Do we speak each others´ language?
A methodology for developing generic GI-competencies

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SUMMARY

The knowledge, skills and attitudes GI-personnel need are often unclear. In addition, GI-curricula between different educational institutions are difficult to compare due to the absence of standardised or generic definitions. This paper aims to describe the method that was applied to reach a universal understanding between educational organisations. The method was developed during a project conducted by four educational institutions. A circular process was applied to reach a generic overview of GI-competencies in which not only knowledge, skills and attitudes were taken as a starting point, but also more practical aspects such as GI-roles and GI-products. It could be regarded as the first step to enable easier student exchange between levels (Bachelor-Master), between organisations and from education to GI-related jobs. The method is an open and ongoing process in which other (educational) organisations could participate. New developments in the GI-domain could in the future easily be implemented.

KEYWORDS: *GI competencies, education, job descriptions, standardised*

INTRODUCTION

Currently, advertisements for GI-jobs are often unclear in what organisations seek from new GI-personnel. Many different job descriptions exist for similar positions, with many definitions possible. For people searching a new job, especially people who have just finished a degree or course in GI (Geo-information) or a related field, it is difficult to find the job fitting their demand. On the other hand, for employers it is unclear how to describe GI-vacancies adequately. There is no generally accepted terminology or methodology that enables clear and unique definition. For example, what are the tasks of a GI-specialist? Is this a technical job or a job that needs thorough insight in possible solutions in the GI-work process?

In addition, in education, similar problems exist. Many educational institutes in the Netherlands educating in GI have often individually defined competencies (Rip & Epema, 2004) or are in the process of doing so (Meyles & de Bakker, 2003). Our impression is, that similar things are happening in other countries (e.g. Goodchild & Kemp, 2003; Brox & Pires, 2004; Huxhold, 2004). This results in competencies having different meanings in different surroundings. This also means that it is difficult to assess what the competencies are from students who finished a similar degree at different institutions. For example, it could mean that both students are competent in GI-analysis, but one student can analyse GI-work flows in organisations, whereas the other is competent in technically solving complex spatial problems.

As in other European countries, students in the Netherlands often follow a master course at another institution after they have finished their bachelor degree. Additionally in the near future, students will be encouraged to follow modules or subjects at different institutions, as aimed at by the Bologna declaration. But how to find a suitable course at another institution? Are the concepts in their module descriptions the same thing as in one's own institution? What knowledge, skills and attitudes are

taught there? Student exchange can only be successful, if GI-competencies are comparable between educational institutes. Otherwise, it is not clear if another course has something new to add. Therefore organisations need to have a system in which course contents can be compared. Competencies can be a useful tool to do this.

GI-science and GI-education have for some time been coping with the problems as described above. The increasing need to co-operate between institutions requires solutions. Important questions are still: What should a student learn to become a competent GI-employee? How can an educational institute stay up-to-date with the developments in the world of geo-information? At the same time, the job market finds it difficult to clearly define what GI-personnel should be able to fulfil a job (Meyles *et al.*, 2003). How than could the institutions teach students the things that the labour market needs? To solve this discrepancy is a task for education, although the job market should validate the results. This paper aims to do a step forward in solving these problems.

WHAT ARE COMPETENCIES?

Competencies in the Dutch educational setting can be described as a set of knowledge, skills and attitude a person requires for carrying out a certain task (Van Mil & Van Muyden, 2002). In the Netherlands in higher education, a recent trend shows a shift from knowledge-based education to competency-based. One important reason for this is the insight that when a student graduates, not only up-to-date domain knowledge is required for the graduate in his/her new job, but he/she also needs to have communicational skills, for example. Additionally, the student must have the right attitude, for instance being keen to learn new things. In the working environment, competencies can be used to make clear what abilities are needed to carry out a job. A competency-based job description could be used in job advertisements and descriptions.

PROJECT AIMS

The project described in this paper aimed to create a comparison of curricula with GI on the basis of competencies among four different agricultural education institutions. The project was funded by Wageningen University. The objectives were:

- To be able to describe and compare the contents of GI-curricula between educational institutions. On important condition to do so was to be able to understand each other (or, in other words, “speak each others' language”);
- To compare incoming and outgoing levels in GI-education. Main reason was to improve the possibility to exchange students, specifically from Bachelor to Master-level, but also from both levels to the job market (Figure 1);
- To improve curricula and to identify gaps/overlaps. Some subjects can be followed at several institutions, whereas others might not be covered in any of the four curricula. An important factor was also to identify new developments in the GI job market which should included in GI-curricula. In other words: the project could be a useful tool in analysing how well the different GI-curricula fit to the needs of the job market.
- To enable students in making a choice in cooperation with their lecturers to follow subjects or courses at other institutions.

This paper describes the method that has been developed by four educational organisations in the Netherlands to reach the aims as described above. The method was developed during a project by one university for academic education (Wageningen) and three universities of professional education (the Van Hall Instituut, Larenstein and CAH Dronten). The latter three educate students to a bachelor-level. All institutes have an agricultural background and have a focus on rural areas.

At the institutions there is a large difference in the use of GI for education. At CAH, GI is mainly taught as a tool from a practical point of view, especially in (precision) agriculture and rural development. Geo-information taught at CAH is mainly at an introductory level. At Larenstein and

the Van Hall Instituut, GI-education is part of a broader field as an analysis tool for studies like environmental sciences, landscape planning, animal management, forest management, etc. In addition both institutions have a post-bachelor's study in geo-information in which Larenstein focuses on technical aspects and the Van Hall Instituut aims at the use of GI in work processes. At Wageningen University an MSc-course in geo-information science is given, as well as BSc and MSc courses in related fields such as soil science, water management, nature conservation and landscape planning.

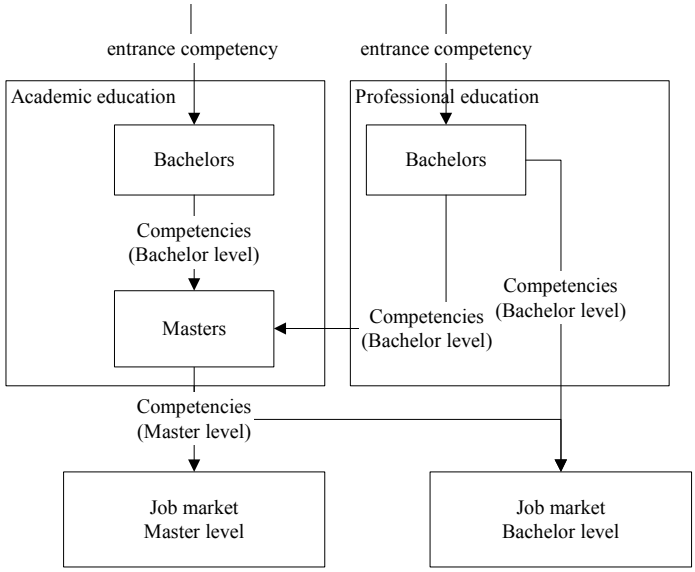

Figure 1: GI-competence levels, based on Bachelor and Master course routes in The Netherlands.

METHODOLOGY – A DESCRIPTION

Initially, in 2004, there was a big difference in GI-competency descriptions. In Wageningen competencies were already well defined at a fairly detailed level (Epema *et al*., 2004; Rip & Epema, 2004). At CAH, no definitions were yet available. Both Larenstein and the Van Hall Instituut were in the process of describing them. The participants in the project ranged from people with a broad overview of geo-information to people with in-depth knowledge of a specific application of the domain. Some participants were relatively new in the field, whereas others had five to more than fifteen years of experience.

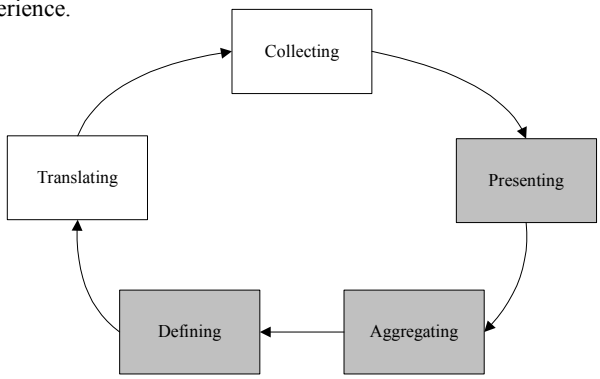

Figure 2: the working process principle. Boxes in grey indicate the process during workshops, whereas the white boxes indicate the processes at individual institutions.

For this project, several methodologies could be used. Often, questionnaires or interviews are applied as a tool to analyse competency needs (e.g. Goodchild & Kemp, 1992; Meyles *et al*., 2002; Huxhold, 2004). However, the difficulty is whom to interview. Does the person reflect the views of his/her organisation or even the entire working field? Does this person have an overview? Also, studies are conducted on job descriptions (e.g. De Bakker *et al*., 2004). However, as indicated earlier, job descriptions often do not correctly reflect the content of the job. Therefore, in this project, the principle of collecting-presenting-aggregating-defining-translation as shown in figure 2 was adopted. First, individual organisations collected their own descriptions of required knowledge, attitudes and skills for the different courses in which GI plays a role. The results were presented during a workshop to the other institutions. During this workshop, all available material was combined (aggregated) and consequently defined. The loop was closed (Figure 2) by translating the definition back to the own institutions. By covering this circle multiple times, a fairly accurate overview would be created.

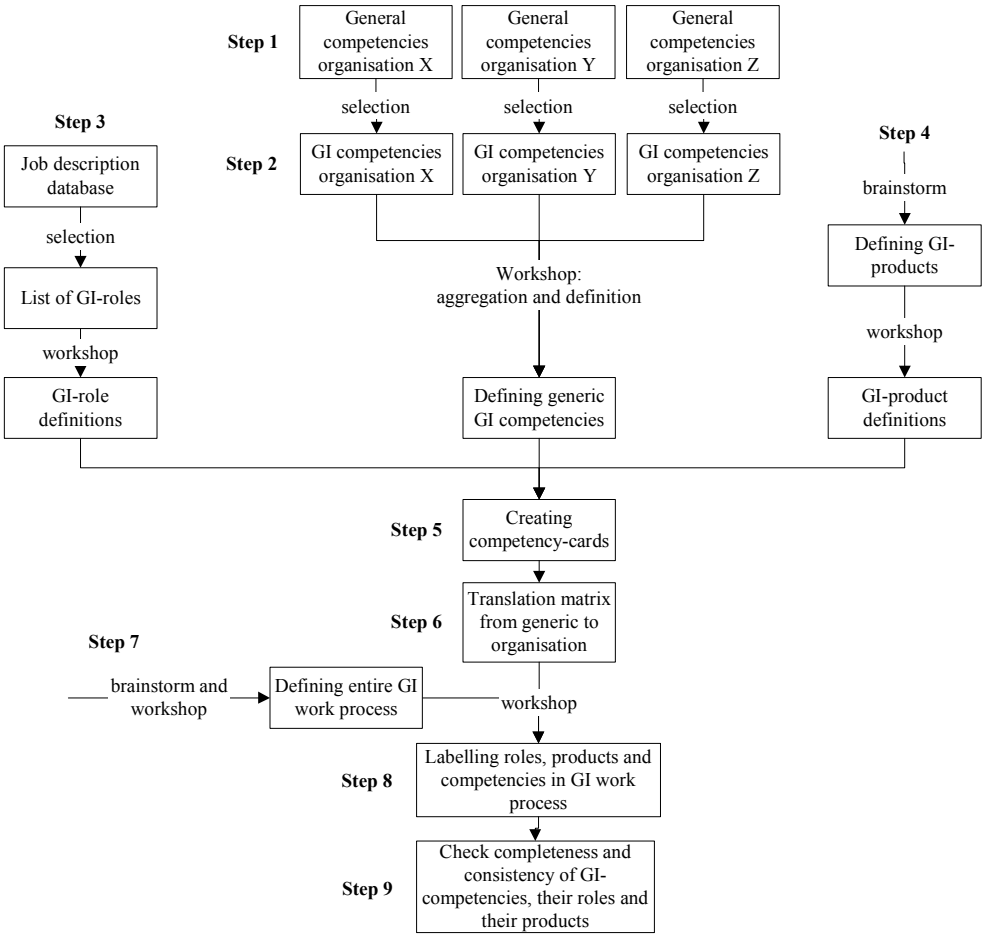

Figure 3: the working process

The circle-principle as described above was implemented as follows. Different starting points were chosen to create a list of well-defined GI-competencies to be as complete as possible. Competencies can be described not only by knowledge, skills and attitude, but also by GI-roles in an organisation and GI-products. Al these factors could be taken as starting point. Figure 3 shows a simplified project set up with the different steps involved. The steps are described in more detail below. This process was still ongoing during the time of the writing of this paper and this description should therefore be regarded as preliminary.

Due to the varying definitions per competency, the project involves a relatively large amount of discussions and workshops. Many discussions were conducted at a central location, but a discussion board via Internet was also an important facilitating tool.

The first step of the project was to create an overview of existing competencies at individual institutions. For each single course that involved GI-education such a competence list was created or provided. In the second step, only the competencies relevant for GI and GI-work processes were selected individually by each organisation.

After this, a set of GI-roles was created. A rough list was selected from a large database of GI-job descriptions available at the Van Hall Instituut. The list was complemented by the other participants during a workshop. In total about 20 roles could be identified. Examples are cartographer, GI-consultant and GI-analist. During this session, the roles were also defined and clustered if necessary. Some roles were abandoned as being too vague (e.g. GI-specialist, GI-expert). A preliminary list with definitions can be found in table 1.

Table 1: Preliminary GI roles

GI-role	**Description**
Viewer	Views data that is in the right format. Possibly visual analysis only.
User	Uses one or more GI-applications on a routine basis within a certain domain.
Programmer	Builds applications for the application designer or coordinator/manager. Strong link with application design; is sometimes combined into one role.
Analyst	Analysis and application of a spatial problem in such a way that work process and solution can be implemented. Relates problem to data, tools, organisation structure and data model / design.
Digitiser	Converts spatial data to digital GI-format(s). This can be from analogue to digital as well as digital-digital conversions. Design of the data model sometimes also part of the role.
Cartographer	Visualises spatial data for a specific purpose.
Application/data manager	Takes care of data, metadata en application management. Is often separated in different roles.
Coordinator/manager	Leads a GI-team and GI-projects by initialising, controlling and coaching.
Application designer	Creates functional design for GI-applications. Strong tie with the GI-programmer.
Researcher	Searches for scientific GI-solutions for spatial problems.

GI-role	Description
Technician	Not clearly defined (in The Netherlands)
GI specialist	Not clearly defined (in The Netherlands)
Lecturer	Teaches competencies (knowledge, attitude and skills) to others and acts like a coach in the process.
Consultant	Has a broad overview and can creatively solve possible spatial problems in the GI-work field.
Trainer	See “Lecturer”.
Data-collector	Collects spatial data en stores the location with it.
Supplier	Makes GI-related products available, such as data or software. Can give advice on these products.

In step 4, typical GI-products were listed and defined. Products like maps or datasets are good examples, but products like a work process or flow diagram were less obvious but nevertheless important.

Using the competency list created in step 1, generic GI-competencies were defined according to one single format, the so-called Competence Card format as used at the Van Hall Instituut based on Van Mil & Van Muyden (2002), simplified for use within this project. The card is described in this fifth step. Aim was to create a total list of about ten competencies, which were independent of institutions. Included were a definition, the associated GI-roles (step 3), required knowledge, skills and attitude and level. The typical products for the competency were also indicated. Table 2 shows an example of one specific GI-competency.

The process confirmed the differences between existing competency definitions. They were subjective and ranged widely between institutions. Therefore, in the sixth step, a matrix was created to enable a translation from institution specific to generic competencies. Each institution carried out this step individually. With these matrices, the objective to understand each other was achieved.

Table 2: Preliminary example of a GI-competency description

Competency
Use of Geo-information in working processes / organisations
Definition:
The application of GI in a (wider) working process. Knowing where GI in the working process is or can be used. Being able to recognize what the implications are for the use of GI in a working process in terms of knowledge sharing, finance and efficiency for the organisation
Applicable to GI-roles:
Application user, analyst, cartographer, application manager, data manager, coordinator, application designer, researcher, lecturer, consultant.
Relevant GI-products
To be defined

Table 2 (continued): Preliminary example of a GI-competency description

Level	Knowledge	Skills	Attitude
At a later stage to be divided in levels	Specific datasets required for the working process; Important datasets for the (local) general context; Basic knowledge on type of applications for converting from data to information; The structure of own organisation General steps required to carry out a GI-working process; Being able GI cost-benefit analysis	Creating flow diagrams Wide overview Application of problem – solution - problem	Critical Wide view Creativity

In a separate step (step 7), a generic flow diagram of the whole GI-work process was created. The entire process meant everything from data capture to map or report and included processes such as analysis, application development and organisational implementation. Boxes indicate activities, and data flow from box to box. The activities, which in combination form simple or more complex work processes, lead to different types of GI-products as defined earlier. For clarity, a section of the flow diagram is indicated in figure 4.

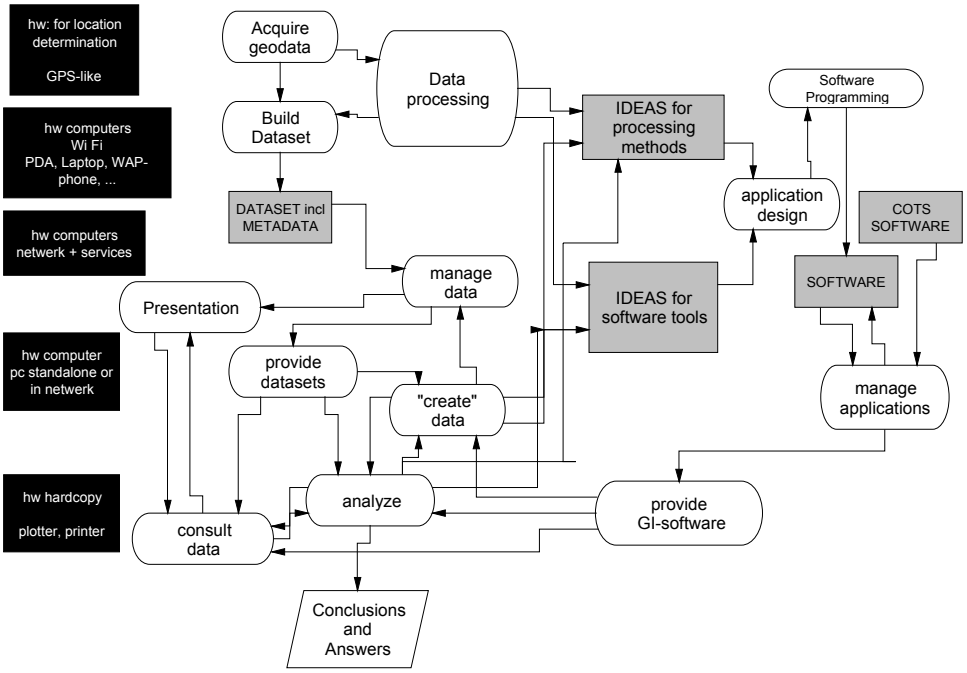

Figure 4: An early version of the GI process model

The resulting diagram was a useful tool to identify, classify and delineate GI-roles (steps 8 and 9). Each individual role could be taken separately and individual activities could be highlighted. In this way, a role profile could be created. Also, an analysis of overlapping roles, or gaps (activities without a specific role) can be identified.

Each activity could then be labelled by the already defined competencies. Which competencies are required by which specific activity and at what level? As a result, the diagram now combines a complete overview of the work process with competencies, GI-roles and GI-products. By selecting the activities for one specific role, a competence profile for this role can be identified easily. Also the products that have a strong link to this role can be identified. The diagram therefore has several functions: it can be used for employees to classify their jobs, and by employers to create a list of activities to make a transparent job description. The diagram is a useful tool to analyse which part of the GI-process is covered by the curriculum. Gaps are easily found.

In the following step, competencies could be compared with aims/objectives of individual modules at institution level. In this way, an analysis could be carried out to identifying gaps/overlaps in the GI-curriculum.

The methodology as described above aims to create an open, transparent way of describing and comparing curricula. Although set up by four educational institutes, it can be used by others. As each participating institution made their own translation from their GI-competencies to the generic ones, other institutions can do this themselves. After this translation has been completed, full use can be made of all descriptions and additionally, alterations can be made to the generic competence description if required. If competencies for GI-education are not yet defined in the organisation, the generic ones could be used.

To enable comparison with the job-market, two extra steps were conducted. First, the resulting competencies were reported to a board of representatives from the GI-domain during a workshop. Comments coming from this board could, if necessary, be implemented in the competency descriptions. In addition, a recent development within the domain of geo-information was used as a pilot study to test whether competency descriptions were complete. The use of mobile application in GI was used to test this. Results will be described at a later stage.

The methodology does not aim to create one single definite version of GI competency descriptions. During the process, it became clear that it needs to be open as insights change. The rapid developments in the GI-world also make it necessary to be able to alter the results.

DISCUSSION

The quality of the results should not be compared to the result of a theoretic analysis. As in any cooperation, the result depends on how well the participants are able to represent the view of their organisations and what space the organisation allows them.
The authors believe however, that the “open source” type of set up of this methodology will enable other institutions to join in fairly easily and contribute. In that way, a de facto standard might develop in the years to come. And of course, the matrix being independent from any institution it could be improved by theoretical work. Any school or university could profit from such contributions.

The working field has not validated the methodology and result at the moment of writing. This will take place early 2005. Additionally, a peer review by additional educational institutions is discussed as being a useful input for comments in the future. The results of the validation and possible peer reviews will be communicated during the AGILE 2005 conference.

In future, resulting competencies from this methodology can be used for describing GI-courses within educational institutions, but also comparing GI-programmes between organisations.

Additionally, GI-educational programmes can be more easily be explained to (potential) employers. Resulting competencies can also be used to define GI-jobs within organisations and to create reliable, comparable GI-job descriptions.

These possibilities could eventually be scaled up to cooperation across national boundaries. This could stimulate international student exchange as intended by the Bologna declaration of 1999.

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