vaaituskoneen käyttökuntoon ja toimia lattamiehenä.

Hän kykenee tekemään yksinkertaisia kartoitus- ja paikalleenmittaustehtäviä mittanauhan ja kulmaprisman avulla.

3
Tasojen 1-2 lisäksi hän osaa siirtää korkeuden jonovaaitusperiaatteella ja ymmärtää vaaituksen sulkemisen periaatteen ja tarkoituksen. Hän hallitsee vaaituskirjanpidon sekä –laskennan. Hän osaa toimia takymetrimittauksessa prisma-miehenä.

Opiskelija tuntee tavallisimmat karttakoordinaatistot (maantieteellinen ja suorakulmainen KKJ).

4
Tasojen 1-3 lisäksi oppilas tuntee ja osaa omatoimisesti rakentaa maanrakennustyömaalla yleisimmin käytössä olevat korkeuden merkitsemistavat, kuten ”sihtilaput”, portit, tasokolmiot ja linjapukit. Lisäksi hän ymmärtää em. merkintätapojen tarkkuuden.

Hän osaa suorittaa pintavaaituksia ja piirtää tulosten pohjalta tarvitsemiaan leikkauspiirustuksia ja tarvittaessa korkeuskäyriä. Hän osaa käyttää tasolaseria. Hän tietää, mikä on teodoliitti ja takymetri.

Oppilas tuntee sähköisessä muodossa saatavia karttaaineistoja ja hän osaa käyttää Maanmittauslaitoksen Karttapaikkaa.

5
Tasojen 1-4 lisäksi oppilas pystyy tarvittaessa ohjaamaan muita työn suorituksessa.

YHTEYS MUIHIN OPINTOIHIN:
Maa-aines, karttatulkinta, ympäristötekniikka, ympäristönhoito

KIRJALLISUUS: Monisteet

LAATI: Kari Nieminen

LAND SURVEYING, BASIC CONCEPTS

According Nykysuomen sanakirja (translation by Kari Nieminen):

Land surveying = to map areas of land in order to find out conditions for ownership and taxation ,
(domain = tilus)

Surveyor = a professionally qualified person, who is entitled to subdivide landed property and other similar type of official land surveying procedures

Maanmittari Ruotsin vallan aikaan
[Lantmätarnas härjningar]

Kaikkialla Ruotsissa tavattava maanmittarien ammattikunta kuuluu papiston lisäksi hyvin toimeentulevien luokkaan. Maanmittarit nylkevät ihmisiä ja saavat aikaan enemmän pahaa kuin kaksinkertainen määrä englantilaisia maalaisasianajajia. On mahdotonta tehdä tarkkaa selkoa näiden ruotsalaisten verenimijöiden voimasta ja vaikutusvallasta. On myös vaikea kuvitella mielessään mitään ammattikuntaa, joka saisi jossakin maassa suurempaa vahinkoa aikaan tai nylkisi muita vielä enemmän.

Talonpoikien viljelysmaat on tosin aidattu, mutta kukin tila omistaa yhteisestä maasta vain pienen kaistaleen. Rajamerkin virkaa toimittaa tavallisesti vain pieni oja tai maahan isketty paalu. Hyvin usein näitä rajapyykkejä häviää, mikä johtaa kaikenlaisiin omavaltaisuuksiin ja kiistoihin. Tällaisessa tilanteessa haetaan tavallisesti paikalle maanmittari, joka ottaa tilanteesta vaarin nylkeäkseen kumpaakin osapuolta niin kauan kuin riitaa kestää. Tässä ei kuitenkaan ole vielä kylliksi. Maanmittari on tottunut iloisiin ja makeisiin päiviin. Hän pelaa ja juo mielellään ja tietysti hän tarvitsee paljon rahaa. Tarpeen tullen maanmittari vihjaisee jollekin talonpojalle, etteivät rajapyykit hänen maillaan ole oikein kohdallaan. Samalla hän lupaa hoitaa asian kuntoon. Tämä tietysti ärsyttää talonpojan naapuria ja niin riita on valmis. Kumpikin riitapuoli on valmis luopumaan vaikka puolesta omaisuudestaan saadakseen vain oman kostonhimonsa tyydytettyä. Vastapuolen etua loukataan täsmälleen niin paljon kuin tuon petollisen välimiehen ahneus vaatii.

Paremmat ajopelit, tavallista vauraampi talo tai poikkeuksellisen uljas hevonen ovat yleensä maanmittarin omaisuutta. Nälkäisten jalopeurain lailla maanmittarit käyvät ympäriinsä etsien kenet he saisivat niellä. Maanmittarin ilmestyminen paikkakunnalle ennustaakin aina vaaraa. Ihmeellistä, että niinkin kumousherkässä maassa kuin Ruotsissa tuollaiset riistäjät ja rauhanhäiritsijät saavat kenenkään estämättä tehdä tuhoaan.

(Lähde: Edward Daniel Clarke: Matka Suomen halki Pietariin, 1799.)

What are official land survey procedures? (Mitä ovat maanmittaustoimitukset?)

Ostitko omakoti- tai rantatontin? Se muodostuu itsenäiseksi tilaksi lohkomistoimituksessa. Lohkominen käynnistyy automaattisesti, kun lainhuuto on myönnetty.

Onko rajapyykkisi kadonnut? Hae rajankäyntitoimitusta kadonneiden rajapyykkien tai muutoin epäselvien rajojen paikallistamiseksi.

Epätietoisuutta tieoikeudesta? Onko tilallesi virallista tieyhteyttä? Kulkeeko joku mielestäsi luvatta alueesi kautta? Haluatko siirtää pihasi läpi kulkevan tien toiseen paikkaan? Onko tien kunnossapitokustannusten jakamisessa epäselvyyksiä? Hae yksityistietoimitusta, jos asia ei muuten selviä.

Kangerteleeko yhteisomistuksessa olevan metsäsi hoito? Eikö sopimusta tilan jakamisesta saada aikaan? Halkomistoimituksessa Sinulle kuuluva osuus (esim. 1/3) voidaan erottaa itsenäiseksi tilaksi.

*Tarvitsetko venevalkaman? Onko kesämökkisi saaressa etkä tiedä, missä saat pitää venettä ja autoa? Hae **rasitetoimitusta**, kun tarvitset käyttöoikeuden toisen omistamaan maahan esimerkiksi venevalkamaa, pysäköintipaikkaa tai vaikkapa vedenottoa varten.*

Vaikeuttaako vesijättö rantasi käyttöä? Jos rantaviiva on tonttisi kohdalla pysyvästi paennut, voidaan haitta yleensä poistaa vesijätön lunastustoimituksessa. Siinä vesijättömaa liitetään korvausta vastaan omistaamasi kiinteistöön.

Omistatko useita tiloja? Jos omistat vierekkäin useampia tiloja, voi olla järkevää hakea niiden yhdistämistä yhdeksi tilaksi. Yhdistämispäätöksen tekee maanmittaustoimisto.

Kuinka haet maanmittaustoimitusta? Maanmittaustoimitusta haetaan aina kirjallisesti. Eri toimituslajeissa tarvittavista asiakirjoista ja toimitusten kustannuksista saat tarkempia tietoja maanmittauslaitoksen toimipisteistä.

(Lähde:www.maanmittauslaitos.fi)

To measure = to find out bigness, size or value of a quantity

Geodesy = a field of science which deals with defining the shape and size of the globe as well as land surveying and describing its surface

To map = to draw a map of a certain region (map = a miniature picture based on land survey measurements of restricted area)

In Finland in land surveying there are professional qualifications on three levels:

1. Master of Science for Surveying and Mapping Technology, MSc (Surveying) (maanmittausinsinööri, teknillisen korkeakoulun suorittanut, DI)
2. Bachelor of Science for Surveying and Mapping Technology, BSc in Surveying (maanmittausinsinööri AMK, ammattikorkeakoulun (polytechnics) suorittanut, ennen maanmittausteknikko)
3. kartoittaja (ammatillisen koulutuksen suorittanut, ennen kartanpiirtäjä, kartografi)

Technical surveying = the actual technical measurements carried out by various land surveying instruments which among other things are:

- tape measure
- surveyor´s stake
- angle prism
- level
- laser level, pipe laser
- theodolite
- total station (tacheometer)
- GPS receiver

When doing the technical land surveying we either:

1) …want to **map (register)** by surveying desired point´s X, Y, Z (H) coordinates = **mapping**

2) …want to **set out** (stake out) a new desired point´s coordinates X, Y, Z (H) = **setting out**

To level = to find out or set out **only the height (H)**

MAANMITTAUKSEEN JA VAAITUKSEEN LIITTYVÄÄ SANASTOA	
(translations edited by Kari Nieminen)	
Englanti >> suomi	
absolute levelling	korkeuden määritys merenpinnasta
area	pinta-ala
area (of land)	maa-alue
automatic compensator	automaattitasain
backsight	taakse
backsight reading	taaksepäin-lukema
circular bubble	rasiatasain, rasiatasaimen kupla
concept	käsite
continous levelling	jonovaaitus
cross-hair	hiusristikko
decrease in elevation	negatiivinen korkoero (ts. alempana)
differential levelling	korkeuseron määritys pisteiden välillä
digital level	digitaalinen vaaituskone
direction of travel	vaaituksen etenemissuunta
domain	tilus
entitled to	oikeutettu (jhk)
estate	maaomaisuus, maatila (estate car = farmariauto)
levelling mark (H, Z) (epävarma käännös)	korkeuskiintopiste
position mark (X/Y) (epävarma käännös)	tasokiintopiste
footscrew	jalkaruuvi
foresight	eteen
foresight reading	eteenpäin-lukema
graduated staff	vaaituslatta (mitta-asteikolla varustettu)
graduation	jako
laser level	tasolaser
level	taso, vesivaaka, vaaituskone
level station	kojeasema
levelling	vaaitus
levelling screw	tasausruuvi
map	kartta, kartoittaa
mount	asentaa, kiinnittää
network of position marks (epävarma käännös)	tasorunkoverkko
personal estate	irtaimisto (vrt. real estate)
precise level	tarkkavaaituskone
real estate	kiinteistö (vrt. personal estate)
rise in elevation	positiivinen korkoero (ts. ylempänä)
setting out	maastoon merkintä, asettaa merkki
staff	latta
stake	seiväs, paalu
steepness	jyrkkyys
subdivide	lohkoa kiinteistö (maanmittaustoimitus)
subdivision	lohkominen (kiinteistön)
surface levelling	pintavaaitus
survey	mitata, kartoittaa
surveyor	maanmittari
term	ammattisana, termi
territory	maa-alue
to be levelled	olla vaakasuorassa
to level	vaaita, tasata vaaituskone
tripod	kolmijalka, jalusta
tubular bubble	putkitasain
tide	vuorovesi
gauge	mittari, mitta-asteikko
immediate	välitön
vicinity	läheisyys
benchmark	vertailupiste
vertical crustal motion	maankohoaminen
National Levelling Network	korkeuskiintopisteverkosto (vrt. tarkkavaaitukset Suomessa)
height system, datum	korkeusjärjestelmä
datum, height system	korkeusjärjestelmä
hence	tästä (syystä)
intermediate point (temporary)	vaihtopiste (väliaikainen) vaaituksessa

MAANMITTAUKSEEN JA VAAITUKSEEN LIITTYVÄÄ SANASTOA	
(translations edited by Kari Nieminen)	
Suomi >> englanti	
ammattisana, termi	term
asentaa, kiinnittää	mount
automaattitasain	automatic compensator
digitaalinen vaaituskone	digital level
eteen	foresight
eteenpäin-lukema	foresight reading
hiusristikko	cross-hair
irtaimisto (vrt. real estate)	personal estate
jako	graduation
jalkaruuvi	footscrew
jonovaaitus	continous levelling
jyrkkyys	steepness
kartta, kartoittaa	map
kiinteistö (vrt. personal estate)	real estate
kojeasema	level station
kolmijalka, jalusta	tripod
korkeuden määritys merenpinnasta	absolute levelling
korkeuseron määritys pisteiden välillä	differential levelling
korkeusjärjestelmä	height system, datum
korkeusjärjestelmä	datum, height system
korkeuskiintopiste	levelling mark (H, Z) (epävarma käännös)
korkeuskiintopisteverkosto (vrt. tarkkavaait. Suomessa)	National Levelling Network
käsite	concept
latta	staff
lohkoa kiinteistö (maanmittaustoimitus)	subdivide
lohkominen (kiinteistön)	subdivision
läheisyys	vicinity
maa-alue	area (of land)
maa-alue	territory
maankohoaminen	vertical crustal motion
maanmittari	surveyor
maaomaisuus, maatila (estate car = farmariauto)	estate
maastoon merkintä, asettaa merkki	setting out
mitata, kartoittaa	survey
mittari, mitta-asteikko	gauge
negatiivinen korkoero (ts. alempana)	decrease in elevation
oikeutettu (jhk)	entitled to
olla vaakasuorassa	to be levelled
pinta-ala	area
pintavaaitus	surface levelling
positiivinen korkoero (ts. ylempänä)	rise in elevation
putkitasain	tubular bubble
rasiatasain, rasiatasaimen kupla	circular bubble
seiväs, paalu	stake
taakse	backsight
taaksepäin-lukema	backsight reading
tarkkavaaituskone	precise level
tasausruuvi	levelling screw
taso, vesivaaka, vaaituskone	level
tasokiintopiste	position mark (X/Y) (epävarma käännös)
tasolaser	laser level
tasorunkoverkko	network of position marks (epävarma käännös)
tilus	domain
tästä (syystä)	hence
vaaita, tasata vaaituskone	to level
vaaituksen etenemissuunta	direction of travel
vaaitus	levelling
vaaituslatta (mitta-asteikolla varustettu)	graduated staff
vaihtopiste (väliaikainen) vaaituksessa	intermediate point (temporary)
vertailupiste	benchmark
vuorovesi	tide
välitön	immediate

YMPÄRISTÖNHOITOON LIITTYVÄÄ SANASTOA	
(translations edited by Kari Nieminen)	
Englanti >> suomi	
energy supply	energiahuolto
environmental operative	ympäristönhoitaja
environmental permit application	ympäristölupahakemus
natural and environmental protection	ympäristönsuojelu
nature conservation	ympäristönhoito
real estate	kiinteistö
reconditioning of contaminated soil areas	pilaantuneiden maa-aluiden kunnostus
recycling	kierrätys
soil excavation	maa-ainesotto
soil improvement	maanparannus, kunnostus
sustainable development	kestävä kehitys
waste management	jätehuolto
water area	vesialue
water supply	vesihuolto
Suomi >> englanti	
energiahuolto	energy supply
jätehuolto	waste management
kestävä kehitys	sustainable development
kierrätys	recycling
kiinteistö	real estate
maa-ainesotto	soil excavation
maanparannus, kunnostus	soil improvement
pilaantuneiden maa-aluiden kunnostus	reconditioning of contaminated soil areas
vesialue	water area
vesihuolto	water supply
ympäristölupahakemus	environmental permit application
ympäristönhoitaja	environmental operative
ympäristönhoito	nature conservation
ympäristönsuojelu	natural and environmental protection

BASICS OF LEVELLING

USES OF LEVELLING

In the context of tidal measurements, levelling is used for the following purposes:

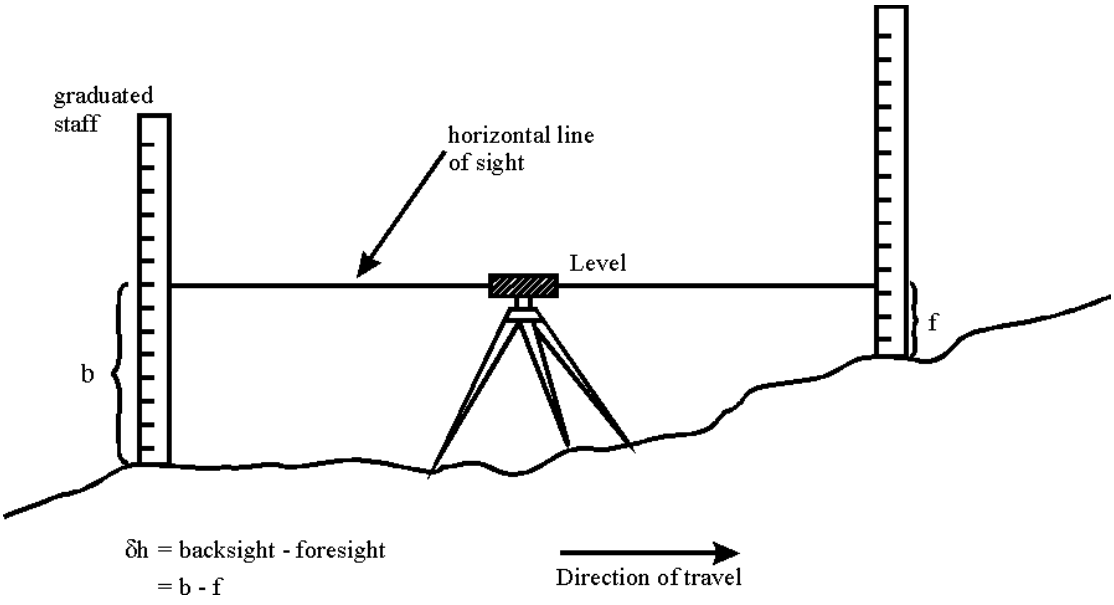
- Referencing of Tide Gauges: To determine and check the vertical stability of the tide gauge bench mark (TGBM) with respect to reference points (benchmarks) in its immediate vicinity. In order to isolate any local movements, there should be at least three such benchmarks, and the levelling should be repeated on an annual or semi-annual basis.

- Connection to GPS Reference Points: To determine its regional stability and to separate sea level rise from vertical crustal motion, the TGBM should be connected via GPS to reference stations fixed in a global co-ordinate system. Generally speaking, the GPS antenna cannot be directly placed on the TGBM and a GPS reference point must be established a short distance away. This must be connected to the TGBM by levelling.

- Connection to National Levelling Network: Mean sea level is used to define vertical datums for national surveying and mapping - hence the TGBM must be connected to the national levelling network. Connection to the network will also allow all tide gauges to be connected to each other, providing information on spatial variations in mean sea level.

PRINCIPLE OF DIFFERENTIAL LEVELLING

Differential levelling provides a means of accurately measuring height differences between points some tens of metres apart. A level is set up on a tripod and levelled so that the line of sight is horizontal:



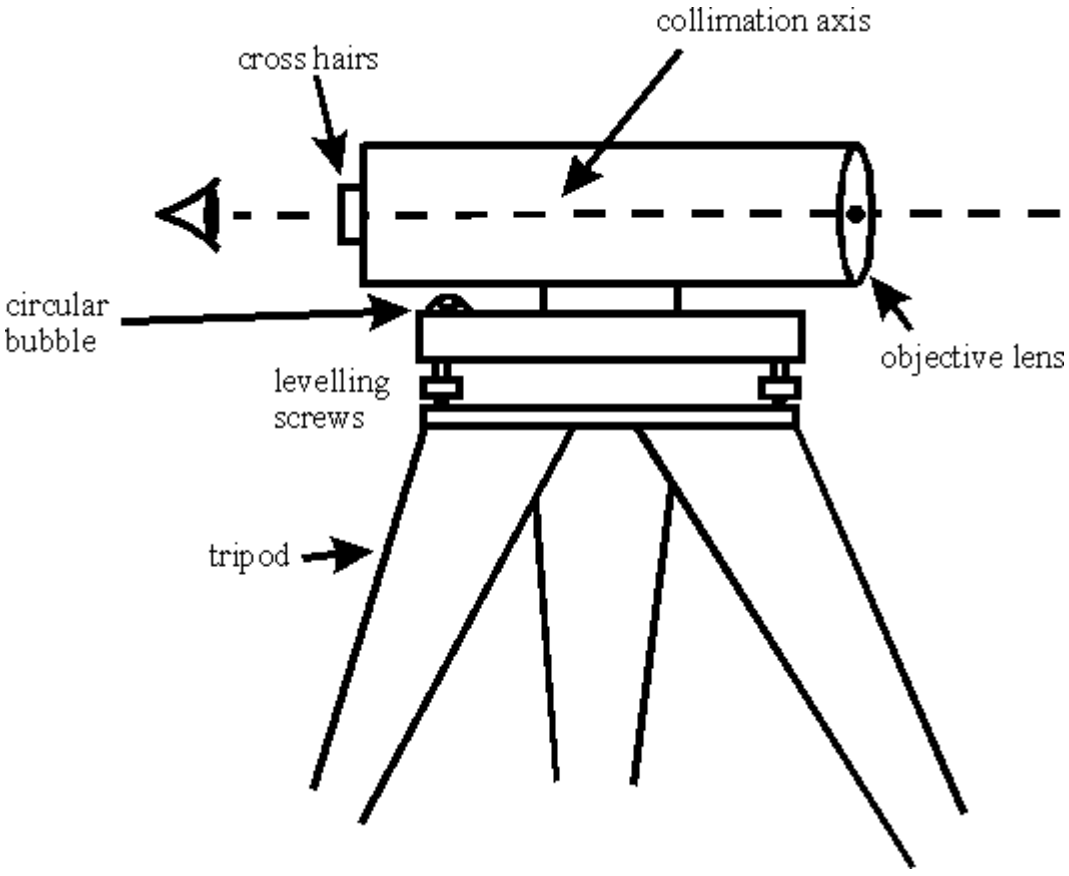
A graduated staff is held vertically over the first point and a reading made of the intersection of the cross-hair with the image of the staff (backsight - b). The same (or an identical) staff is then held vertically over the second point and a further reading made (foresight - f). The difference between the two readings is the difference in height between the two points:

$$\delta h = b - f$$

If b is greater than f then δh is positive (i.e. there is a rise in elevation in moving from the first to the second point).

This process can be repeated - the level can be moved to beyond the second point and the height difference between the second and a third point measured by the same process. Further repetitions will allow the height difference between widely separated points to be determined by accumulating the height differences between (temporary) intermediate points. The distance from level to staff is dictated by the steepness of the terrain and the clarity of the image viewed by the observer. Usually the maximum sight length is restricted to 50-60m.

The sketch below shows a schematic illustration of a basic level:



The level is mounted on a tripod, and has three levelling screws that (in conjunction with a circular bubble) allow the level to be levelled. These screws have a limited range and the tripod head must be set approximately level beforehand by adjusting the tripod legs.

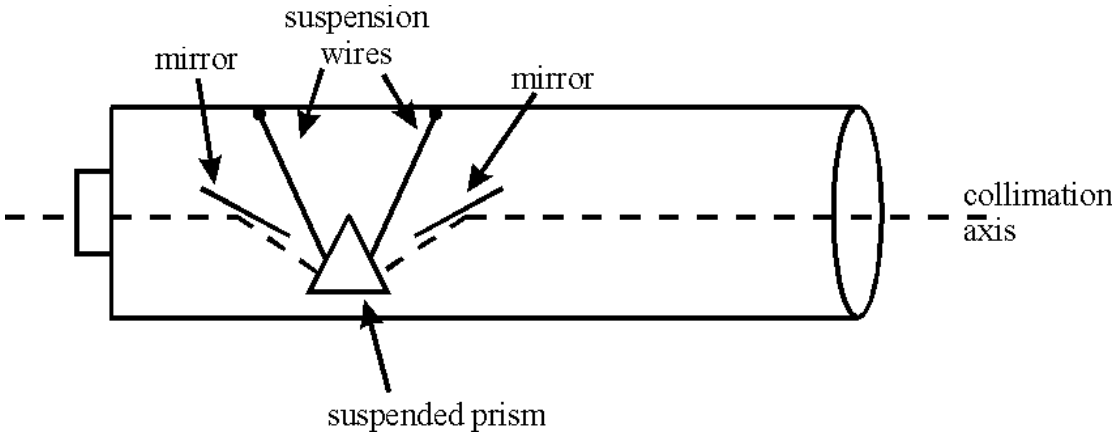
The upper part of the level consists of a telescope tube with an objective lens and an eyepiece with a cross-hair. The line of sight (collimation axis) is defined by the line

joining the centre of the cross-hairs with the focal point of the objective lens. The telescope is mounted on an axis that allows it to be rotated in the horizontal plane.

The circular bubble is not very sensitive and is not the sole means of levelling the level. Older levels will have tubular bubbles attached to the side of the telescope, and the footscrews are used to level this bubble, which then provides a horizontal line of sight in the direction of the collimation axis.

Automatic Compensator:

Modern levels will all use some form of automatic compensator, which allows the user to level the instrument with the circular bubble only. Any small departures are compensated by the compensator. The figure below shows a schematic illustration of one type of compensator:



In this device the image of the object is deflected by a fixed mirror to pass through a prism, after which it is deflected by another mirror to the eyepiece. The prism is supended by wires and its orientation changes as the telescope tube is tilted. The geometry of the device is designed so that any tilt of the telescope tube is compensated by a tilt of the prism and the collimation axis remains horizontall. The compensator has a limited range (a few minutes of arc) and the level must be levelled reasonably well using the circular bubble before the compensator will work correctly.

Types of Level:

Broadly speaking, there are three classes of level:

- *Builder's/Engineer's Level:* As implied by the name, these are used by builders and engineers. Their design is basically as described earlier, and they use graduated staffs in which the smallest graduation is 1cm. Millimetres must be estimated, and the accuracy of a single reading will be about 2-3mm.

- *Digital Level:* This type of level uses a special bar-coded staff. The image of the staff passes through the objective lens and then via a beam splitter to a photodetector array, where it is digitised. The microprocessor compares this image to a copy of the bar code and calculates the staff reading, which is displayed and/or stored. The sensitivity of the device is such that single reading accuracies of 0.2mm to 0.3mm can be achieved,

and sight lengths can be extended up to 100m.

- *Precise Level:* This is a modification of the conventional level in which a parallel plate micrometer is placed in front of the objective lens. This allows the image of the staff graduation to be moved up or down by very small measurable amounts. For sight lengths of under 50m, single reading accuracies of 0.02mm to 0.03mm can be achieved.

As precision improves, so prices increase. It is tempting to use a builder's level for reasons of economy, and many tidal institutions have done so. However, if measured small changes in mean sea level are to be meaningful, the stability of the TGBM must be unquestioned, and accuracies of 1mm or better are desirable for the levelling connection. Precise levels have been used and will continue to be used, but if a new level is to be acquired, the best option would be a digital level.

(These notes are based on lectures by Professor Charles Merry, University of Cape Town, at the 1998 GLOSS Training Course at UCT. Figures by Gillian Spencer.)

Source: www.pol.ac.uk/psmsl/training/levelling.doc