Competencies and learning for management information systems
– the case of a health information system in Malawi

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Abstract

Previous research has established that users need competence in both computing and the context of the software. Information systems often fail due to low competence amongst users, and no study is known to provide a systematic account of the user competence needed. This research concerns competence needs amongst users of a management information system where there is no operational IS from which to obtain data for the MIS. The study shows that three subject matter areas of user competence are needed for IS, domain knowledge, work competence and computer literacy, and numeracy is a fourth area needed for MIS. Nonaka’s (1994) model of organisational learning distinguishes between tacit competence learnt through internalisation and socialisation and explicit knowledge developed through externalisation and combination. Work competence, being management in this case, is basically tacit competence, while domain knowledge, computer literacy and numeracy are based on explicit concepts. User training should therefore start with practice in the case of work competence and presentation of concepts in the three other subject matter areas.

Keywords

Organisational learning, user competence, user training, support, computer literacy, MIS, implementation

1 Introduction

Orlikowski (1992) demonstrated the need for learning how a groupware system fit into work. Sein, Bostrom and Olfman (1998) proposed a six step model for user competence, where the three lower steps concerned learning to use the functionality of the software. Step four was to understand the general purpose of the system in the organisation, step five, inferential, to develop more abstract concepts in order to see what the system could do in addition to what training said, and step six, motivational, to develop the imagination to see what the system could do to me and the organisation. Competence on computer systems as well as on their use seems necessary.

Marcolin et. al. (2000) used the categorisation of cognitive, skills, and affective competence for studying methods of measuring user competence. Skills relate to the lower levels of Sein et.al.’s model, while cognitive competence concerns the higher ones. The affective competence, which Marcolin et.al. studied, was self-efficacy. Their categorisation of competence is taken from pedagogical research in schools, which often classify learning goals in these three types.

In a model of development of competence in organisations, the main distinction is drawn between tacit and explicit knowledge (Nonaka, 1994). Explicit knowledge is what is found in textbooks and literature, while tacit knowledge is the competence that enables the practice in the organisation. Nonaka also distinguishes between individual and social competence. These dimensions of competence differ from the categorisations for schools, although skills and affective competence is often in the individual, tacit area, while the cognitive is individual
and explicit. Since this research is on competence development in organisations, the Nonaka model will be preferred. This paper aims at characterising the competence dimensions of management information systems according to Nonaka’s model.

There is a multitude of types of information systems, like operational, knowledge, e-business, e-government, and they all have distinctive competence needs. This study has examined a management information system with its specificities. The research advantage of a MIS is that it concerns people and groups at both operational and managerial levels, and its purpose of improving organisational performance is more challenging than handling transactions. Marcolin et. al. (2000) also distinguish between subject matter areas, and correspondingly, management information systems involve several areas, including computing and the domain to be managed. This study will characterise the subject matter areas in terms of Nonaka’s model.

While being aware of the competence needed, new insight into learning to become better users is the main goal of this paper. Nonaka’s model characterises learning as a continuous loop between the four competence types that appears in his 2x2 dimensions. Based on empirical studies and literature, the paper will identify starting points for learning in the different subject matter areas.

In order to unveil competencies, one could research an organisation where the MIS runs smoothly, its data is used in management, and which contributes to organisational change. Such a study could provide many insights, but a possible obstacle for research in such a setting is that most competencies are tacit and thus difficult to spot, and the organisation could rely mainly on socialising for retaining and improving its competence. The case chosen here is of an opposite kind, where competence and other resources are scarce, thus finding ways of organisational learning is crucial. Also, the system is only partly computerised, so that information work can be studied both with and without the digital equipment, thus the computer literacy part can more easily be separated from other MIS competence.

The research was carried out in Malawi as a part of a multi-country project on health management information systems (HMIS) in Africa and Asia (Braa et al., 2004). The HMIS produces health indicators, visualised in graphs. The chief software developer made a rough estimate that 80% of resources in the project are spent on training and support.

The health service workforce of Malawi consists of 15,000 people. According to developing country standards, there should have been twice this number; 64% of the nursing positions are vacant, and only a minority of the employed staff has the required professional training. A massive hiring is a futile strategy for improving this situation due to the lack of qualified applicants. The health education is of international quality, but computer literacy is scarce.

Practical implications are provided in the section on supporting the learning of the HMIS.

2 Competence development

2.1 Organisational learning

Three reasons why relevant learning theories should not be restricted to the individual level are:

- The need to regard user competence development in groups, as shown by Gallivan et.al. (2005)
- the aim of retaining and developing competence in the organisation, and
- the purpose of the MIS, which is to improve organisational performance
Nevertheless, the individual will be taken as a starting point for characterising learning.

Following (Lai, 1997), *individual learning* is development of competence which provides a relatively stable change of the potential for action. The requirement of relative stability is necessary to differentiate changes in patterns of behaviour from random changes. If action does not take place, the reason may be that there is no room for action, although the competence is present. Change of behaviour therefore also presupposes the necessary room for action.

While individual learning aims at changing individual action, *organisational learning* concerns development of relatively stable change of the potential for cooperation (Skorve, 2007). And again, unless conditions are present, the organisational competence will not lead to changes in the organisational behaviour. For example, the staff might have learnt that regular meetings with neighbouring clinics are useful, but unavailability of transport renders these meetings impossible.

From the concept of cooperation follows that *two* is the smallest number of people who have to be involved for organisational learning to take place. Cooperation is to be understood in a broad sense, including the relation between a manager and a subordinate, regardless of the democratic or dictatorial attitude of the manager. Organisational performance is dependent on both individual and cooperative work, so change of this performance may require both individual and organisational learning.

Nonaka (1994) has extended the individual-collective dimension with the explicit-tacit one for characterising the learning processes in organisations. Explicit knowledge is the theoretical type of knowledge found in textbooks and other representations, which are detached from the activity where the knowledge is used, and which is often called know-that. By contrast, tacit knowledge denotes the know-how, skills, and automated procedures, which are used in familiar situations. Lam (2000) has developed this model further; through characterising four types of knowledge, as shown in Figure 1.

![Figure 1. Knowledge types and the knowledge development process](image)

Nonaka (1994) also identified four processes of transformation of knowledge. Starting from the embedded knowledge, individuals are *socialized* into a community. The social process of
combining different chunks of individual knowledge is called combination. The transformation of the explicit to the tacit is called internalisation, while the opposite process is externalisation, and these could take place in both the individual and the collective case.

Instead of using the word knowledge, the concept competence will be used in the following to signal that the abilities of those competent are related to specific tasks.

Since a MIS is a system for the collective, explicit codes, the encoding type of competence is crucial for its functioning, and it is the kind of encoding that is useful for management that is favoured. Other studies of HMIS in the region conclude that local contextualisation of training is necessary for developing the competence needed (Williamson, 2001, Mukama, 2003), thus supporting the need for the embedded type of competence.

2.2 Subject matter areas

Marcolin et. al. (2000) bring in “knowledge domain areas” as a dimension in their classification of user competence, and work processors and spread sheets constitute the areas of their study. These areas only concern the type of software used, while Orlikowski (1992) and Sein et.al. (1998) emphasized the need for competence both in computing and its context.

In the field of IS development, the context is divided into the domain of the information system and the work tasks in which the IT is used. The domain is described in a class model, which is implemented as a data structure, while the tasks are mapped into use cases, providing the functionality of the software. In general, the subject matter areas requiring user competence therefore consists of the software, the domain and the work tasks.

In a study of another HMIS, Sahay and Molla (2007) identified three competence areas, technical, public health, and implementation and use context. Being a HMIS system, the use context is management. Like any other MIS, understanding the data also requires numerical skills. The subject matter areas of competence needed for using HMIS are thus management, health, numeracy, and computing.

Computer literacy is a scarce competence in many developing countries. Being a machine based on simple principles, one should expect that its teaching would favour the embraigned, context-free, scientific style of competence. However, reports show that mimicking instructors’ behaviour displayed by a projector is a favoured style of teaching (Herskin, 2006), thus students get socialised without necessarily understanding the principles behind the operation of the software. Also, such courses tend to favour teaching of computer use that is not related to the learners’ work, meaning that they get socialised into the wrong collective.

A study of learning of basic principles shows that principles are not learnt unless the teacher explains them explicitly and devotes enough time for practicing (Stamatova and Kaasbøll, 2007).

A comprehensive study of computer training in an HMIS was carried out in Zanzibar, including general computer literacy and use of the same software as in Malawi (Ngoma and Kaasbøll, 2008). By using health data and running interactive sessions on data entry and reporting, the middle line managers and staff became socialised into running the system and also contributing to improving data quality. A check on system performance three months after training demonstrated that organisational learning had taken place and had yielded improved performance.

Arithmetic and graphs are school material of the scientific type, and most maths education presents concepts and helps to internalise through repetitive exercises partly within domains with which the students are already familiar. The failure of many people to master calculation of percentages is nevertheless common in all parts of the world, and numeracy requires also the ability to express reality in the formal language of maths.
The health domain is based in medical science, so again, the school training would be favourable.

No generally accepted categorisation of work tasks seem to exist. Markauskaite (2007) suggests a general set of areas of ICT literacy: plan, access, manage, integrate, evaluate, create, communicate, collaborate, reflect and judge, and a survey amongst teacher students showed that these were clustered into five groups: problem solution, communication and metacognition (reflect and judge), basic ICT capabilities, analysis and production, and information and internet-related. Phelps et.al. (Phelps et al., 2005) distinguish between IT capability and competence, where competence is limited to the technical skills, while capability requires metacognitive skills in addition, like ability to learn, adaptability to change, willingness to experiment, etc., thus less restricted than Markauskaite’s definition.

The current study is limited to health management tasks,

While computing and the domain of the information system are based on science and technology, the work tasks for which an IS is used would normally constitute a practice for which there is no school subject to study. MBA studies teach managerial tools and techniques, but this approach to management training has been severely criticised. According to Mintzberg (2004), management competence, and leadership competence in particular, can only be developed based on experience, and due to managers’ role, their experience will be part of the collective area in Lam’s model, that is the embedded competence.

3 Case – organisation and work

The Malaŵi health system serves a population of 12 million, and life expectancy is 37.5 years and declining. The health service is carried out at clinics, to which the patients come. The clinic staff reports quarterly the number of children fully immunised, the new number of HIV positives, the number of nursing hours and more than 100 other data items on paper forms to district level, where the data is entered in a computer, although the clinic managers could also be considered as working in the middle line. The district is staffed with a health manager; immunization, HIV, and several other vertical programme coordinators, and a specially appointed HMIS coordinator has HMIS as her or his main task in each district. The districts report to the Ministry of Health, where the national HMIS manager works.

Also almost all the appointed managers have patient care duties, and likewise, all health staff carry out management as part of their job, at least of their own tasks. The HMIS is a system for supporting the management function, so it concerns all staff to a larger or smaller extent.

The software computes health indicators and presents them as graphs showing changes over time. Indicators are presented and discussed in meetings where district managers convene with clinic representatives, and similar meetings take place between the districts and upper level management.

4 Ethics and data collection

Since the study did not cover individual patient information or medical procedures, the only ethical consideration is that data collection consumes the health workers’ time, which could in many cases have been devoted to patients. This is compensated by a 10% levy on the research expenses paid to the Malaŵian Ministry of Health, which granted the permission for data collection.

Aiming at uncovering types of competencies and ways of changing them, a qualitative approach was selected. Within two health districts, 53 interviews were carried out and 13 meetings were observed during August – October, 2006. The two districts were designated
by the Ministry of Health due to their difference in HMIS performance, one good, one bad. The informants were selected by the researchers and covered staff at all levels, with emphasis on staff in various kinds of managerial roles. In addition, two hours of observation was carried out at a master course in public health in March, 2006.

Interviews normally took place in the informants’ workplace and took 20 minutes to 2 hours. The interviews conducted were mainly in English but some of the respondents preferred to use the local language Chichewa, which one of the research team members spoke, and she translated when necessary.

Notes were taken, but no voice recording took place due to the informants’ unfamiliarity with electronic recording.

5 HMIS competence in the organisation

This section will present empirical findings according to the four subject areas and characterise the competencies and learning which can explain them.

5.1 Management

The HMIS aims at improving the service by providing managers with a tool to assess performance for subsequent action. One of the programme coordinators gave an example of this:

For example when I get the reports, I check how many EmOCs and deaths they had, how many patients were referred from this facility and if they have many cases it shows that they are not able to perform certain functions/service properly so it means they have problems and maybe need training.

The decision taken by the coordinator was based on her embrained public health competence and embodied competence of correspondence between referrals and deaths. She opens for a trainer to share embrained and encoded competence with the health staff, which might manifest itself in organisational learning.

The programme coordinators are responsible for ensuring that the services are organised in a way that meets the patients’ needs. One coordinator gave an example of how data was used to modify service delivery in the Family Planning programme:

The reports show how the programme is performing, for example it was noted that there are low figures in Norplant clients and that most women were going to BLM [a private clinic] and we discovered that it was because when women came to get that service at the hospital, they were always told to come another day because no one was available to provide that service. So we decided to commit one day of the week for which someone is made available to provide this service at the hospital.

Based on the information received, a new form of cooperation was established, so organisational learning took place. Being anchored in the organisational behaviour, this competence seems to have developed into the embedded form.

The reports guide the coordinators in identifying problematic areas and these are further investigated during supervision. One coordinator explained that

By looking at the reports, I can see which facilities are having problems in terms of submitting on time and filling the reports (i.e. have gaps) and so I take note of these facilities and when I go for supervision I investigate the reason for this.
The embodied knowledge of being able to spot problems may lead to a discussion with the health staff, opening for organisational learning.

In one instance, one coordinator felt that there was nothing he could do to act upon the information as he stated:

I see the graphs showing how we have performed but there is nothing I can do to change the situation because it is the ministry who decides what [amount of drugs] we get.

In this case, the manager could have taken a decisional role or a spokesperson, but he ends up doing nothing. Learning took place, but its potential for action did not materialise due to lack of room for action.

An example from a quarterly meeting between clinic managers and some other clinic staff is presented below. One of the clinics presents a nicely, hand drawn graph on immunization, and a discussion between him and the manager of another clinic emerges:

- We only reached 77.6%, which is below the target and worse than the last quarter.
- Why is it so?
- When we had scheduled measles immunisation, only 13 children turned up, and we are not allowed to open the bottles when less than 20 come.
- You can’t send the children home; that is not fair. We allow for fewer children.
- That’s not according to the guidelines.

No conclusion is reached, but the dilemma seems obvious to all present, and arguments for both sides were raised. The manager who followed the guidelines perceived that there was no room for action, much similar to the previous case. The other manager, however, did not accept the structure of the encoded guidelines, so this clinic had developed embedded competence through organisational learning, and in addition, they had developed the embedded competence that the guidelines can be broken, thus learning that their room for manoeuvring can be extended. The explicit discussion that took place might lead to similar or opposite organisational learning in some of the other clinics present in the meeting.

As indicated above, clinic staff manages their own work, they report HMIS data to the middle line, but this data is not used in the clinics. Some staff expressed a need to learn how they could use collected data in order to understand why data was collected. A health staff member responded that the lack of interest was:

… because we do not understand how we can use it!

The health staff seems to possess an embrained competence of the HMIS data and its encoding, but a striking lack of embeddedness of this explicit competence into their own management.

The examples indicate that management competence to a large extent is of the tacit type, and that it has to be embedded in order to be effective.

5.2 Numeracy

During a meeting, the graph in Figure 2 was presented by a clinic manager. Competence needed for creating this includes calculation of percentages, how time can be represented in graphs, how to determine scales, colour coding, interpretation of percentages larger than and smaller than 100 etc. Arithmetic and visualisation of numbers are competence of the
embrained type, which in this case has lead to a successful encoding. There were other examples of more senseless graphs generated by means of a spreadsheet, where for example the percentages of fully immunised, BCG, penta, polio and measles were occupying one sector each in a pie chart.

When numerators changed place with denominators or dysfunctional graphs were produced, the HMIS officer or others had to turn to their embrained numerical competence and make the mathematical principles become explicit for the health staff or managers. Learning mathematics only through imitating others and never been explained the principles, would probably imply that most of us would never understand the principles since we are not professional mathematical researchers.

Figure 2. Immunization indicators for three months.

5.3 The domain and its encoding

The MIS studied has public health as its domain, so users need to know how vaccines should be stored, how HIV can be prevented, the health benefits of closed latrines, etc. Without this scientific knowledge and its embedding in the local community, the health services including the HMIS would be futile. There are time bound regularities in the health of a population group. Tuberculosis incidents are relatively uniformly distributed, malaria has seasonal variations, and cholera have sudden outbreaks. This is again embrained competence based on science, which a programme manager used:

[Facility Name] is the worst performing facility and I know this because when the reports come from this facility, the figures fluctuate a lot so it seems they are just guessing the figures, and they usually report late.

Saying that they report late, the manager indicates that the trouble lies in the reporting, and not in the domain competence of the clinic. Another example also points to the individual competence of managers:

By looking at the coverage rates and dropout rates on the reports, we can compare with the WHO standards and this tells our performance.

The scientific basis of this comparison of encoded performance has been learnt as embrained competence during education. The next two quotations illustrate what a manager does when trying to correct erroneous reports:
At one time, a certain facility reported on the HMIS form that it had zero cases of Malaria and I knew that it could not be true so when I asked the facility they gave me a figure.

By looking at the reports, I can see which facilities are having problems in terms of submitting on time and filling the reports (i.e. have gaps) and so I take note of these facilities and when I go for supervision I investigate the reason for this.

In addition to the embrained competence needed for diagnosing the errors, these managers have also used their embedded social competence for finding reasons for mistakes and achieving a corrected encoding.

5.4 Tools for handling the representations – computer literacy

Clinic staff reported on paper forms, they drew graphs manually as illustrated above, and they infrequently received copies of the computer reports prepared at the district level. The HMIS officer, also called the statistician, was one of the few people in the district being competent to run the HMIS software. One of the programme coordinators said:

The graphs are used during national level meetings where the data for all districts is reviewed… I ask the statistician to produce graphs for me for the meeting… I give him my programme data to use for making the graphs.

The statistician was regarded competent to do the reporting by means of the software, which requires computer literacy in addition to the domain knowledge and numeracy.

The HMIS officer also knew what the programme reports should look like, so he seems to have the collective competence of knowing who needs what. Even though some of this may be found in encoded guidelines, local adaptations call for development of embedded competence in this area in the middle line.

6 Discussion and conclusion

6.1 Organisational competence

Learning was defined above through its results, but the definition did not say anything about the process of competence development. Nonaka (1994) postulates learning processes of internalising, socialising, externalising and combination.

The learning processes concerning the MIS seem to start from two different bases. Learning the arithmetic comprises starting out with concepts and principles of the explicit kinds and internalising and socialising these through working with the real data from the clinics. Without the socialising, no organisational learning of arithmetic will take place. Similar learning processes should happen concerning the domain, its encoding, tools and computing, but as stated above, learning processes of computing tend to have weaknesses in the initial step of embracing the principles.

Learning management starts from practice. Based on embedded competence, general, explicit concepts can be embraced and again internalised, leading to possible individual and also organisational learning. Cooperation patterns may change even if the explicit concepts that were internalised by one manager do not become collective, as long as the internalised change becomes embedded in the organisation.

Learning subject matter grounded in science usually start out by training, while learning subject areas which are mainly of the embodied or embedded type could start from practice.
6.2 User competence

Both Orlikowski (1992) and Sein et al. (1998) emphasized that users need to understand both computer systems and its work context, while Marcolin et al. (2000) only regard the software competence. The HMIS study confirms that context is of two kinds, domain and tasks. Work tasks, here managerial, are normally based in practice, while the domain of health is based on science, and it requires numeracy as a third subject matter. In the case of spreadsheets, both numeracy and the domain of the numbers should be included, and concerning text processing, language skills and also domain competence are needed for using the IT tool for improving organisational performance. Work tasks constitute the additional practice based competence. Tasks and domains constitute levels four to six in Sein et al.’s model (1998), and the HMIS case shows that use of the IT tool requires competence in all relevant subject matter areas, including the software area.

7 Practical implications

Any activity can trigger learning, but in order to accelerate the process, three supporting activities had been established; formal education, supervision and a recognition scheme for data quality.

The formal education consists of master courses in public health. Here, the participants brought their experience for presentation, discussion amongst colleagues and theoretical input from teachers, in accordance with how Mintzberg (2004) envisions management training. A participant told about how a cholera outbreak was discovered and reported, how the houses of those infected were located, and by means of the local competence of the villagers, a well where the lid had been damaged and animals had been, was finally located. Lively discussions took place, and the teachers emphasized the strategy of searching from the houses and upwards in the terrain. Such an endeavour requires a mixture of competence in public health, reporting, data analysis and management of critical incidents, and while the participants knew the basic principles of cholera and its reporting requirements, the lesson focussed on how to deal with all the factors when trying to stop the epidemic.

District managers, programme coordinators, HMIS officers and specifically appointed staff had supervision as a main part of their duty. Most respondents in this study perceived supervision to be helpful. It was argued strongly that supervision should follow up training and that training was needed first. Supervision or briefing on the job was not perceived to be enough to perform well on HMIS responsibilities. Both increased supervision frequency and access to training was reported by respondents to be potential incentives for improved data quality. Data quality concerns the domain, its encoding, tools and numeracy, which constitute those subject matter areas which, as argued above, lend themselves best to a deductive learning process. The health staff seems to be of the same experience, first learning the theory in a course, then internalising and socialising by means of a trainer at the workplace. The positive appreciation of supervision was not unanimous, however:

When they come they usually just come to check how we are doing or teach us something new.

The supervisors who came to check up did not aim at supporting learning, but at monitoring subordinates. Those who came to teach something new should rather have left that to a training course and followed up during supervision visits.

The recognition scheme is an award for the clinic which performs best on data quality during the last six months. Timeliness, completeness and consistency are measured, and the overall best performing clinic receives equipment like flip charts, calculators or felt pens. Awarding the clinic aims at promoting organisational learning and not only individual improvement.
The scheme does not include instruction or supervision for learning to improve data quality, so the clinics are left to themselves on how to improve. Most clinics took the competition seriously, so they seemed to have been triggered to manage organisational learning and improved cooperation on their own. Managerial skills needed to submit timely reports and knowledge of definitions of data elements are examples of the types of competence needed for improving data quality. If the clinics are aware of their ignorance of data definitions, they can ask supervisors for explanations, but if not, the scheme has no mechanism for feedback except for a score. Clinics might therefore repeat erroneous practice unknowingly.

The research team invented a fourth supporting activity for boosting organisational learning of data and software and carried out a pilot experiment. Reporting in the clinics tended to be carried out by one person who had received training for this. If she left the clinic, the reporting competence was lost, and another person had to attend training before reports of reasonable quality could be made. In order to achieve organisational learning, the idea of pair programming (McDowell et al., 2006) was drawn upon. Pair programming implies that two people sit in at one workstation, one uses the keyboard to type code, while the other asks questions, looks up in the programming libraries, checks against requirements etc., so that they keep talking while coding. After an hour, they shift roles. This style of working has improved learning and code quality, and one important mechanism is probably the verbalising taking place, which implies explicating principles and concepts as well as subtle tricks and elegance in the solutions. The social pressure that emerges contributes to hindering dropouts during programming education. This procedure was tested during reporting of quarterly data in a clinic. One of the two had experience with reporting while the other was a novice. After a while the novice questioned decisions made by the experienced, assuring that she understood everything that he did. They also discussed difficult issues and what to fill in complicated fields. After a short while being the one who held the pen, also the novice comprehended the report, they started working together and decisions were based on mutual agreements. Organisational learning took place, but they consumed more time than the experienced person used to when working alone.

7.1 Obstacles to learning

The low wages in the health system makes any kind of fringe benefit attractive, and allowances for transport and training were amongst those. Several facility managers reported to find it difficult to orient new staff on HMIS on their own. Some health staff simply refused being oriented because they had not received training and the accompanying allowances. One HMIS focal person explained:

They don’t want to learn how to fill the registers or reports because I was the one who went for training. I received allowances, and because I did not share with them they say I should do it.

Raising the wages for educated personnel seems to be the long term means for avoiding this unfortunate implication of the current remuneration scheme.

Learning can take place also without the corresponding organisational change, due to structural restrictions. Such learning of potential behaviour has drawbacks, however. Without practicing, the individual will forget instead of internalise, and socialisation is impossible. Training should therefore either be restricted to those changes that can take place within the structures, or the staff also has to learn to challenge and change the structures when necessary.
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