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TOWARD A DEFINITION OF FOUR ORDERS OF COMPETENCY FOR THE USE OF INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) IN EDUCATION

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Abstract

This paper describes the initial stages of an attempt to profile competencies related to the use of information and communication technology (ICT) in an educational setting, along distinct dimensions. Items were selected and adapted from existing literature, and an initial classification yielded four orders of competency. This was then submitted to judges for validation and a subsequent questionnaire was administered to 19 teachers. A first look at the results has shown that competency levels are low and a further correlation analysis of the results has shown that 4 orders of competency can be clearly identified.

Introduction

After spending the 80's purchasing and installing computers in the classrooms, it was soon realized that, unlike educational television, this technology required constant interaction from the user and therefore one needed to learn how to use it to take full advantage of its potential. In the past decade or so, much attention has been focused on identifying specific competencies to be developed in schools in order to empower both students and teachers as users. Some of these efforts were initiated on a national level by large organizations while others, on a more local scale, were the work of teachers mapping out what school children should know about the use of computers.

In the United States for example, in the early 90's, the International Society for Technology in Education initiated a process to develop standards that would eventually be adopted by the National Council for the Accreditation of Teacher Education for accrediting teacher education programs across the US, [1], [2], [3], [4], [5]. In these documents, sets of performance indicators, describing what teachers should know about computers, were grouped under several headings.

In Ontario, during the same period, some school boards produced lists of indicators to help teachers identify what children should be doing with computers and in which grade level. All these indicators were of a purely technical nature. They described the proficiency of use of very specific tools and functions. Since then, in the new curriculum [6] put out by the Ontario Ministry of Education, elements of use of ICT have surfaced in all disciplines.

After collecting a list of items from the ISTE [5] list as well as others such as Bégin et al. [7] , Industry Canada [8], and items from the Ontario Ministry of Education curriculum [6], it became clear that they were simply too numerous and too confusing since each list had its own classification system. It was felt that in order to target competencies to be measured, and in order to eventually plan a teacher education program that would address the development of such competencies, the list needed to be organized in some way, around broader dimensions, so that a simpler model would more adequately profile these competencies.

Problem

In order to select the indicators, an inventory of all collected items was compiled in a database and then an attempt was made to sort them. At this point, characteristics had to be identified for these indicators. First, it was decided that what constitutes a competency would have to be described as a combination of elements of knowledge that can be called on to identify and act upon a specific task or problem [9], [10]. Also, an attempt was made to look at the reason for using computers in the classroom [11]. A look back at the introduction of computers in schools revealed that, at that time, the computer itself was the object of study and one was expected to learn the basics of operation. This fundamental idea was used to group all items describing competencies of a technical order.

Later, it became apparent that the power of this technology could be used by school children to extend the mind's capacity to treat information in a variety of ways [11], [12]. The competencies required to achieve this relationship between the learner, his ideas and the computer were identified as being of an epistemological order.

In the 90's, with the rapid spread of the Internet and the WWW, information access became almost too easy. As we move into this information age, the relationship between the learner and documents containing information became more complex and a great number of indicators were identified as being of an informational order.

Soon the Internet opened another area of possibilities for the masses, that of communication. This took the initial idea of electronic messages and E-mail and turned it into a combination of synchronous or asynchronous communication tools using text, sound and more recently, live two-way video. These possibilities of using the computer technology to interact with other people created an actual cyberculture and brought on the need to develop certain competencies specific to this world. These were being identified as of a social order, and include competencies dealing with social, ethical, and personal security problems and tasks.

Two questions soon emerged:

1. Are these orders of competency sufficiently distinct and/or independent to stand out and be measured in a general definition of competency and
2. Can these four orders of competency be defined in such a manner as to eventually allow the identification of specific user profiles?

We therefore started with the idea that items describing competencies related to the use of computer technology in the classroom could be classified in these four orders as defined:

- Competencies of a technical order (T) allow us to operate both the computer hardware and the software covered under the heading: ICT (**Information and Communication Technology**). These are defined as the array of conceptual and procedural knowledge usually constructed when experimenting with computers then applied as useful methods to operate ICT tools efficiently.
- Competencies of an informational order (I) allow us to draw on information available through ICT in an effective and efficient manner. These are defined as the array of conceptual and procedural knowledge usually constructed while searching for specific information using a variety of databases or search engines, in order to extract useful procedures for identifying, selecting, classifying and coherent grouping of data.
- Competencies of a social order (S) allow us to interact with other individuals or groups by way of ICT. These are defined as the array of mostly procedural knowledge usually constructed while reflecting on communication experiences, where a concern for the needs of others emerges, thus establishing a viable way of thinking and acting with other individuals or groups.
- Competencies of an epistemological order (E) allow us to capitalize on the power of computers to solve problems, test ideas and create or modify structures. These competencies are defined as the array of conceptual knowledge, usually constructed by reflecting on and anticipating what the technology can do, to draw analogies, connections, operational schemes and methods to be used in problem solving tasks.

Our objective is to attempt to validate these orders with the hypothesis that the teachers would be able to identify their area of competency or lack of thereof, and that the four orders would emerge as independent dimensions when measured by our instrument.

Method

A first exploratory selection of the items mentioned earlier yielded a set of 19 items that appeared to correspond to our needs. The initial list was put together as a questionnaire and distributed to a test group of 10 teachers and parents in a suburban school setting. The results were compiled and a study of correlation between items revealed no significant or stable groupings along the stated orders. On the other hand, many problems with the items became evident. First, many items were too long and lead to many possible interpretations. Other items were apparently simply misunderstood.

A subsequent careful reselection and often rewrite of items lead to a list of 30 items. The list, along with the definitions of the four orders of competency, was sent to 6 judges, with expertise in both the field of study and the context of Ontario schools, asking them to determine which order of competency each item would be assigned to.

These 30 items were also assembled in a questionnaire to be filled out by a sample group of teachers. Each item was written as a statement starting with "I am able to:" followed by a phrase indicating a competency related to one of the stated orders. The definitions of the orders were not included with this questionnaire and the items were randomly distributed. The subjects were asked to respond as to whether they agreed or not, with the statement on a scale from 1 to 4 (1= total disagreement, 4 = total agreement).

The original 30 items were distributed as follows: T= 7 items, I= 5 items, S= 11 items and E= 7 items. The intention was to correlate each item to the sum of its corresponding sub-scale thus offering a second method of matching items with orders of competency.

Results

The 6 judges' responses were collected and Table 1 shows that there was a sufficient agreement between the judges for 22 items. We considered sufficient agreement in the cases where at least 4 judges out of 6 (at least 67%) related an item to the same order of competency. Also, 8 items were therefore considered weak: 4, 6, 13, 18, 20, 24, 25 and 27.

Table 1: Agreement amongst judges

items	agreement	%
2;5;8;15;21;23;28	6 out of 6	100%
1;7;9;10;12;19;22;26;29;30	5 out of 6	83%
3;11;14;16;17	4 out of 6	67%
27	3 out of 6	50%
18	2 out of 6	33%
4;13;24	1 out of 6	17%
6;20;25	0 out of 6	0%

The questionnaire version was designed for teachers in French language schools. The test sample consists of 19 teachers (16 females, 2 males and one unidentified) of an inner-city school. The median age is approximately 40 years. Most teachers have more than 10 years of experience (median around 15 years) and in general, work experience outside of the teaching profession is stated as 9 years or less. More than half of the subjects (11) did not indicate having taken any professional development courses while 8 mentioned having taken some courses after their initial teacher education program. In general, most teachers stated frequent use of the computer (16 out of 19). The teachers from the sample group are relatively evenly distributed across the grades in the school (grades 1 to 8).

Following a close examination of subjects' responses, we selected five items where there was strongest agreement for each order T, I, S and E, thus creating four sub-scales. This resulted in the rejection of one third of the original items where there was little or no agreement. Items: 1, 6*, 9, 20*, 21, 25*, 26, 27*, 28 and 30 were rejected, all having a correlation (Pearson's R) ≤ 0.6 with sub-scale. In the light of the correlation analysis, we decided to reject these ten items including the four (*) where there was no agreement between the judges. On the other hand, four other items, (4, 13, 18, 24) on which there was no clear agreement by the judges, were retained because they were highly correlated with their sub-scale (≥ 0.6). This reduces the scale to a total of 20 items distributed evenly to yield 5 items for each of the 4 orders (Table 2). For the subsequent analysis, the total scores range between 20 and 80 and the scores for each sub-scale range between 5 and 20 with respective midpoints of 12.5 and 50. For the interpretations, scores of 12 or less on a sub-scale or less than 51 on the total is considered to represent an absence of competency whereas a score over 12 on a sub-scale or over 50 in total indicates some competency.

Table 2: Items retained for each order

Order	Items				
T	3	4	5	19	23
I	7	11	14	16	17
S	8	10	12	18	22
E	2	13	15	24	29

In order to offer clarification as to the types of items retained in table 2, table 3 offers a translation of the highest correlated items retained for each order. When reading the table, the informational order (R=0.74) seems to stand out from the three others (R≥0.80). This would suggest that amongst the four orders, this one seems to be the least clearly discernible.

Table 3: Translated examples of retained items

Items (Translated from French originals)	Correlation	Competency order
5 - Install and use a computer and it's peripherals, without help.	0.80	Technical
16 - Make use of semantic networks to prepare for keyword searching	0.74	Informational
8 - Describe the ethical, cultural, and societal issues related to the use of technology	0.89	Social
13 - Use technology to support compilation, organization, analysis and synthesis of information.	0.87	Epistemological

Table 4 shows the means and standard deviations for total scores for each sub-scale as well as for the total scores for all items.

Table 4: Competency score by order

	order T (20)	order I (20)	order S (20)	order E (20)	total score (80)
mean	11.68	13.79	10.89	12.42	48.79
st. dev.	3.46	3.59	3.88	3.45	12.01

A first observation is simply that the overall competency level is relatively low in that the 48.79 average is below the neutral score of 50. For each sub-scale, the corresponding neutral points being 12.5, order I shows a mean above this threshold whereas orders E, S and T are below. It is also believed that the test subjects did not construct these competencies in an even manner. In fact, many subjects scored each sub-scale quite differently. For example, subject 14 scored 18 on sub-scale I, but only 10 on sub-scale T; subject 15, scored 17 on sub-scale I and only 11 on E.

Conclusion

An initial observation deals with the global competency of this first sample of teachers. Our data shows that a small number of individuals consider themselves competent in the four identified orders while a relatively large number do not feel at ease with some of the more basic computer related skills. Although they consider themselves frequent users, they do not seem to have developed the variety of abilities that frequent use would suggest. This seems to be supported by the fact that these teachers have not shown interest in professional development in this area.

A second observation deals with the instrument itself. It would seem that, although there is evidence of substantial overlap, the results effectively discriminate between the four orders of competency as stated: technical, informational, social and epistemological. In our opinion, the corroboration from 6 judges as per the categorization of items to order insures sufficient validity for the instrument. A further analysis of the empirical data supported this in that five items were in high correlation with the partial scores of each of the orders.

It must be emphasized that the overlap in identified components of competencies in our data, since so many subjects responded with low scores on some of the indicators, suggests that it is unreasonable to assume that they can discriminate between competencies. In future assessments of this nature, we would recommend a closer look at data from teachers who have demonstrated at least some level of general competency with computers.

All the items were drawn from published literature and other sources. Our concern was to examine their organization in relation to the competencies as defined. Our instrument has allowed us to identify 4 orders of

competency within the general competencies related to the use of ICT in education. On the other hand, we believe that it is possible to isolate indicators of a fifth distinct order of competency. This order would seem to be of a strictly pedagogical nature and would probably describe the ability of a teacher to guide learners in a process aimed at the development of their own ICT competencies.

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