ARE YOU FUNCTIONALLY MAP LITERATE?

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ABSTRACT

Planners and decision-makers working in a development context must use spatial information, but yet very little spatial information is used. A possible reason for this is that they are map illiterate, that is, they do not have the competence to use maps.

Map literacy is not well understood but is accepted to be associated with literacy and numeracy. To better understand map literacy we can turn to the understanding of literacy and numeracy. Literacy does not mean much in practical terms and therefore functional literacy is used. Likewise, it is better to refer to functional map literacy. The definition and constructs of functional literacy are reviewed. As with reading, an understanding of the various map reading tasks is required. A review is made of studies in map reading.

A definition for functional map literacy is proposed. This is followed by proposing a structure for skills level along the lines used for functional literacy levels. This is used to provide a measure for determining whether or not a person is functionally map literate.

1. INTRODUCTION

Spatial information is used in many varying applications, ranging from the simple location of places to optimising routing to complex determination of spatial patterns of natural or human-made phenomena. Spatial information is particularly important for development. It is claimed that as much as 80% of decisions for development purposes are spatially based. It is also stated that the main reason why development projects fail is because of lack of information. Taking these two points together then it is evident that the lack of the use of spatial information in development projects is a major contributor to failed projects.

It must then be asked why spatial information is not used as expected in development projects. Some blame can be attributed to the lack of available spatial information, particularly in the least developed countries. However, this is not true in all cases as projects fail even when the spatial information is available. Is it possible then that development professionals are not using the available spatial information? If so, then why not? Is it possible that such persons are not able to use such information. This fits in with reports of low levels of understanding of spatial information.

Spatial information is best conveyed by a map. It can then be said that the lack of the use of maps by development professionals is a major contributor to the failure of projects. What comes into question is the ability of such persons to understand the map and to correctly utilise the information from a map in their tasks. Is it then that such persons are map illiterate, or put another way, have an inadequate level of map literacy.

What is meant by map literacy? How is map literacy determined? These are not easy questions to answer, mainly because map literacy is not well defined.

Balchin (1) introduced the term ‘graphicacy’, which is the ‘fourth ace’ (1). The other three being literacy, numeracy and articulacy. Graphicacy can be viewed as an understanding of graphs. This includes a map. So graphicacy is the understanding of a map. If graphicacy is related to literacy then it is possible to say that map literacy is related to literacy. To help us understand map literacy we can therefore draw from the understanding of literacy.

2. LITERACY

Literacy is generally understood to mean the ability to read and write, or more fully, “the capacity to recognise, reproduce and manipulate the conventions of text" (2). Literacy is generally taught in the home and in schooling, however, it is difficult to measure literacy, or to clearly state who is literate and who is not (3). A person deemed not to be literate, that is, lacking knowledge of written language is said to be illiterate (4).

Due to the difficulties of understanding what is meant by literacy, a more practical approach has been taken and reference is rather made to functional literacy. In the 1960's UNESCO used the term, functional literacy, as "the process and content of learning to read and write to the preparation for work and vocational training, as well as a means of increasing the productivity of the individual" (4). The Organisation for Economic Cooperation and Development defines functional literacy as "whether a person is able to understand and employ printed information in daily life, at home, at work and in the community"(5).

Functional literacy is relevant to the development of communities and national economic growth. "The inability to read and write not only prevents people from functioning fully within their communities, but also exerts an influence on national priorities and the use of human and material resources" (3). According to UNESCO the highest occurrence, up to 95%, of illiterate people live in developing countries (4). Taking this figure together with the observation that "there is a high correlation between illiteracy on the one hand, and poverty and infant mortality on the other" (4) shows that functional literacy must be a priority for the development of communities.

Functional literacy has been linked to communicative competence and we can use the latter to help us understand the former (4)(6). Based on the theoretical framework of communicative competence Verhoeven (4) proposes a construct of functional literacy, namely grammatical competence, discourse competence, (de)coding competence, strategic competence and socio-linguistic competence, each comprising various abilities, as shown in figure 1 below. This construct begins to concretise educational objectives.

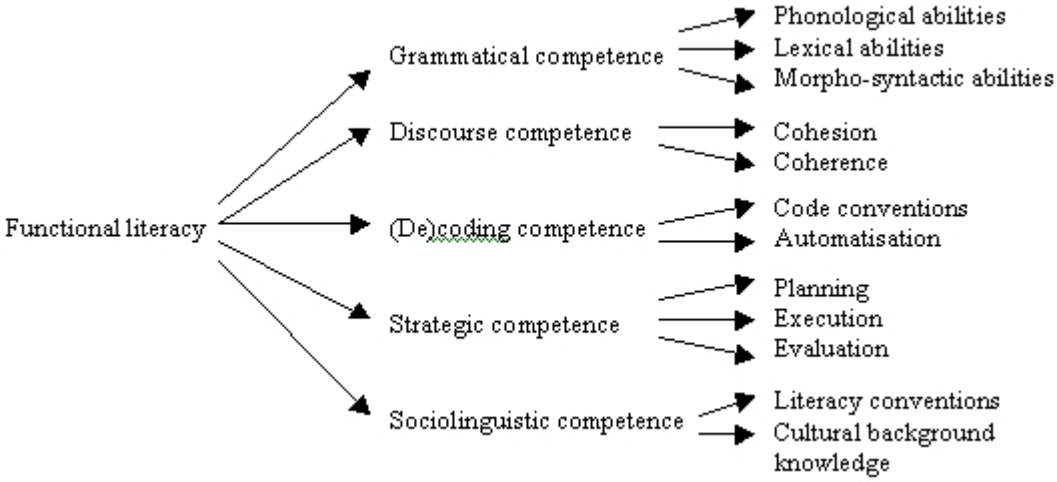

Figure 1. The construct of functional literacy (4).

Research since the 1970's has considered the "relationship between words and their meaning and towards the mental processes involved in reading …. Reading was now considered as a form of information processing." (7). The reading process, considered to be a complex skill, was broken down into a number of sub-processes, ultimately arriving at a cognitive representation of what the writer intended to communicate. The reading process involves inferencing and it inference tests may be a better means of measuring reading abilities (7). The ability to make inferences from reading depends on a number of factors, one of which is prior knowledge.

Educational objectives for reading according to Bloom (quoted by Pumfrey (8)) can be categorised as successive stages in the development of a person's understanding and competence in the cognitive domain as follows:

a) Knowledge
b) Comprehension
c) Application
d) Analysis
e) Synthesis
f) Evaluation

Taking this to the next level Pumfrey (8) refers to the Barrett Taxonomy of reading tasks, namely,

- recognition (locating and identifying),
- recall (from memory),
- reorganisation (classifying, outlining, summarising, synthesising),
- inferential comprehension (including prediction and interpretation),
- evaluation (including judgement), and

- appreciation ("includes both the knowledge of and the emotional response to literary techniques, forms, styles and structures"(8))

Leseman (9) uses the information processing approach to reading and interpretation of text and gives the general component tasks as:
- perceiving, recognising and interpreting visual stimuli;
- decoding the perceived visual patterns;
- word recognition and lexical interpretation;
- parsing a sentence into its meaning constituents and establishing a local coherence of meaning;
- forming then 'text-model' or message.

A structure for objectively understanding functional literacy can be extracted from the above models. However, it does not provide measures from which functional literacy can be established. In Britain the Basic Skills Standards of the Basic Skills Agency (10) measure literacy at three levels, namely Entry, Level 1 and Level 2. To be classified at a particular level requires the person to demonstrate a consistent performance of 80% at that level. Of particular interest for map literacy in the reading skills standards and numeracy skills standards are respectively the skills : "Read and understand graphical material such as tables, signs, charts, labels, plans, maps etc; Calculate lengths, areas, weights or volumes accurately using appropriate tools, e.g. rulers, calculators etc."(10).

The standards for these skills for each of the levels is, respectively:
- Entry level - Get the main idea from a simple source (e.g. safety signs with a single message).
  Find specific pieces of information from simple tables (no more than 2 variables).
- Level 1 - Understand and act on a graphical source up to one page long (e.g. a town map, price list, sign with multiple messages).
  Find information from complex tables, with at least 2 variables and with additional sources/keys.
- Level 2 - Select material from more than one graphical source (e.g. complex tables, plans).

- Entry level - Simple calculations on familiar items in either metric or imperial units, e.g. calculating areas of rectangles from lengths in the same whole unit.
- Level 1 - Calculations on items of unfamiliar or irregular shape in either metric or imperial units.
- Level 2 - Calculations on items of complex or composite shape, use scale drawings, convert between metric and imperial units." (10).

Based on these skills levels it is said that a person is functionally literate at Level 1, and is functionally numerate at the Entry level (10). Achieving the functional level does not mean that adults will not experience difficulties in certain areas, but once they reach the functional level they achieve a 'take-off' point from which to access mainstream education or vocational training (10). In most countries the schooling system assumes that the attainment of a specified grade implies the learner is literate. This assumption is not always true as has been shown in research (9).

The above BSA Basic Skills Standards can be equated to the QCA National Framework of Qualifications in Britain as Entry = Entry; Level 1 = Foundation; Level 2 = Intermediate (10).

Leseman (9) suggested the following levels of difficulty in reading and writing:

Easiest level - reading and writing of very short texts, with very simple syntax and simple or no inference (e.g. street name, shopping list, person's name and address). Generally the tasks of perceiving, recognising and interpreting visual stimuli, and decoding the perceived visual patterns.

Most difficult level – reading and writing of texts that require complex inferential reasoning to establish a logically coherent mental model. It would include the use of more complex conventions and language structure (e.g. writing a report, official correspondence, longer critical articles in newspapers or fiction books).

Head (11) argues that map reading "fits comfortably into the information processing model of the reading of printed text …..Map reading, like all reading, then, is cognitive." The studies into reading can therefore be applied to that of map reading. There are however some differences in that the very nature of maps does not sequence information as in text, and cartographic semantics are far from standardised (11).

3. REVIEW OF MAP LITERACY RESEARCH

There is very little research on map literacy itself. What research there is has focused mostly on the understanding of childrens' behaviour and on map reading tasks associated with improving map design. Researchers have recognised the role of the map user and extended their concept of cartographic communication to include the "representations of

phenomena in space that a user may draw upon as a source of information or an aid to decision making and behaviour in space" (12). This tended to be based mainly on the concept of spatial information processing. However, most research into map design and the efficacy of maps made assumptions about the competence of research subjects in map use, based on the schooling level or claimed experience with maps. That is, the level of map literacy was assumed. There appears to be little evidence of the level of map literacy of research subjects ever being established. Nonetheless, this research can be used to better understand what is meant by map literacy.

The prior knowledge and the abilities of the map user influence the efficiency and success rate of the map user in reading, analysing and interpreting the information from the map (13,14,15). There must be a differentiation between prior knowledge and abilities with map understanding and domain specific knowledge and abilities. Kulhavy (15) showed that experienced map users used conceptual schemas not related specifically to cartography nor geography. This implies that during the interpretation activity the map user requires more than an ability with maps. For example, a user can be given maps that give the soil type and rainfall information and be asked to select areas where maize can successfully be cultivated. Without prior knowledge of the requirements to successfully cultivate maize, the map user would be at a loss. Gerber (14) goes on to indicate that map users' abilities are "influenced by their visual perception of symbols, their general experience with maps, their ages and education, their cultural backgrounds, imaginations, interests and temperaments …. socio-economic levels". Some studies have suggested that the gender of the map user influences their map abilities as well, with males performing better than females (16).

Muehrche (17) uses the convenient categories of map use activities as map reading, map analysis and map interpretation. Head (11) refers to these three activities as "the ability of readers to understand the [map] language". These categories are consistent with the research on literacy as discussed above. Muehrche (17) uses map reading as the initial tasks of recording visual stimuli, identification and recognition. While in the analysis tasks the patterns and interrelationships are discerned. This could include measurement, calculation, comparison and manipulation. "Map analysis gives us descriptions, not explanations or interpretations" (17). Lastly, the interpretation makes sense of or gives meaning to the relationships and patterns and involves inferencing. This implies that the user is drawing on prior knowledge and experience. There is a natural order in these activities, not only in the sequencing but also in the levels of task difficulty.

Board (18) grouped the main map reading tasks under navigation, measurement and visualisation as follows:

Navigation	*Measurement*	*Visualisation*
Search	Search	Search
Identify and locate own position on map	Identify	Identify
Orient map	Count	Describe
Search for optimum route on map	Compare	Compare
Search for landmarks en route	Contrast	Contrast
Recognise landmarks on route	Estimate	Discriminate
Search for destination	Interpolate	Delimit
Identify destination	Measure	Verify
Verify		Generalise
		Prefer
		Like

Morrison (19), drawing on the earlier work of Board, offered an alternative arrangement of map reading tasks, indicating that often the more complex tasks are composed of combinations of the more elementary tasks:

Pre-map reading tasks
- Obtaining, unfolding, etc.
- Orienting

Detection, Discrimination, and Recognition Tasks
- Search
- Locate
- Identify
- Delimit
- Verify

Estimation Tasks
- Count
- Compare or contrast
- Measurement
  a) direct estimation
  b) indirect estimation

Attitudes on Map Style
Pleasantness
Preference
Etc.

Some tasks require other tasks to have been completed first (prerequisite tasks). For example, the estimation tasks require that objects have first been searched for, located and identified (19).

Head (11) considers the map reading tasks as being divided into the broad categories of 'measurement' and 'visualisation'. Measurement is assisted by visualisation and often requires the use of aids (e.g. scale ruler). "The map use types that rely upon natural language methods may be considered as a) landscape visualisation, b) navigation, and c) interpretation for place and space." (11). There is an important difference here with the meaning of 'place' and 'space'. 'Place' is used in context of location or 'being in place', while 'space' involves identifying spatial forms and patterns or 'knowing about space' (11). The latter would then be at a more complex level than the former. Gerber (14) supports this broad categorisation in establishing that competence in cartographic language consists of two components, namely, identification and comprehension. Identification is the simpler of the two.

He breaks comprehension down into four hierarchically ordered elements:
- "knowledge of the sign in context (i.e. on the map);
- knowledge of the sign out of context (i.e. in a separate legend);
- understanding of the concept represented by the sign; and
- the ability to make inferences using the knowledge from the sign."

The above implies that the map user must have the ability of identification to undertake comprehension.

Olson (20) organised map reading tasks into three levels of increasing difficulty:
- Level 1 – "involves comparison of the characteristics of individual symbols: shape, relative size, importance, and so on"
- Level 2 – "recognising properties of symbol groups on the map as a whole: spatial pattern, likeness to other map patterns, etc". The tasks are more complex but still dealing with abstract symbols. " Symbol-referent relationships are not involved but rather relationships within or among whole sets of symbols."
- Level 3 – "using the map as a decision-making or content-knowledge-building device through integration of the symbols with other information. At this level the symbol-referent relationship is directly involved and the symbols themselves are important only insofar as they represent phenomena and their spatial characteristics."

Board (18) confirms Olson's hierarchy of map reading tasks in the context of the needs of geography. The level 3 tasks are considered necessary in geography, particular because the 'map is not an end in itself". He summarises the main geographical questions as "questions involving location and extent, distribution and pattern, spatial associations, spatial interactions and spatial change." (18).

Head (11) relates his concept of 'interpretation of place' as being equivalent to Olson's level 1 and 'interpretation of space' as being equivalent to Olson's level 2 and higher. Level 2 will then require the construction of mental models and visualisation.

4. DEFINING FUNCTIONAL MAP LITERACY

It has been shown that map literacy can be regarded as similar to literacy. Map literacy though, like literacy, is conceptual and difficult to express in practical terms. We therefore turn to the use of functional map literacy.

Drawing from the studies of functional literacy and the understanding of maps the following definition of functional map literacy is proposed:

4.1 Functional map literacy is the ability to understand and use maps in daily life, for work and in the community

Functional map literacy then forms part of a person's fundamental life skills, together with literacy, articulacy and numeracy, to fulfil basic needs of survival and socio-economic well-being. Being functional map literate will place a person at an advantage over a person who is functional map illiterate, through being empowered by knowledge that is otherwise not accessible.

In the broadest context we can understand functional map literacy as consisting of the following components:
- Knowledge
- Comprehension

- Application
- Analysis
- Synthesis
- Evaluation

These components can be described by the tasks of (in no particular order):
- recognition (searching, locating and identifying);
- orient map;
- recall (from memory);
- detect;
- reorganisation (classify, outline, summarise, generalise, synthesise);
- estimation (count, calculate, compare, measure, interpolate, delimit);
- inferential comprehension (including prediction and interpretation);
- evaluation (including judgement);
- appreciation;
- decoding the perceived visual patterns;
- symbol group recognition and lexical interpretation;
- parsing a spatial relationship into its meaning constituents and establishing a local coherence of meaning;
- compare;
- describe;
- contrast;
- discriminate;
- forming the spatial mental-model or message.

This list is by no means exhaustive.

It is obvious that these tasks require different levels of skill. Also, the same task can be performed at different skill levels depending on the application. It is also obvious that a particular task requires the completion of another task - prerequisite or elementary task. A more complex task can consist of two or more simpler tasks.

Functional map literacy will then require competency (albeit to varying levels) in the different map use tasks.. Taking these together with the three hierarchical levels of Olson (20) and that of the BSA (10), we can arrange them in levels of difficulty. In this way it will be possible to determine the different levels of functional map literacy. A skills level is proposed here:

Entry level:
Get the main idea from a single or simple symbol (search, locate, identify, compare a single symbol). Simple estimation (measure, calculate, relative size) on familiar symbols.

Level 1:
Recognising properties of symbol groups on the map as a whole and analysing spatial patterns (more complex recognition, reorganisation, decoding, detection, compare, discriminate, contrast) More complex estimation.

Level 2:
More complex tasks leading to understanding the meaning of spatial phenomena for knowledge enhancement. At this level inferential reasoning is used from the spatial relationships, patterns and map phenomena of one or more referents or source. Higher-order mental models are constructed. The user draws on domain specific knowledge.

These levels can be thought of as equating to Muehrcke's (17) three main activities of map reading, map analysis and map interpretation, respectively.

It will be possible to test competency at each of these levels. To be competent at a level will require an average rating of 80% (see the requirement of BSA). Competence at the levels is cumulative i.e. to achieve competence at level 1 assumes competence at the entry level, and likewise level 2 assumes competence at level 1.

Being guided by the BSA definition, it is proposed that:

4.2 A person is functionally map literate at Level 1
To be able to function adequately the map user will be required to do more than simply identify a single symbol or measure a single distance but to recognise patterns of symbols, perform spatial operations and to understand the cartographic language. It cannot be expected from every person but professionals working in a development environment should achieve competence at Level 2.

5. CONCLUSION

It is not disputed that maps, either in printed or digital form, are the main source of spatial information. It is not disputed that spatial information is essential for successful and sustainable development. Why then is spatial information and therefore maps, used so little.

Cartographers have concentrated on the improvement of maps to make them efficient and effective in planning and decision making. They have achieved much, even studying the map user. However, not much has been done about the map use skills of the map user. A better understanding of map literacy is required. To be practical, as this is more relevant, we use functional map literacy.

A proposal has been made on better understanding functional map literacy, through providing a definition and the levels of competence of functional map literacy. From this it will be possible to determine whether or not a person is functionally map literate.

To measure functional map literacy will require a better understanding of the various map user (or map reading) tasks within each of the levels. Once there is agreement on which tasks to measure for each level then it will be easy to set up the evaluation for the tasks.

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