# The impact of skills and demographics on end-user developers' use of support

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## ABSTRACT

There are many end-user developers but they are quite often left to their own devices when it comes to finding support for development tasks, particularly those who belong to small organisations. With less access to formal support sources we would expect them to turn to more informal as well as on-line sources. However, the use of on-line sources requires skill and confidence in using computers and the Internet. In this paper, we look at a group of small organisations and what impact the skill and demographic factors have on the use of different support sources among existing and potential end-user developers. The analysis was performed using the self-organizing map. It suggests that personal contacts form a default source for people and that increased skills leads to less reliance on these. Computer and Internet skill are the most important factors influencing support use, enabling some end-user developers to "self-help".

### Keywords

End-user development, on-line support, SME, small organisations self-organizing map.

## INTRODUCTION

The practice of end-user development (EUD) is very common. According to Scaffidi, Shaw and Myers (2005) there are more end-user developers than professional programmers. Extrapolating the estimate in Scaffidi et al. for computer usage suggests that around 55 million, potential and actual, end-user developers exists in the United States alone. In addition to the more traditional areas of EUD, such as spreadsheets and databases considered in the Scaffidi et al. study, web design and related activities are relatively new areas where many more end-user developers can be found. Increasingly, regular software also allows for extensive customisation that is pushing the envelope towards being out-right EUD, e.g. through the introduction of macros and scripting. In all of these cases users are gradually taking on the role of developers and consequently facing a growing need to support these new tasks.

These end-user developers generally lack the training a professional developer would have, in fact, the definition of an end-user developer and associated development usually revolves around the lack of formal training in programming or development activities. E.g. Lieberman, Paternò and Wulf (2006) formulates it thus: "*EUD can be defined as a set of methods, techniques, and tools that allow users of software systems, who are acting as non-professional software developers, at some point to create, modify, or extend a software artifact*".

End-user developers are found in organisations of all types and sizes, but particularly interesting are those end-user developers who are part of very small organisations. In small organisations, many of the traditional forms of support, such as helpdesks, are limited or non-existent. Furthermore, a small-organisation emphasizes one of the main EUD issues, which is that it does not form the main focal point for the effort (Nardi, 1993). In smaller organisations each member will have more responsibilities, which is likely increased further by incorporating information technology in the organisation, all culminating in the single business proprietor, who has sole responsibility for not only the core business but also all ancillary tasks.

For these developers the possibilities afforded by support from sources on the Internet could be important in replacing or supplementing the traditional forms of support. In our experience many people are not taking full advantage of this. We therefore ask: why is this so? Can we identify the reasons why this potential is not fully explored?

Shaw, DeLone and Niederman (2002) investigated factors impacting end-user support satisfaction and concluded that contextual factors are important for determining satisfaction with support and that they vary among different groups. Cross and Sproull (2004) note that some factors are prevalent for all types of information seeking such as gender, job type and relation to the source. Previous research has focused on the use of computer support *in general*, (e.g. Govindarajulu, 2002; Nilsen and Sein, 2004; Shaw et al., 2002) often within one organisation.

Like Cross and Sproull (2004) we attempt a more holistic modelling of information seeking by analyzing contextual factors and groups. Our study differs from previous studies by using the self-organizing map in building the model and analyzing the results. This enables a multi-dimensional analysis without prior determination of potential groups. We also take a slightly different view in analysing support from the end-user developers' perspective. Demographic and computer/Internet skill were picked as potential contextual factors based on Cross and Sproull (2004), Nilsen and Sein (2004) and Shaw et al. (2002).

The dual aims of this study are 1) to explore if any groupings can be identified in the use of support despite the very heterogeneous nature of end-user developers and 2) to examine the impact of demographic factors as well as computer skill and Internet skill on support source usage. To achieve this, self-organising maps (SOMs) (Kohonen, 2001) are used, which should assist in analysing the complex connections of the very heterogeneous end-user developer population (Klann, Paternò and Wulf, 2006). From the dual aims we have derived the following research questions (RQ):

- RQ1: With no prior assumptions on possible groupings, can we still find commonality among users of support sources?
- RQ2: What is the impact of gender, age, education and job-type contra those of skills?
- RQ3: Are there any connections between groups, demographics/skill and support use?

The rest of the paper is organized as follows. The next section deals with the methodology, presents the data set used and discusses the reasoning behind the factors included and training the map. This is followed by an analysis of the results. Finally, we summarize and conclude this research.

## METHODOLOGY AND DATA

The research methodology builds on the design science and empirical research paradigm. We build an artefact, a self-organising map (SOM). This data-mining technique is used in determining potential groups of users and relationships between the different factors and support sources. A central ingredient when using SOM is the choice and pre-processing of relevant input variables for it. The input variables were derived from a questionnaire as described below.

### Self-organising maps

The SOM is a neural network using unsupervised, competitive learning. It uses a two-layer (input/output) design where multi-dimensional data is mapped onto a two-dimensional plane (i.e. the map) through the training process. One feature of the SOM is that items of data are placed on the map in manner where the items resemble those around them, creating clusters of similar data items.

Even the relatively small sample we maintain is ponderous to examine for each attribute (demographic/skill factors and support sources), especially, since relationships are likely to be fairly complex. The SOM software package used, in this case "Viscovery SOMine 5.2", allows for analysis and visualisation of the data in multiple ways. An important feature was the relative ease with which categorical data could be handled. In addition the software provides us with basic statistical information/tools that have been used in the analysis, e.g. correlations between attributes.

### Data

Our data originated from a larger questionnaire that concerned a proposed teaching project for developing ICT skills in small-organisations in a region in Finland. That project was mainly focused on potential participants' skill levels and current usage of ICT. This gave us the demographic and skill data. The other part we used in this research was designed for this study to answer the RQs. Respondents were asked to indicate which support sources they currently used for solving work and computer problems respectively (see Table 2). Aiming at practicality while remaining academic leads to some trade-offs, which may limit the research somewhat. The questions on support sources are one such compromise. Based on previous experience and knowledge of the population targeted, we expected many of the respondents to not have direct experience of end-user development (fairly novice users) or to not recognize it as such (end-users often do not recognize their efforts as software development). Therefore, we asked people for example to list the support sources used for "problems in your work" and the sources used for "computer-related work-problems". This would give us some idea of how developers might behave when performing development activities which combines the more familiar domain (work) knowledge with the potentially less familiar computer knowledge.

The questionnaires were sent to all municipal offices for distribution among the employees and to all firms registered in the six municipalities constituting the Åland Island archipelago. The number of firms the survey was sent to was 209 and the response rate 17.2%. For municipal employees sampling was random, as all employees were encouraged, but not required, to fill in the questionnaire. According to Statistics and Research Åland (2009) there are a total of 148 employees in the public-sectors in the Åland Island Archipelago, giving an approximate response rate of 27.7%. Of the 77 total responses 60 were usable for this analysis. The demographic breakdown of these are summarised in Table 1.

| Gender | | Job-type | | Age | | Education | |
|---|---|---|---|---|---|---|---|
| Male | 43 % | SBO | 32 % | 25-35 | 17 % | Elementary | 7 % |
| Female | 57 % | Public | 55 % | 36-45 | 27 % | High-school | 38 % |
| | | Both | 13 % | 46-55 | 43 % | Lower academic | 22 % |
| | | | | 56+ | 13 % | Higher academic | 33 % |

**Table 1. Basic demographics of respondents**

| **Support Sources used** | **Work problems (n=60)** | | **Computer problems (n=60)** | |
|---|---|---|---|---|
| *Personal contacts* | 47 | 78 % | 51 | 85 % |
| *Trial and error* | 18 | 30 % | 28 | 47 % |
| *Internet searches* | 41 | 68 % | 21 | 35 % |
| *Internet forums* | 8 | 13 % | 6 | 10 % |
| *Help function* | - | N/A* | 16 | 27 % |
| *Helpdesk* | - | N/A* | 6 | 10 % |
| *Books* | 19 | 32 % | 1 | 2 % |
| | * not applicable to work-related problems | | | |

**Table 2. Use of different support sources**

### Chosen attributes and data preparation

Our analysis included 19 attributes compiled from the original raw data of 60 respondents. Seven attributes represented different factors likely to impact use of support sources and the remaining 12 represented each type of support source for respective type of problem. The independent variables consists of the demographic and skill attributes, and thus included in the map's training, whereas the sources used are dependent variables and given zero priority in training, i.e. they are visible to aid analysis, but did not affect the result of the map. The attributes are listed in Table 3.

**Demographic and skill attributes (independent variables)**

| Gender | Job | Industry | Age | Education | Computer skill | Internet skill |
|---|---|---|---|---|---|---|

**Work-problem support source attributes (dependent variables)**

| Books | Personal contacts | Trial and error | Internet search | Internet forum |
|---|---|---|---|---|

**Computer-problem support source attributes (dependent variables)**

| Books | Personal contacts | Trial and error | Internet search | Internet forum | Help function | Helpdesk |
|---|---|---|---|---|---|---|

**Table 3. Breakdown of the 19 attributes used in the analysis.**

Gender has been important in many cases. Males are more comfortable with computers and the web (Liaw, 2002). Nilsen and Sein (2004) mention gender and self-efficacy as influencing factors. Gender impacts areas of end-user development such as, debugging and self-efficacy in end-user developers (Ko, Abraham, Beckwith, Blackwell, Burnett, Erwig, Scaffidi, Lawrance, Lieberman, Myers, Rosson, Rothermel, Shaw and Wiedenbeck, 2011). Burnett, Wiedenbeck, Grigoreanu and Subrahmaniyan (2008) note that gender is a factor that determines how software features are used.

Job type affects what sources are available for the end-user. Small business owners (SBOs) do not have access to all the same support sources as those in the public-sector do. In comparatively larger organisations colleagues and formal support are more easily available, whereas SBOs are less likely to have access to personal contacts and other sources. Different work tasks will also lead to differing support needs. We also separated out those who worked partly as SBOs and partly in the

public sector as they have a rather special position between the normally mutually exclusive job categories. Thus "Job type" is a nominal attribute with three categories, "Job:Public", "Job:SBO" and Job:Both".

The Industry attribute is closely related to "Job type" and was included to provide a better granularity. Specific job tasks might be part of the explanation for why a source was chosen. Task focus and use of computers differs between public administration where computers are the main tool of the trade and public service, such as schools and other social services, where computers play a lesser role and the main task is the service provided, similarly different types of SBOs may be different in their use of computers.

Initially all industry data items were considered individually, but the items in the attribute were gradually consolidated into 4 major groups by grouping the items which mapped in nodes close together. In this way the categories "public office", "public service" (schools, child- and elderly care) were formed. Similarly, the 19 separate industries named by the respondents were consolidated into two categories, "SBO combine1" and "SBO combine2". This was done as a compromise as the many industries with a single entry creates a visual overload in the map. There was no discernible similarity to these industries like there was for the public sector "industries". Having two attributes with similar basic information strengthens the clustering effect of this information, but we argue the benefits of the improved visualisations outweigh this. Maps were created with either and both attributes present and there is no impact on the analysis and results.

Age was included as some age effect could be expected. People who have grown up with technology are more familiar and comfortable using it (Brown, 2002). While we have encountered both old and young users of Internet and on-line sources, our experience suggest younger people are more likely to use Internet sources. Young people use the Internet more frequently (Statistics and Research Åland, 2001). Age was treated as a numerical attribute.

Education was picked as an attribute because it gives an opportunity for gaining computer knowledge through computer courses which are now common in syllabuses. Education is an ordinal attribute scaled from 1 to 5 representing different levels of education. A low education in this population means having a secondary level education, i.e. low only in the sense that it is possible to achieve further educational degrees at a university or college.

People need to be comfortable with computers, the Internet and search engines to use them and skill increases confidence (Liaw, 2002). The computer skill attribute is an average based on the respondents reported skill in among others, office-, graphics- and e-mail applications. The Internet skill attribute is based on the respondents reported Internet usage for different tasks. Both attributes are scored from 1 to 5 where 1 represents little/no skill/use and 5 represents high skill and extensive use.

### Training of the maps

The SOM will usually be adapted to the data to be analysed and certain degree of adjustment is usually necessary. In this case most of the parameters were left at the software package's default values. The main adjustments were map-size and the attributes included in training the map. This differs somewhat from the suggested map-size (e.g. Kohonen 2001), but it seems to fit the data better. The target size was set at 100 nodes, but as suggested by the software's heuristics the map-size eventually used in training was 72 nodes (8x9). Although comparatively large for a small dataset of 60 items, the smaller map-sizes seemed to lose explanatory power, when otherwise mutually exclusive items were stacking in the same nodes.

## RESULTS AND ANALYSIS

We identified six (6) clusters, namely*, male public sector*, *male SBOs*, *female public office*, *female SBOs*, *female public service*, *female job type: both*. These groups and their main distinguishing attributes are illustrated in Figure 1.

The interpretation to the six clusters is given by analyzing the feature planes (Figures 1 and 2) where the weight for each neuron is visualized by colour imaging, warm colours representing high values and cold colour representing low values. The education attribute's value e.g. is high for the neurons on the left-hand side of the map and low for the neurons on the right-hand side (mostly). Hence, persons that are mapped onto the neurons on the left-hand side of a self-organizing map have a higher educational level than the persons on the right hand side. This is most clearly seen with binary type variables like gender where males are on the top half of the map and females on the bottom half. Therefore, males with high education are mapped on the upper half and left-hand side of the SOM, while high education females map to the lower half right-hand side and so on. A visual representation of the clusters and the main distinguishing attributes as displayed in the software package is found in Figure 1 and Figure 2.

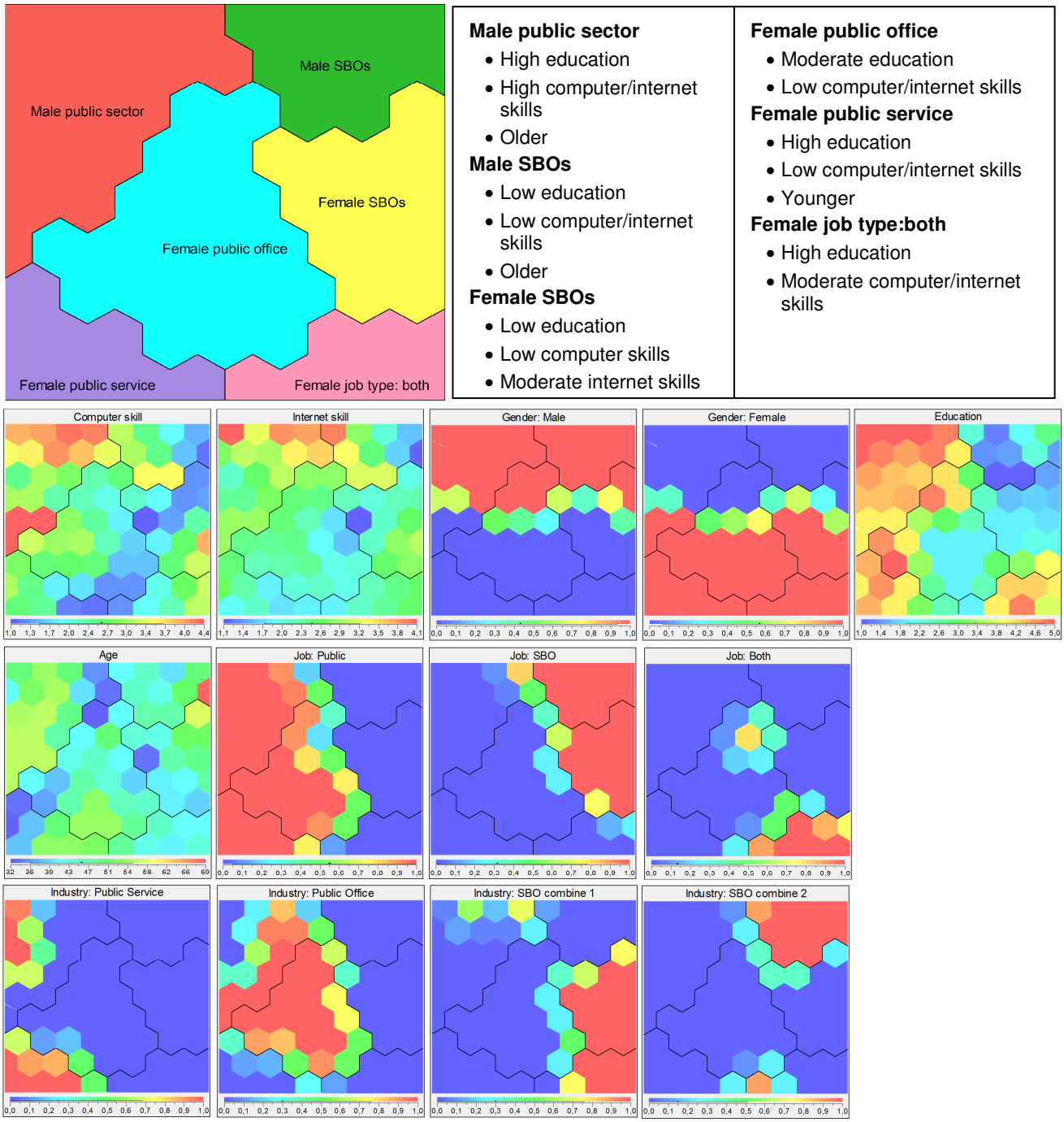


**Figure 1. The clusters and feature planes for the demographic/skill attributes in the SOM software.**

### Demographic and skill attributes

The clusters (Figure 1) are formed based on the demographic and skill attributes. There are some strong connections between these that we may need to be aware of for the analysis. Gender and job type/industry are the main clustering factors with the other attributes further refining them. E.g. public sector jobs require certain levels of formal education resulting in higher education naturally being related to some types of jobs, whereas anyone can start up their own business. While the labour market is largely gender neutral there is still a tendency for males to be overrepresented in managerial positions. We see this here with the 'male public sector' cluster where public sector males are brought together by the requirements of broadly

similar managerial positions, whereas females in the public sector are divided into two clusters depending on the particularities of their work.

Education associates with higher computer skill. Those with more education have had more exposure to computer courses. Higher computer skill is also found in public sector clusters, where computer courses may be available to workers and also where people have more education and likely more exposure to computer training.

Internet skill and computer skill are closely connected. It seems in this case Internet skills can be considered as a continuation of computer skills. In the survey males scored themselves higher with regard to computer skills, this may to some degree represent overconfidence. This could lead to less reliance on other support sources, but does not seem to be the case as higher skill increases use of most support sources except personal contacts Overconfidence may not be a problem when seeking support if it gives the confidence to actually go out and ask questions.

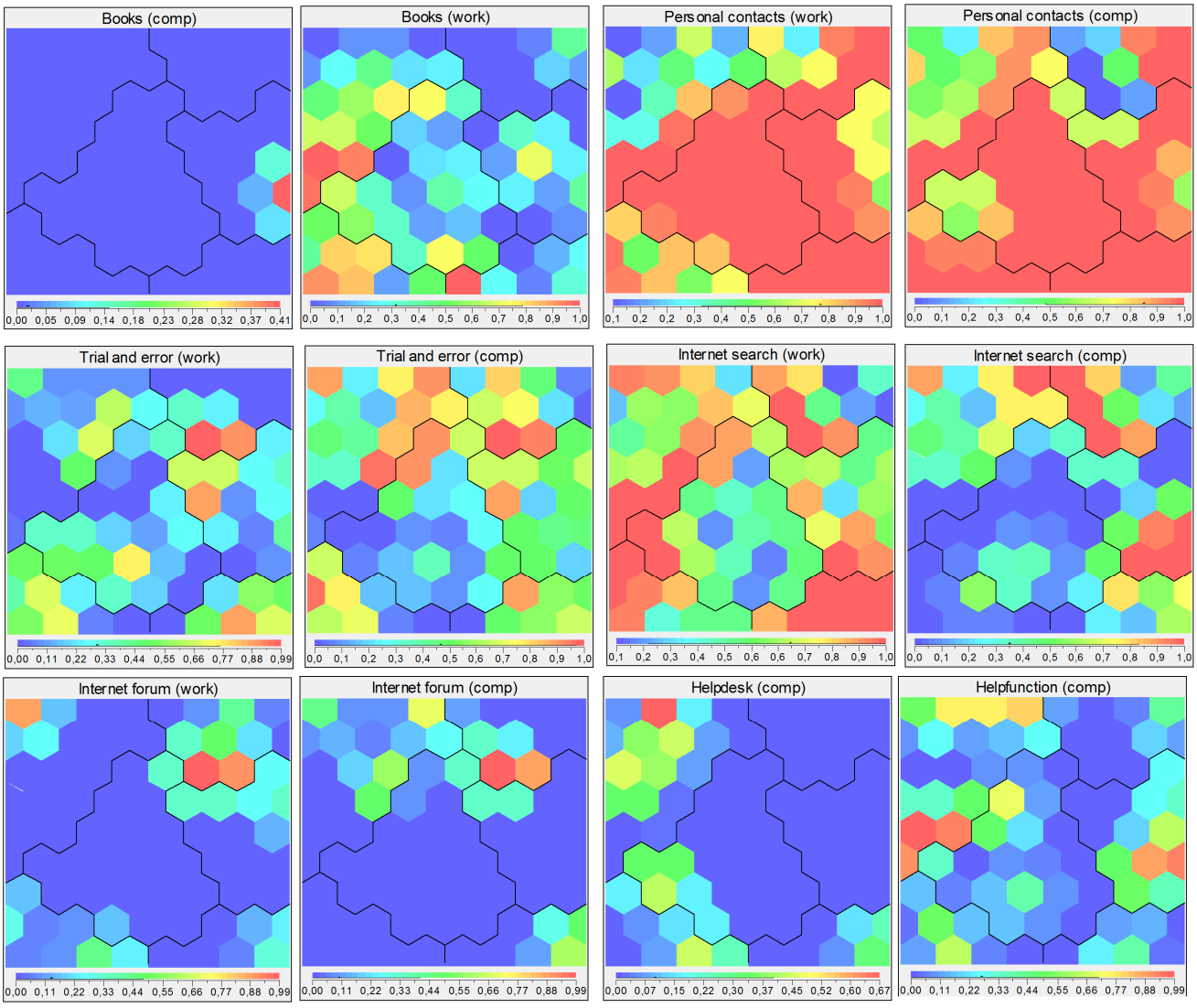


**Figure 2. The feature planes for the support sources in the SOM software.**

## Support sources

**Books** The SOM indicates that books are mainly used by females and in the public sector for work problems. Only one responder used books for computer problems so that particular item cannot be adequately examined.

**Personal contacts** are widely used by respondents. In Figure 2 some areas show less usage, the "male public sector" cluster is one. Also in the SBO clusters there are some who do not use this source. One plausible explanation is that these are

respondents who feel their work tasks cannot easily be supported by other people, e.g. lack of domain knowledge. That SBOs do not use personal contacts is fairly intuitive, most of these are sole proprietors and would not have any colleagues to ask. In that sense it is perhaps somewhat surprising that so many in the SBO clusters do still report using personal contacts as support. It seems the need to communicate is strong and that those who do not have colleagues as such find other personal contacts to support them in their efforts.

Gender seems to influence personal contact use. Males use them less than females do. Interestingly this is less prevalent for computer problems than work problems. So even though males are less disposed to using personal contacts they do use them to some degree for computer problems. This suggests that personal contacts are somewhat influenced by gender which is in-line with Nielsen and Sein (2004). More skilled people are also less reliant on personal contacts as support.

Figure 2 shows where areas of non-use largely correspond to each other. People using personal contacts are also somewhat less likely to use other forms of support, especially for computer questions and as many as 35% use personal contacts as the sole support source for computer problems. While generally popular among all groups it seems personal contacts are used more by females and those less skilled.

**Trial and error** (T&A) was used by roughly half the population (see Table 2). The absence of any strong connections suggests T&A is another default response to problem solving. T&A for computer problems connects to Internet skill, but not computer skills. Since Internet skill seems a continuation of computer skills a probable interpretation is that skilled individuals attempt solutions by applying their knowledge in a T&A process. T&A seems associated more with males and SBOs. Males are more likely to experiment by tinkering (Ko et al. 2011) and SBOs would need to be more flexible in their work.

**Internet searches** for computer problems relate to Internet and computer skill as well as Internet forums and using the help function. Searchers also seem to be less reliant on personal contacts. Taken together this could possibly be an indication of the more skilled users supporting themselves.

Searches for work problems are used more by younger and educated people. While the searches are used (occasionally) in most clusters there is a distinct lack in the 'female public office' cluster, possibly due to the administrative tasks' nature as fixed processes that need to be followed. By contrast the 'female job type:both' extensively use searches, it is not farfetched to assume their dual role requires more flexibility in performing tasks.

Although Internet searches for computer problems and work problems are generally both used by people, they differ when regarding the other attributes. Mostly in the public sector clusters there are many who simply do not, possibly due to better access to formal support. The SBOs use searches more, probably because they have fewer options available.

**Internet forums** were used by few so some caution is needed in interpreting the results. Internet forums are used by the most skilled respondents, again those with high Internet skill. It seems safe to say that familiarity with the Internet is an important factor for using forums, more so than computer skill and that using forums for one purpose means you are open to using it for another.

**Helpdesks** is somewhat used instead of personal contacts. This seems intuitive as people using the helpdesk would probably not need to ask another colleague for help. The helpdesk should not require any particular level of skill to use and should be approachable by all users. This source was used by very few people though, so should be treated with some caution. This lends support to the question if helpdesks actually help people as noted by Govindarajulu (2002).

**Help function** use corresponds to nodes with higher computer skill. Higher skill enables better understanding of the help information. There is also a connection to Internet searches. It seems logical that users would use these information sources together. This supports the idea that existing help functions are not compatible with the end-users' needs. Better computer skill, whether actual or simply perceived, increases the end-user's ability or willingness to make use of "self-help" computer support sources.

## SUMMARY AND CONCLUSION

In this paper, we have explored the existence of groupings and examined the impact of the demographic and skill attributes on support sources in a population of actual and potential end-user developers. Using self-organising maps allowed us to analyse the data in a slightly different manner. This has some interesting potential, however, a larger dataset and preferably one where all sources are used somewhat extensively would potentially increase the generalisation of the results. The clearest results were found among those sources with higher number of users, i.e. personal contacts, Internet searches and Trial and error. With such a diverse population as end-user developers it may not be surprising that there is little commonality to the use of support sources and that the connections are fairly complex.

Attempting to answer RQ1 we found that, in this population, there is a very strong connection to work with groups forming more along types of tasks performed rather than traditional demographic factors. This fits the task centeredness and heterogeneous nature of end-user development (Klann et al., 2006; Nardi 1993). Like Shaw et al. (2002) we find differences across groups, most clearly in the non-use of some sources. RQ1 ties in with RQ3 as some of these differences can be explained by the groups, but some can not. It is fairly clear that the "male public sector" is not using personal contacts and that the females in the public sector do not generally use trial and error or Internet searches, whereas these are more prevalent in SBO clusters. It was also surprising to find so many SBOs using personal contacts. Initially we did not expect SBOs to have ready access to such.

As for RQ2, in some cases support usage seems mainly tied to certain attributes instead of groups. Cross and Sproull (2004) list factors that impact information seeking such as gender, job type and relation to the source and we see some of these effects in the use of support, however, not in the degree that was expected. The general lack of impact of the demographic factors is somewhat surprising. Gender has less impact than was expected considering the effect it has had on other areas of end-user development (Ko et al. 2011; Sein and Nielsen 2004). Job types influence somewhat what support sources are available, but not necessary what support is used. Age was expected to influence skill and computers use more (Brown 2002), but it seems this working population is not yet "computer/Internet savvy". Only the education attribute seems to have a broader impact on the use of support, directly or indirectly through the skill attributes. This factor has a larger impact than expected. It would seem education provides opportunities for expanding computer and Internet skills.

Further, in answering RQ2 and RQ3 we find the clearest impact on support use come from computer and Internet skills. In of itself this is not surprising, however, when combined with an almost complete lack of impact from other factors this warrants some further consideration. Computer skill is strongly connected to the use of support methods for computer problems; higher skill seems to indicate more use. The same is true for Internet skill, to an even higher degree. The central importance of Internet skill is rather interesting. The strong connection to Internet sources is expected, yet the connection to the other computer sources less so. The answer seemingly lies in the strong tie between computer and Internet skill as those with the highest computer skill also have good Internet skill. This is a two-edged sword. While the importance of skill means that people can with training and experience become better at using Internet based sources, in the short term it is problematic if it forms a barrier for end-user developers and solidifies their reliance on usually less reliable support, such as personal contacts.

When creating the survey the questions were split into the computer problems and work problems parts, as a substitute for asking about end-user development problems. This led to some uncertainty as to the validity of doing this. However, we found a strong connection between the corresponding work and computer problem support sources suggesting that this may be at least an adequate substitute. People using a source for one type of problem often use it for the other. While we used factors based on the literature it may be that they are not suitable for the end-user developer context.

While not the focus in this paper we found that formal sources either need skill to use (helpfunction) or was not utilized much by the users (helpdesk and books). This can be problematic and would help explain why personal contacts are so widely used.

When providing or considering support it will not be as important who people are, but rather what they do. The important thing is not the constitution of these groups, as that will vary over different populations, but that there are indeed groupings which can be found. You can still target groups despite a population that is heterogeneous, but groups will be more eclectic and less distinct.

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