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Workplace Information Literacy in the Scientific Field – an Empirical Analysis Using the Semantic Differential Approach

Abstract

The study focuses on eliciting a semantic concept of Information Literacy by capturing the information worker's perception of the information process. It is presumed that this perception influences the formation and advancement of Information Literacy at the workplace. The approach is based on the creation of a semantic differential scale. Target group are scientists from the field of natural sciences. The survey shows that five partly correlated principal aspects play a major role: personal motivation, experience, personal and corporate utility, organizational support and information quality. Consequently, fostering adequate information handling at the workplace implies the promotion of its utility e.g. by its integration into the business culture, the provision of high-quality, easy-accessible information by the information services or the library, the integration of relevant trainings and the encouraging of personal motivation by adequate psychological incentives.

Research Context

Information Literacy refers to the efficient and effective handling of the rising complexity of the information process. On this note, the prevailing educational Information Literacy initiatives[1] aim to turn the members of our information society into information literates (Armstrong, 2005): "knowing when and why they need information, where to find it, and how to evaluate, use and communicate it in an ethical manner". Academic educators and

[1] e.g.: AACRL, AASL, CILIP, NFIL, SCONUL

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URN: http://nbn-resolving.de/urn:nbn:de:bsz:352-opus-59236

librarians have successfully managed to establish this concept in academia and the educational field, gradually embedded learning objectives into school and university curricula at all levels (Baettig, 2005; Homann, 2000; Ingold, 2005; Kuhlen, 1999; Kuhltau, 1993; Rader, 2002; Tuominen, Savolainen & Talja, 2005; Virkus, 2003).

Within the field of industry and commerce, however, researchers are still in the process of discussing acceptable definitions of ”workplace Information Literacy“ (Donnelly & Craddock, 2002; Kirk, 2004; Lloyd, 2004). In addition to the difficulties to separate it from somewhat related concepts like *time management*, *information management*, *computer literacy*, *internet experience* or *research skills*, a successful transfer of the rather strategic and theoretic educational concepts and objectives is doubtful (Bruce, 1999; Cheuk, 2000; Cheuk, 2002; Lloyd, 2004; O'Sullivan, 2002). One outstanding exception – taking into account the personal understandings of Information Literacy – is the phenomenological approach by Christine Bruce (Bruce, 1999; Webber & Johnston, 2003).

Aim of research

Our study focuses on eliciting a semantic concept of Information Literacy by capturing the information worker’s perception of the information process. It is assumed that this perception influences the formation and advancement of Information Literacy at the workplace. The approach is based on the formation of a *semantic differential scale*. This scaling tool has been used mostly for measuring social attitudes, especially in the fields of linguistics and social psychology (Osgood, Suci & Tannenbaum, 1957). It typically consists of a seven-point bipolar rating scale using adjectival opposites.

Scale Construction and Revision

The scale was constructed in three stages: In the *creativity stage*, five experts, working in the field of information science and librarianship, were asked to generate as many items as possible related to the scientific information process. Altogether 90 items were created. In the *evaluation step*, three professional information scientists sorted out synonyms as well as

problematic items and classified them thematically. This led to 65 items and seven categories: utility, quality, expertise, method operandi, effort, personal motivation, work-related circumstances. This item pool was the basis for the creation of a randomly organized semantic differential questionnaire.

Consecutively, the questionnaire was revised in three stages: In the *pre-testing phase 1* ten volunteers participated in a small-scale pre-test. This led to 44 items which formed the SEMDIFFIL (semantic differential of Information Literacy) – Questionnaire.

Pre-Test phase 2 was part of the real-time study (2a). From December 2006 until January 2007, participants were given the additional possibility to exclude items. In January 2007 this option was eliminated and the respective items were taken out of the pool. Based on this survey, the questionnaire was reduced to 36 significant items forming the second version of SEMDIFFIL (2nd version). The *Questionnaire – Revision Phase* was performed on basis of the second survey (2) – executed from February 2007 until April 2008. A small number of items were singled out as they showed to be difficult to interpret or differentiate from other items. The following table shows the remaining 34 items of the SEMDIFFIL (3rd version), which formed the basis of further analysis.

	Adjective pair (German)	**Adjective pair (English)**
1	niedriger Aufwand - hoher Aufwand	high effort - low effort
2	langweilig - spannend	boring - exciting
3	verwirrend - übersichtlich	confusing - clear
4	kritisch – unkritisch	critical - not critical
5	nachteilig – vorteilhaft	disadvantageous - advantageous
7	einfach zugänglich – schwer zu erreichen	easy accessible – difficult to access
8	nicht effizient - effizient	efficient - not efficient
9	kein Stellenwert - hoher Stellenwert am Arbeitsplatz	high significance - low significance at the Workplace
10	unwichtig – wichtig	important - not important
11	unerfahren - erfahren	inexperienced - experienced
12	intuitiv – analytisch	intuitive - analytical
13	irrelevant – relevant	irrelevant - relevant
14	wird nicht unterstützt -wird unterstützt	is not supported - is supported
15	neutral für Erfolg des Arbeitgeber - positiv für Erfolg des Arbeitgebers	neutral for employer success - positive for employer success
16	kein Lerngewinn - Lerngewinn	no learning benefit-learning benefit
17	nicht professionell - professionell	not professional - professional
18	nicht angesehen - angesehen	not respected - respected

	Adjective pair (German)	**Adjective pair (English)**
19	Trainingsbedarf - kein Trainingsbedarf	no training needed – training needed
20	veraltet – aktuell	out-of-date – up to date
21	allein - im Team	stand-alone – team work
22	einmalig – kontinuierlich im Projektverlauf	only once – continuously within the project course
23	schwammig - präzise	woolly – precise -
24	selten – regelmäßig im Arbeitsalltag	seldom – regularly within daily work
25	hält auf - bringt weiter	slows down - helps on
26	spärliches Angebot – großzügiges Angebot an Informationsquellen	sparse – broad regarding offer of information sources
27	unsystematisch – systematisch	systematically - unsystematically
28	unfruchtbar - fruchtbar	unfruitful – fruitful
29	uninteressant – interessant	uninteresting – interesting
30	unzuverlässig – zuverlässig	unreliable – reliable
31	unnütz – nützlich	useful – not useful
32	mit professionelle Hilfe - ohne professionelle Hilfe	using expert help – not using expert help
33	genug Zeit zur Verfügung – wenig Zeit zur Verfügung	enough time available – little time available
34	oberflächlich – detailliert	superficial – in detail

Table A: SEMDIFFIL (3rd version)

Study Design

The target group of the study were researchers from the field of natural science (biology, chemistry, pharmacy, physics). As a means of validation and comparison two groups in different environments were selected. Group participants were chosen by random selection (Survey 1) and stratified random selection (Survey 2). The questionnaire items were organized in random order to minimize order effects.

- Study 1: The first group included 149 employees at German universities. The study was conducted from December 2006 until April 2006 in form of an online questionnaire.
- Study 2: The second group consisted of 79 scientific employees working at a major pharmaceutical company. The study was conducted from February 2007 until April 2008. SEMDIFFIL (3rd version) was part of extended personal interviews.

In order to maintain objectivity, the execution of the study was based on a generated guide on survey design. The following table only gives a short overview over the study schedule.

Survey 1 /2	Total Time: 25 minutes
Phase 1: General Information (approx. 3 minutes)	
At the beginning of the interview, participants were informed that the survey and its analysis was conducted anonymously. Furthermore, participants were notified about the scientific aim and the course of the interview.	
Phase 2: Introduction to the topic (approx. 5 minutes)	
In order to establish a common standard of knowledge, a general definition of the scientific information process and its steps was presented. Furthermore, the filling in of the questionnaire was shown by example.	
Phase 3: Semantic Differential (approx. 10 minutes)	
In phase 3, participants were asked to think about their scientific knowledge work and the related process and skills. Afterwards, they were asked to complete the semantic differential scale spontaneously. The items were shown in 7 randomly arranged sets of in each case 5-7 items.	
Phase 4: Socio-demographic Data (3 min)	
Socio-demographic data was taken with regard to age, workplace, scientific field, usage of information source (etc.).	
Phase 5: Conclusion (3 minutes)	
The researcher thanked the respective subject for the informative and helpful participation. It was stated that the results of the survey will be presented at the end of the year 2007.	

Table B: Study Schedule

Method of Analysis

After data generation, factor analysis and item analysis were applied as a means of item selection and organization (Bortz & Döring, 2006, pp.185-187). The application of factor analysis included the verification and adaptation of the raw data, the appliance of an appropriate factor algorithm, the testing of the communalities and the factor extraction as well as interpretation of the factor loadings. As illustrated in the following table, both data sets showed to be valid for factor analysis (Backhaus, Erichson, Plinke & Weiber, 2006, pp. 269 - 277):

	Survey 1	**Survey 2**
Criteria	Suitability	Suitability
Correlation matrix	Not sure: Matrix shows both, high and small values.	Not sure: Matrix shows both, high and small values.
Significance of correlation coefficients	Yes: 95.5 % of the levels of significance are low (<0.4)	Yes: 87.2% of the levels of significance are low (<0.4)
Inverse of correlation matrix	Yes: 79.8% of the values of the not-diagonal elements are close to 0 ([-0.2;0.2])	Yes: 65.7 % of the values of the not-diagonal elements are close to 0 ([-0.2; 0.2])
Bartlett Test of Sphericity	Not applicable (no normal distribution)[2]	Not applicable (no normal distribution)
Anti-Image-Covariance	Yes: < 25% (7.7%) of values are > 0.09	Yes: < 25% (17.2 %= or the values are > 0.09
KMO-Measure	0.840 = meritorious	0.605 = mediocre

Table C: Verification the Suitability of the raw data for factor analysis

As it was aimed to reproduce the correlation matrix in form of fewer components, principal component analysis was chosen. In case of communalities, a sample size of 80 communality values requires at least h2≈.60. With a sample size of 149 communality values h2≈.50 are stated to be acceptable (Bühner, 2004, pp. 193). Consequently, attributes owning communalities below .50 (Survey 1) and below .60 (Survey 2) were excluded. Regarding the number of factors, a variety of different measures are recommended (Bühner, 2004, pp. 199 - 203): In the course of this study, parallel analysis was applied.

[2] Normal distribution is not a obligatory prerequisite of the applying of a factor analysis (Bühner, 2004, p. 196)

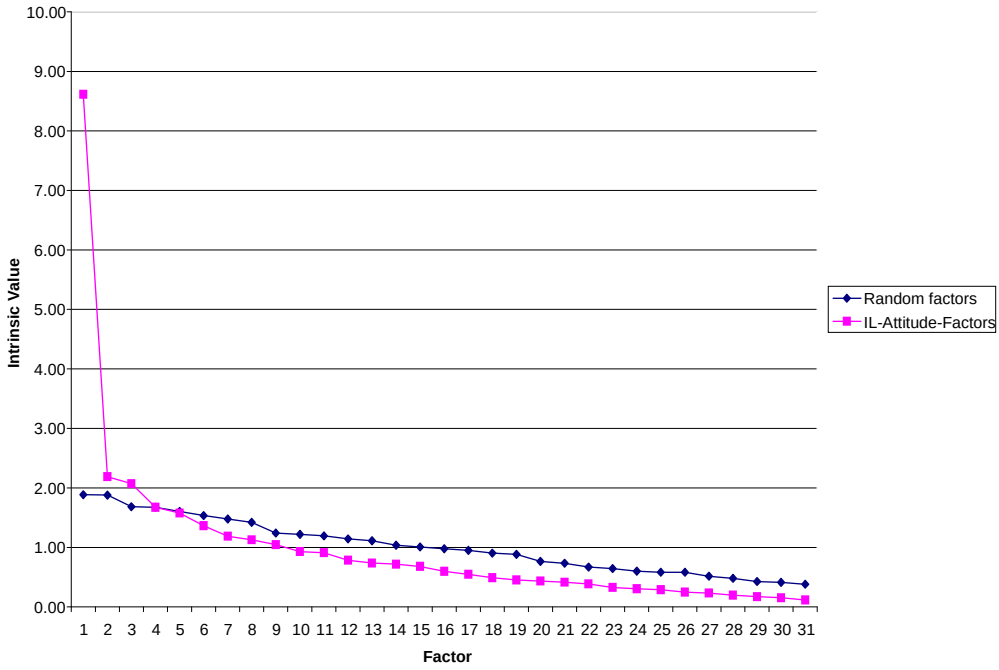

Figure A: Survey 1: Parallel Analysis

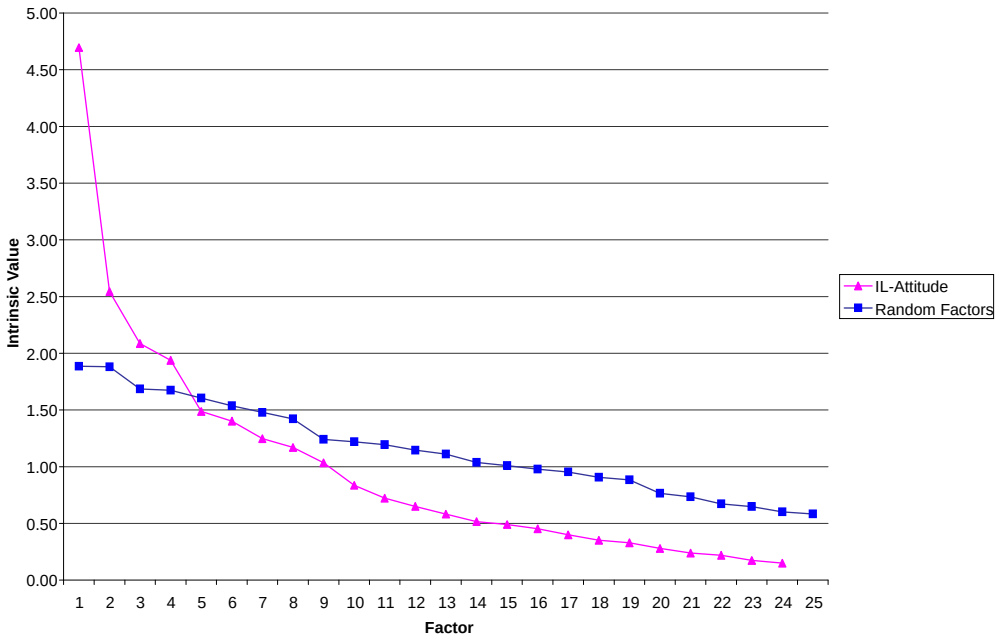

Figure B: Survey 2: Parallel Analysis

In case of Survey 1, the lower line – representing the randomly generated factors – cuts in the middle of factor 4 of the upper line formed by the IL-Factors. Based on content-related considerations the extraction of three factors turns out to be the most sensible. This number of factors is as well typical for the semantic differential (Osgood et al., 1957). The data set of Survey 2 suggests to extract four factors. After the extraction of the respective factor matrix, item analysis for each complete item pool as well as for each single dimension was applied (Bortz & Döring, 2006, pp. 217 - 221).

General Reliability – Survey 1			**General Reliability – Survey 2**		
Cronbach Alpha	**Cronbach Alpha for standardised values**	**Number of Items**	**Cronbach Alpha**	**Cronbach Alpha for standardised values**	**Number of Items**
0.907	0.911	27	0.782	0.803	20

Tabel D: Reliability of data represented by the Cronbach Alpha Coefficient

Item analysis implies the calculation of the *index of complexity* (recommended values: between 0.2 – 0.8), the *discriminative power* (recommended values: 0.3- 0.5 = mediocre, over 0.5= high), and the *homogeneity index* in form of the Alpha Cronbach Coefficient of each item (recommended values: $\alpha > 0.8$ = reliable/good, $\alpha > .70$ = satisfying, $\alpha > .60$ = acceptable, $\alpha > .50$ = miserable, <.50 = inadequate). It was defined that item pool had to own a general and dimension-specific internal consistency $\alpha > .70$ (= satisfying).

Based on the results of this procedure, items were taken out of the pool step by step. After the statistical revision of the data matrix, factor analysis was performed again, applying principal component analysis and varimax rotation. Items were selected step by step based on the value of their factor loadings: In order to keep an attribute in the item pool, the following criteria were applied (Backhaus et al., 2006, p. 299; Bühner, 2004, p. 211):

- Only items that show a high loading (>.5) on one factor and on no other factor (<.3) were selected.
- Items had to be related in terms of content
- At least 3 items had to load on one component.

Survey 1: The generated matrix explains 65.9 % of the general variance, which is stated to be good for a study with a social scientific background (Raithel, 2006, pp. 104 - 117). Furthermore, the KMO-Value of .817 is

"meritorious" for factor analysis. The Scree Test still supports the extraction of 3 factors. The internal consistency of the 13 remaining attributes is α=0.879 and therefore good/reliable.

Survey 2: The generated matrix explains 59.5% of the general variance, which is stated to be good enough for a study with a social scientific background (Raithel, 2006, pp. 104 - 117). Furthermore, the KMO-Value of 0.650 is "middling" for factor analysis. The Scree Test shows that 4 factors are to be extracted. The general internal consistency of the 16 remaining items is satisfying with α=0.732.

Methodological Quality Criteria

To ensure objectivity, reliability and validity of the test, several precautions were met. *Objectivity*: In order to obtain the same results in respect of the execution, analysis and interpretation of the related data, the study was performed and analyzed on basis of a standardized instruction plan. Furthermore, the survey relied on standardized, quantitative methods in form of a fixed-response questionnaire. *Reliability:* The reliability of the study, implying the repeating of the survey under the same conditions reveals exactly the same results, was tested in form of the internal consistency (variation of the parallel test reliability), represented by the Cronbach's Alpha coefficient. *Validity:* As there does not exist a valid external criteria, content validity was tested by the commitment of different experts in the course of the scale construction in order to verify whether it covers all aspects of the underlying construct (Cook & Campell, 1979; Bortz & Döring, 2006, pp. 195 - 202; Bühner, 2004, pp. 33 - 43; Raithel, 2006, pp. 42 - 44).

Survey Results

Survey 1: The first dimension combines items connected to quality aspects of information. Additionally, personal motivation items load high on the first component. The second component contains user characterization as e.g. user experience. Again, personal motivation items load high. The third dimension refers to the related personal utility. The dimensions are displayed in the following table and diagram (low Factor loadings <0.3 are suppressed).

		Component		
		1	**2**	**3**
nachteilig – vorteilhaft	**disadvantageous - advantageous**	0.305		0.789
unerfahren – erfahren	**inexperienced - experienced**		0.875	
nicht professionell - professionell	**not professional - professional**		0.842	
Trainingsbedarf - kein Trainingsbedarf	**no training needed - training needed**		0.792	
schwammig – präzise	**–woolly - precise**	0.743		
unzuverlässig – zuverlässig	**unreliable – reliable**	0.697		
unnütz – nützlich	**useful – not useful**			0.854
unwichtig – wichtig	**important - not important**			0.854
nicht angesehen – angesehen	**not respected – respected**	0.598		
uninteressant – interessant	**uninteresting - interesting**	0.680	0.454	
unfruchtbar – fruchtbar	**unfruitful – fruitful**	0.609	0.366	0.371
langweilig – spannend	**boring – exciting**	0.696	0.423	
kein Lerngewinn - Lerngewinn	**no learning benefit - learning benefit**	0.670		

Table E:Survey 1: Principal factors influencing attitude towards the scientific information process

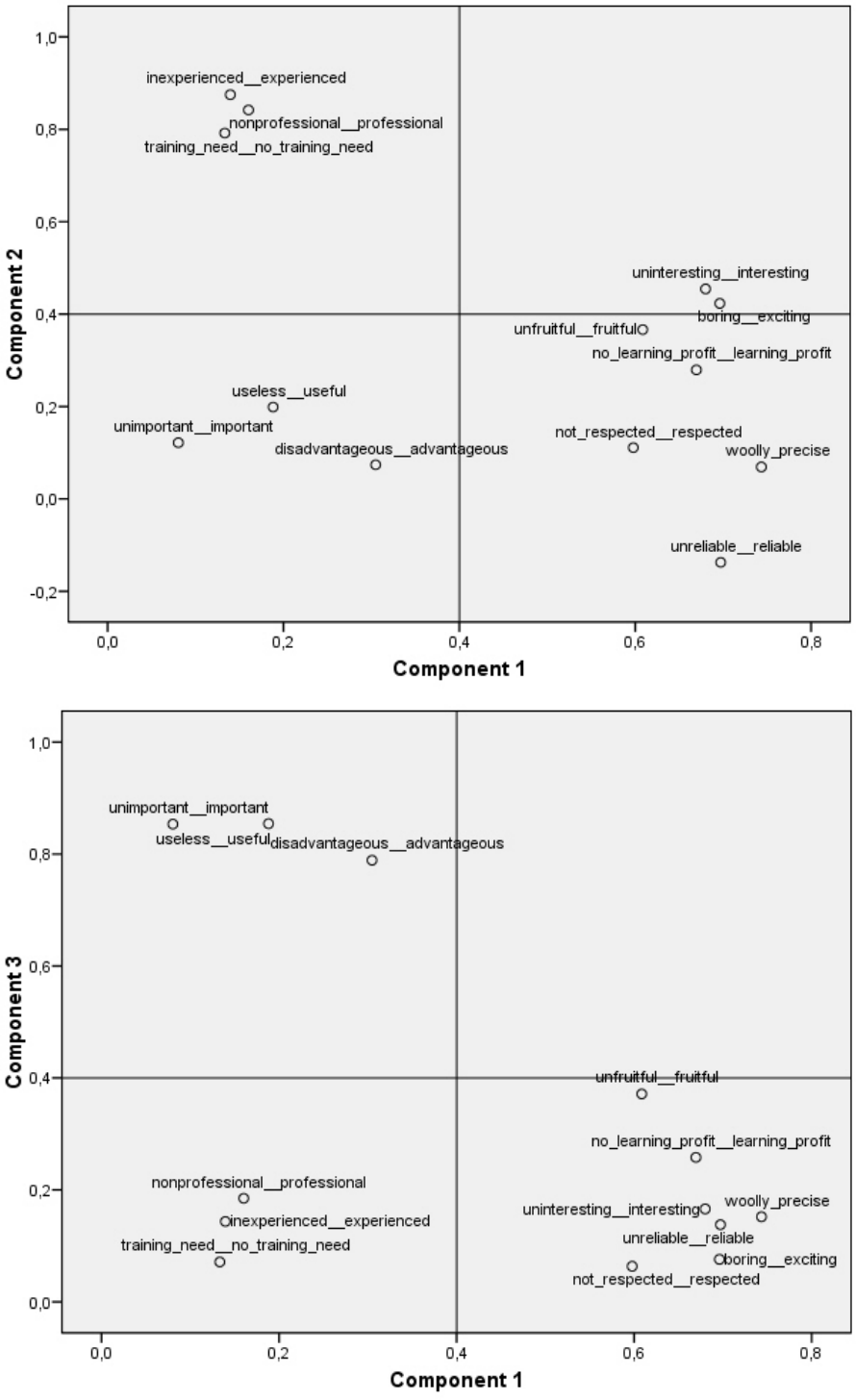

Figure C: Survey 1: 3 Principal factors influencing attitude towards the scientific information process

Survey 2: Component 1 stands for user characterization as e.g. user experience and effort. These items are additionally related to the aspect of organizational support. Component 2 refers to personal and corporate utility related to the process. Component 3 contains personal motivation with regard to the information process. Component 4 refers to the quality of the information process again influenced by the support provided by the corporate environment. The dimensions are displayed in the following table and diagram (low Factor loadings <0.3 are suppressed)

		Component			
		1	**2**	**3**	**4**
langweilig – spannend	**boring – exciting**			0.850	
nicht effizient – effizient	**efficient – not efficient**	0.595			
unwichtig – wichtig	**important - not important**		0.881		
unerfahren – erfahren	**inexperienced - experienced**	0.757			
Irrelevant – relevant	**irrelevant – relevant**		0.836		
wird nicht unterstützt -wird unterstützt	**is not supported - is supported**	0.356			0.563
neutral für Arbeitgeber - positiv für Arbeitgeber	**neutral for employer - positive for employer**		0.663		
kein Lerngewinn - Lerngewinn	**no learning benefit - learning benefit**			0.725	
nicht professionell - professionell	**not professional - professional**	0.734			
Trainingsbedarf - kein Trainingsbedarf	**no training need - training need**	0.742			
einmalig – kontinuierlich im Projektverlauf	**only once – continuously within project course**	0.608			
schwammig – präzise	**precise – woolly**				0.878
selten – regelmäßig im Arbeitsalltag	**seldom - regularly within daily work**	0.508			
uninteressant - interessant	**uninteresting - interesting**			0.833	
unzuverlässig - zuverlässig	**unreliable – reliable**				0.814
unnütz – nützlich	**useful – not useful**		0.690		

Table F: Survey 1: Principal factors influencing attitude towards the scientific information process

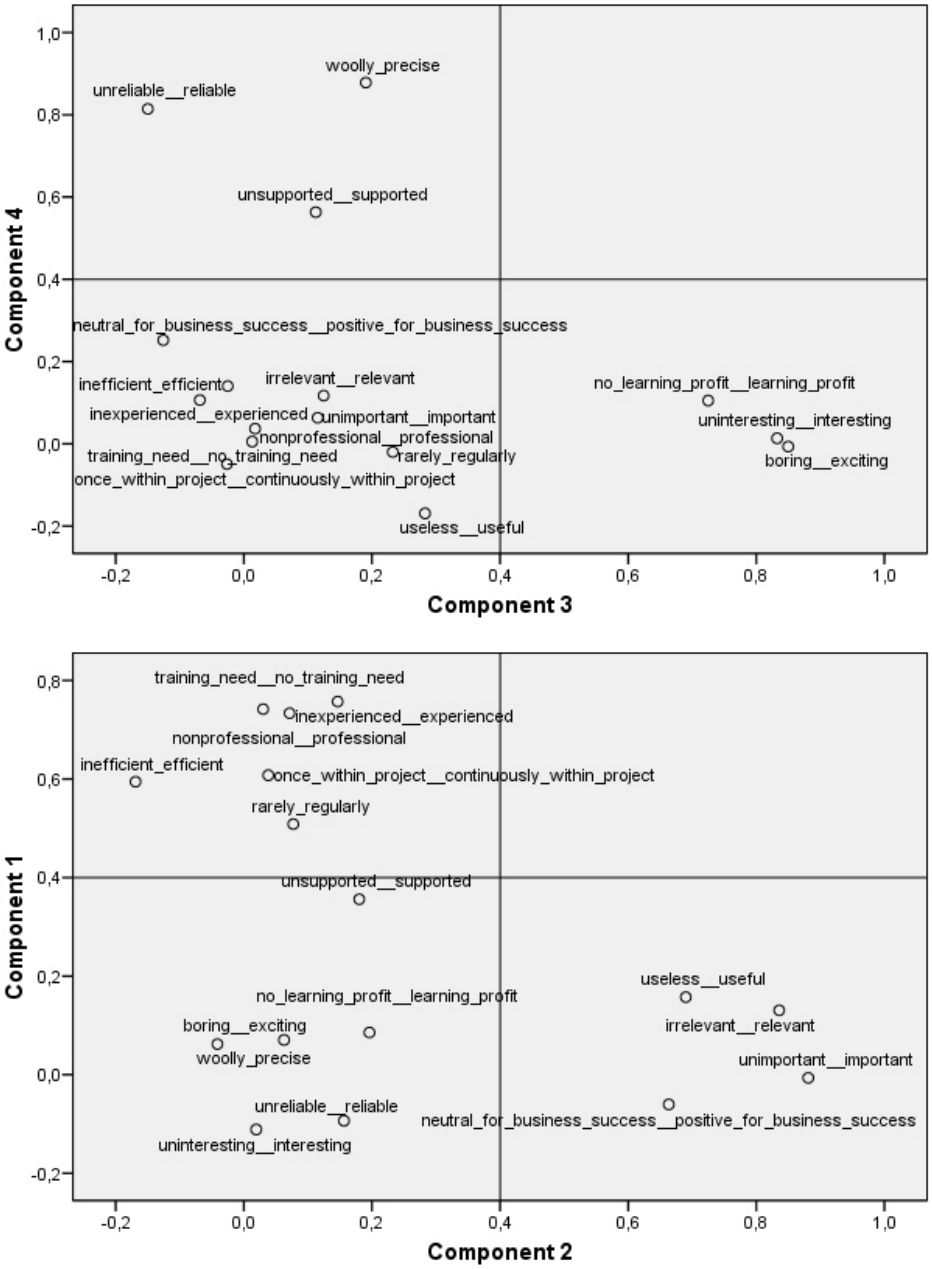

Figure D: Survey 2: 4 Principal factors influencing the perception of the scientific information process

Group Differences

As the variables were not normal distributed, the U-Mann-Whitney Test was applied to test group differences on basis of the central tendencies of the distributions (Janssen & Laatz, 2007, p. 537). As said before, the rating scale

consisted of a seven-point bipolar scale in form of a semantic differential (values ranging from 0 to 6)[3]. Workplace environment items referring to the personal motivation (interesting/exciting) are rated significantly higher at the company workplace environment ($p<0.001$; cf. Median and Arithmetic Average in Table G). Furthermore, the evaluation of the usefulness (cf. Med. in Table G) and the preciseness (Quality; cf. AA in Table G) of the data is evaluated significantly higher at the company workplace. Last but not least, the company employees rate the influence of this kind of work on the success of the organization higher, but feel significantly less supported by their workplace environment (cf. Med. in Table G).

		boring/ exciting	**uninteresting/ interesting**	**useless/ useful**	**woolly/ precise**	**unsupported / supported**	**neutral/ positive for the success of the employer**
Mann-Whitney-U		3775.50	4229.50	4412.00	4332.50	4490.50	3537.50
Z		-4.69	-3.79	-3.53	-3.49	-3.17	-5.23
Univ.	**AA**	3.85	**4.45**	5.06	**3.50**	4.16	3.91
	SD	1.58	1.32	0.99	1.28	1.42	1.71
	Med.	**4.00**	5.00	**5.00**	4.00	**5.00**	**4.00**
Org.	**AA**	4.81	**5.08**	5.51	**4.11**	3.78	5.03
	SD	1.103	0.883	0.574	1.222	1.055	1.158
	Med.	**5.00**	5.00	**6.00**	4.00	**4.00**	**5.00**

Table G:Mann-Whitney-U Test testing group differences

Comparing all available items, it appears that the amount of available time as well as the accessibility of the tools is rated significantly lower (cf. Med. Table H) , while the broadness of the offer and the provided team work culture is rated significantly higher at the business workplace (cf. Med. and AM Table H).

[3] The range of the values is from 0 to 6 as e.g.: 0= boring; 1=quite boring; 2= rather boring; 3= partly/partly; 4= rather exciting; 5= quite exciting; 6= exciting

		not accessible / easy accessible	stand alone / team work	sparse offer / broad offer	little time available / enough time available
Mann-Whitney-U		1453.00	4219.00	4541.00	4520.00
Z		-9.60	-3.72	-3.11	-3.06
Univ.	**AA**	4.09	1.73	**4.47**	3.05
	SD	1.38	1.80	1.38	1.52
	Med.	**4.00**	**1.00**	5.00	**3.00**
Org.	**AA**	2.1	2.66	**5.03**	2.4
	SD	0.821	1.922	1.091	1.688
	Med.	**2.00**	**2.00**	5.00	**2.00**

Table H: Mann-Whitney-U Test testing group differences

Conclusion

The semantic differential scale of Information Literacy (SEMDIFFIL) captures the perception towards the information process at the workplace. Our analysis shows that five principal aspects (loading on 3 or 4 factors) play a major role in terms of the semantic perception of the information process: personal motivation, experience, personal and corporate utility, organizational support and information quality.

Principal Factor / Workplace	**Component I**	**Component II**	**Component III**	**Component IV**
University	Quality & Personal Motivation	Experience & Personal Motivation	Personal Utility	-
Company	Quality & Organizational Support	Experience & Effort	Personal & Organizational Utility	Personal Motivation

Table I: Comparing Semantic Aspects of the Principal Factors of the two Samples

In contrast to the university environment, the personal motivation forms an independent dimension at the company workplace. At the university, this aspect is closely related to the quality of the provided information and the experience of the knowledge worker. On the other side, the organizational support as well as the organizational utility and the effort (time + money) in terms of the process play a major role, mainly within the company environment.

Organization support is hereby closely connected to the quality of the provided information, organizational and personal utility are merged at the company. The influence of the workplace environment becomes additionally clear, when testing group differences: Results imply that the workplace environment has a significant influence on the perception of the information process, in terms of personal motivation, personal and organizational utility and organizational support (e.g. available time, accessibility and number of available of tools and team structure).

Practical Implications

In order to foster Information Literacy at the workplace its utility has to be promoted, the quality of the provided information (e.g. by the information services or the library) has to be ensured and high-quality data has to be easily identified and accessed. Furthermore relevant trainings have to be integrated into the respective curriculum, while personal motivation should be strengthened by adequate psychological incentives. Concepts to integrate the concept into the business culture and organization have to be designed and implemented. Subsequently, strategies for advancing the information process need to rely on different levels.

Pedagogical Level	**Psychological Level**
Professional trainings, adapted to user needs, integrated into schools, universities and business organizations.	Promotion of Information Literacy e.g. in form of adequate incentives, in order to increase the awareness of the necessity of this competence.
Technological Level	**Organizational Level**
Simple, usable and homogeneous information landscapes providing high-quality information.	Integration of Information Literacy into organizational- processes, e.g. in form of an Information Literacy certificate.

Table J: Strategies for Advancing the Information Process

Consecutively, successful strategies as well as missing organizational and technical support were diagnosed and partly implemented, relying on personal interviews at the respective company. The following table shows only a selection of the recommended implications at the respective level.

Level	Implication
Pedagogical Level	An user-adapted IL training concept for scientists of the mentioned company was introduced. This training concept is based on a blended learning approach, thus including in-house seminars as well as Elearning modules. The concept is integrated into the business landscape in form of a Training Wiki.
Psychological Level	The concept of Information Literacy and the respective trainings was promoted in form of various communication channels. This included the integration of the Training Wiki into the general training site of the HR as well as the Homepages of the scientific departments. Furthermore, the importance of this topic was promoted it via News Alerts as well as on internal events (poster).Last but not least, personal interviews regarding this topic were conducted, these contacts were than employed as multipliers of the necessity of the referred competence.
Organisational Level	A user analysis is being conducted in order to adapt the information landscape to user needs. Moreover, the introduction of an Information Literacy certificate into the organization in form of obligatory courses for this special user group is discussed.
Technological Level	Regarding the usability of databases, a process for evaluating and optimizing databases on basis of a user type analysis and a process for the testing of the usability of the respective databases is implemented. Furthermore, a concept for an intelligent database selection aid that connects scientific information sources e.g. internet sources and scientific databases has been created. It adapts the access to information sources to user needs by classifying these sources and allowing for personalization. Furthermore, it adds a social component that allows users and experts to evaluate and tag the available retrieval tools. This helps users to get a better overview over existing tools and the quality and utility of their contents. Consequently, it generates collaborative knowledge on the basis of user and expert recommendation. In contrast to meta-search applications, it does not restrict the usability of existing information sources, but enhances the finding and the access to information by providing a recommendation framework for the selection of appropriate information sources.

Table K: Practical Implications on different levels

Further Research

We assume that the information workers' perception influences the formation and advancement of Information Literacy at the workplace. This ongoing analysis is part of a doctoral thesis that aims at an in-depth description and model of the method operandi of employees within the scientific information process at the workplace. It is supported by the library and scientific information services at a major pharmaceutical enterprise. Simultaneously, successful strategies as well as missing organizational and technical support are being diagnosed and partly implemented.

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