HOW THE USE OF VISUAL COMMUNICATION INFLUENCES UNDERSTANDING: AN INSIGHT INTO THE USE OF DUTCH GOVERNMENT FORMS BY NON-NATIVE SPEAKERS

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Abstract: The current research investigates whether using visual modalities of communication, knowledge visualisation and information design techniques can make an official form easier to understand for its users. Specifically, it focuses on Polish migrants in the Netherlands who often do not speak the Dutch language proficiently. The visual tool is developed and evaluated in an iterative experiment. In the preliminary user evaluation, a prototype is tested on a small sample. In the second user evaluation, the participants are divided into two groups: a fully developed visual tool is tested on one group of users, and a textual guide is tested on a control group. In the third user evaluation, an improved tool is tested on one group of users. All participants fill in a Dutch tax return form based on a fictional scenario and then respond to a series of questions in an in-depth interview. The efficiency and user experience of visual aids are evaluated based on a qualitative research.

Keywords: tax return form, official form guide, communication enhancement, information design, knowledge visualization, user experience

1. Introduction

Approximately 3,8 million people living in the Netherlands are of foreign origin, with the first-generation migrants constituting around 1,9 million of this figure [1]. Migrants are not a homogeneous group, they vary in education level, language skills, motivations for moving abroad and so on [2]. As every resident, migrants have an obligation to pay taxes. We can assume that every year they fill out tax return forms by themselves or with help of an accountant. Very often municipalities provide citizens with guidance booklets or detailed information on their websites [3]. In 2003, the British National Audit Office prepared a report describing how government agencies interact with citizens through forms [3]. They point out that poor form designs lead to more citizens' errors and increased costs for agencies. Moreover, the report specifies a list of problems encountered by users and finally concludes that "all these problems especially affect first-time users of a form and citizens who have the most problems in reading and understanding them." [3, p. 41]. This conclusion seems to affect migrants in two ways: firstly, they are more likely to be first-time users; secondly, they are more likely to face language problems. Furthermore, the competence to fill in a form also depends on individual "document literacy" skills, for example the ability to search documents for answers to questions, finding and using information in forms or diagrams [4, 5].

Looking closer at the case of tax return forms in the Netherlands, there is a significant difference between information available in Dutch and in English. It is clear even at a glance that the original website interface of Dutch tax authorities (*Belastingdienst*) providing information about tax return (*aangifte inkomstenbelasting*) (see Fig. 1) is much more user-friendly than its English equivalent (see Fig. 2). For example, the visual way of structuring information on the Dutch website helps to guide a visitor to a correct destination. Secondly, the information available on the English page is mainly focused on a tax return for non-resident taxpayers. In all likelihood, the tax authorities make an assumption that all resident taxpayers speak Dutch. Also, official guidelines for filling out an online application for individual residents are only available in one language: Dutch.

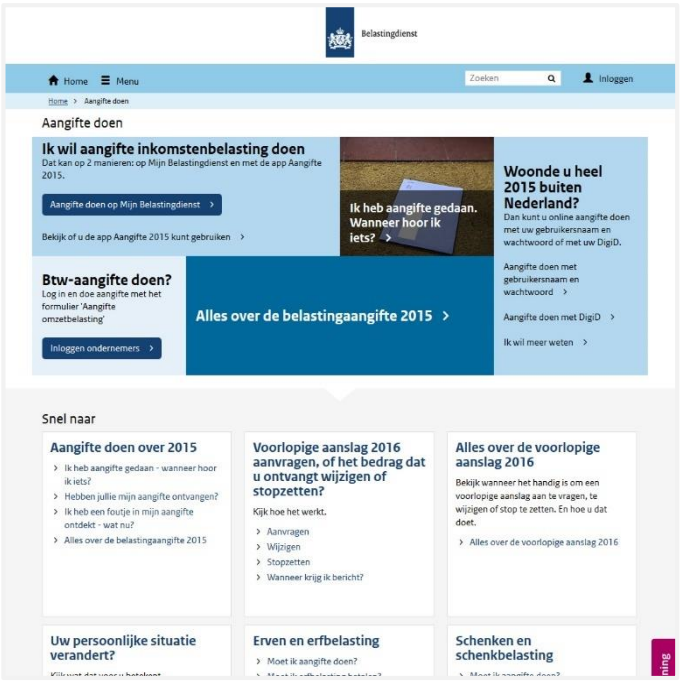

Figure 1. *Page about tax return on the official website of Dutch tax authorities. Dutch version* [6].

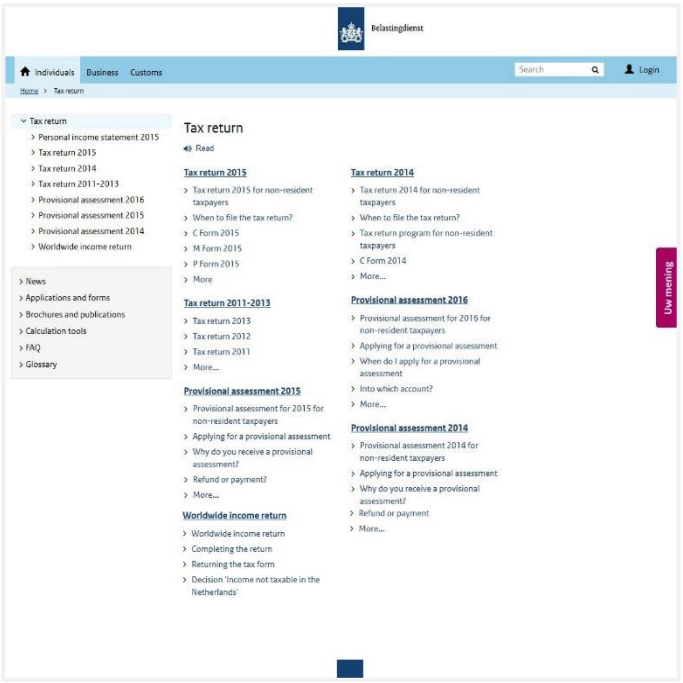

Figure 2. *Page about tax return on the official website of Dutch tax authorities. English version* [7].

Among migrants, the Polish population in the Netherlands is estimated between 250,000 and 300,000 people [8], a substantial amount of them are workers, but even in this group, there are differences. Some of them focus more on staying in the Netherlands, others treat Poland as the main country of living [9]. What is relevant for this research, more than 50% of Polish migrants describe their language skills as "not good" and around 27% do not possess any Dutch language skills [10]. Firstly, an initial language skill level among people coming to the Netherlands is lower than among immigrants to England or Germany, pertaining to a lack of exposure to the Dutch language before coming to the country of destination [11]. Moreover, the English language is part of a curriculum in all levels of education in Poland. This skill makes the communication possible in a country where society speaks English proficiently, such as the Netherlands, but on the other hand, it discourages acquiring a language competency of that country. Furthermore, individual factors such as IQ, language aptitude or the differences in language acquisition cause differences in the outcome [12, 13]. Finally, migrants have different reasons to learn a language, for example, some of them are motivated to learn Dutch in order to be able to work in a specific field or because of their children [8].

The study investigates the possibility of making a government form easier to understand for non-native speakers. Specifically, the study focuses on a Dutch tax return form and selected group of Polish migrants living in the Netherlands. In order to identify an official form that caused the most serious difficulties for this group of users, a questionnaire was prepared. Poles were asked a series of demographic questions and whether they have ever encountered any difficulties in filling out official forms. If the answer was positive, they indicated which Dutch government forms were the most problematic for them. The results showed that the Dutch tax return form (*aangifte inkomstenbelasting*) was the most difficult document to fill out.

The project focuses on making this particular form easier to use by using visual means. There are three reasons for using visualisations: first, simplifying the text in the form will not help people who do not have language skills and who use online translators on regular basis. Second, visually displayed information was shown to be more computationally efficient than language [14] and third, a variety of articles presented the promising results regarding the use of visualisations in official documents or user guides [3, 15, 16].

The study was carried out as an iterative experiment. It started with a simple prototype that was tested in a preliminary user evaluation. Its purpose was to point the direction for the final procedure of

the experiment and to test an initial interface of the tool. The next, improved prototype was tested in the second user evaluation, followed by an analysis of results and adjustments applied to the visual tool, according to the feedback from users. After that, the testing procedure repeated once again in the third user evaluation.

First, an overview of existing research on the topic is provided. However, it mainly investigates the role of visual help for native speakers or for people with low literacy skills. To compare, this study explores whether using visual modalities of communication, knowledge visualisation and information design techniques can overcome the lack of foreign language skills. The overview of related works is followed by a research question, methods used and detailed project description.

1.1 Related works

Using visual help in communication is explored by researchers and experts from different fields, such as legal scholars [4, 16, 17, 18, 19, 20], healthcare researchers [21, 22, 23, 24], and designers [25, 26, 27, 28, 29]. Sometimes experts from different domains cooperate with each other, for instance, information designers work together with legal experts [4, 19], or applied psychologists collaborate with graphic designers [27]. The subject is being investigated in a variety of approaches, most notably *information visualisation* [27, 29], *knowledge visualisation* [25], and *multimodal communication* [30]. However, it is important to point out that these approaches often are set up to tackle similar issues and their scopes overlap. For instance, "information design" is a multidisciplinary area that sees graphic design applied to all aspects of information in order to transfer a message effectively. "Knowledge visualisation" focuses on a transfer of knowledge that is not explicit but has to be reconstructed in the mind of each person [25]. "Multimodal communication" acknowledges that writing is being repressed by other modes of representation in learning resources. According to Gunther Kress, an expert in the field of multimodal communication, "words are (relatively) vague, often nearly empty of meanings; by contrast, images are full, 'plain' with meaning." [30, p. 112].

Overall it can be observed that tools used in these approaches are often the same: all three make use of conceptual diagrams or data visualisations. In this study the overarching term "visual communication" is used, and it includes techniques from knowledge visualisation [25], and multimodal communication [30]. Below is a short overview of related works from different fields adopting a user-centred approach to the visual communication.

Visual legal communication

Collette R. Brunschwig explored visual legal communication practices, such as a legal art, representation of legal actors in the popular culture or telling the story through mental images [18]. Moreover, there is a new category of visual representations, called "Comic Contract" [16, 31] that is based on stories understandable for low-literacy users. Furthermore, several lawyers work closely with designers on applying information design to contracts by improving their readability, using colour coding or adding visualisations [4, 32]. The researchers also investigated needs of contract users, the benefits of using visualisations in legal documents, and the issue of the validity of both [33]. Moreover, there is an interesting case study regarding new format for the Canadian legislation that investigates the use of graphic design principles to improve public access to the law [34]. Furthermore, very detailed guidelines for the layout of documents are prepared by Simplification Centre (see Fig. 4) [17]. In addition, Legal Design Lab created an online visual law library, in order to gather a "usable, beautiful law" [35]. For example, it features a diagram explaining family court procedure, an infographic helping with a problem concerning credit card bills or playful illustrations presenting rules of civil procedure in Florida. Finally, there is a Finnish initiative called TEMWISIT project that facilitates immigrant service procedure through an online platform [36]. The engagement of end users in all stages of the design process was important in this project. It involved simultaneously the adaptation of the interface to people from different cultural backgrounds.

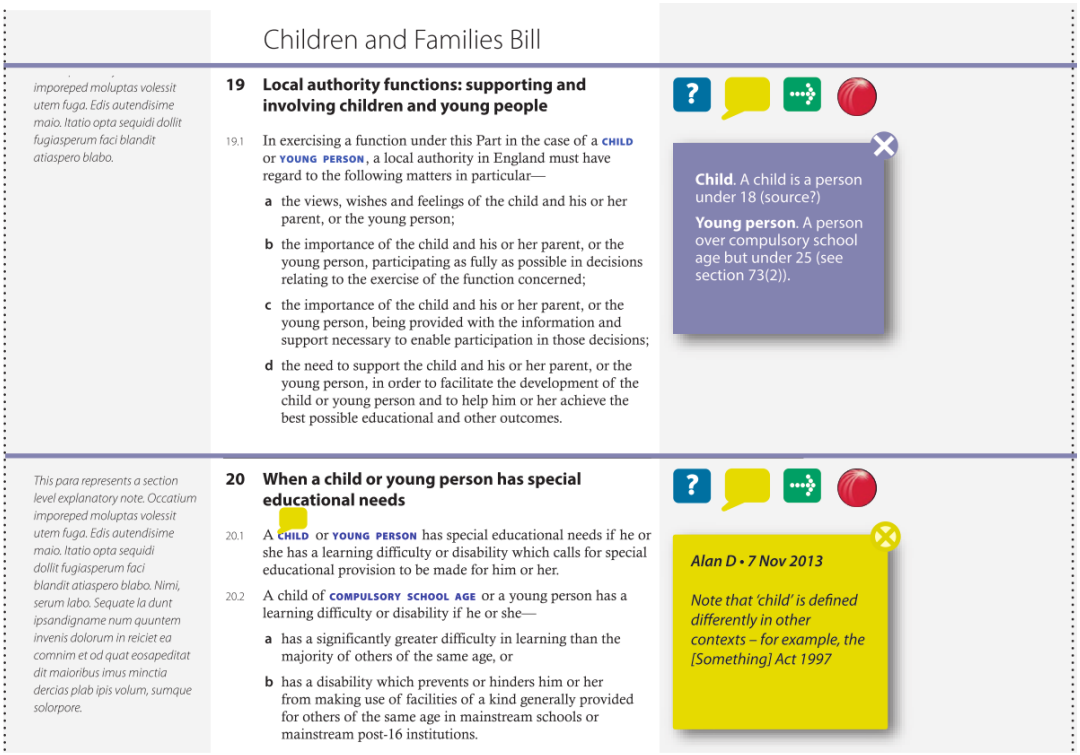

Figure 4. *Wireframe for the bill designed by the Simplification Centre* [17].

Visual health communication

There is a review of research done that focuses on the use of visualisations in health communication [21]. It tackles four issues: the attention of patients, comprehensibility of complex health-related messages, using pictures as a help for people to better remember the information and influence of pictures on a patient's behaviour. The review concluded that adding visual elements to written and spoken language had a positive influence on people in all four cases. Moreover, there is an indication that pictures are helpful for patients with low literacy skills, especially when they need to understand relationships among facts. Furthermore, another article points out ways in which visual cues can enhance health educations messages, such as promoting healthy food [22]. The author provides some guidelines for experts in the field, for instance he advises that adjusting contrast in pictures make them easier to process by people with low literacy skills. Furthermore, another research investigates how an array of icons can support communication about medical risks to non-native speakers [23]. What is interesting, that study used a similar sample to the sample of this project. It involved Polish migrants living in the United Kingdom and it compared how they understand provided information in their native language and in English. Using visual aids proved to be effective in communicating numbers (treatment risk reduction expressed as ratios). The visualisations were easier to understand by migrants, comparing to directly translated information into their language of origin. Finally, one study investigates the use of icons as a graphical language, helping practitioners to remember drug properties (see Fig. 5) [24]. The article presents specific guidelines for creating illustrations, which are focused on simple shapes and colour coding enforcing the meaning. It proved to be an easy to apply, time-saving tool.

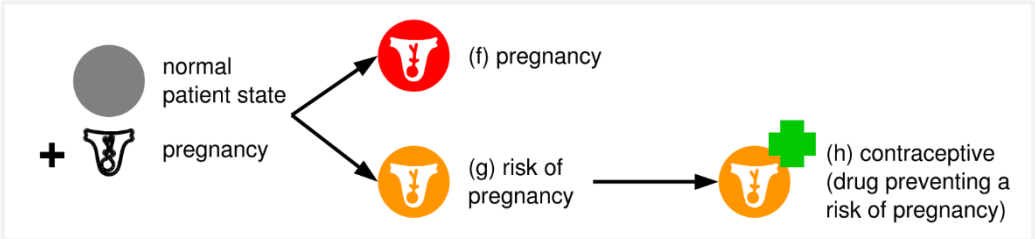

Figure 5. *Example of an iconinc language helping practitioners to remember drug properties designed by Jean-Baptiste Lamy et al.* [24].

Works from designers

Information designers from the Simplification Centre write guidelines and articles explaining how to design layouts of a variety of documents. They describe in detail how information should be structured in order to become clear, what fonts and colour coding work for users or showing different ways of simplification [28]. Additionally, Nigel Holmes calls himself an "explanation designer" [26], who described the development of pictograms or guidelines concerning the design of graphs and charts [37] and David McCandless' *"Information is beautiful"* if full of inspiring infographics, diagrams, and illustrations that structure data in a comprehensible way [38]. Moreover, Remo Aslak Burkhard in his dissertation on knowledge visualisation investigates the use of complementary visual representations to improve the transfer of knowledge (see Fig. 6) [25]. The author based his research on visualisation methods used by architects. Furthermore, he provides an overview of works from the cognitive sciences, psychology, information design and general communication sciences. Another group of researchers also focuses on linking visualisations to knowledge, in a continuum called data-information-knowledge (DIK) [39]. This approach perceives visualisations as communication tools that should be perceived in a wider context, for instance in the context of people's goals and their prior experience. Especially interesting is a type of process in which communicative visualisations are derived from raw data or knowledge in order to be internalised by a recipient as information. According to the authors, these types of visualisations can help a user to understand how to act and therefore can be used in instructions.

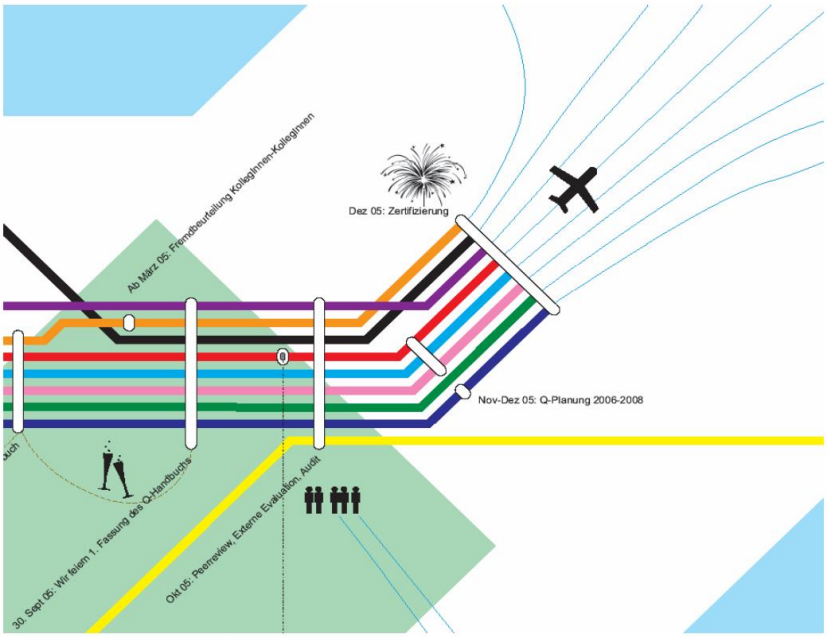

Figure 6. *Fragment of a tube map designed by Remo Aslak Burkhard that uses knowledge visualisation techniques* [25].

2. Research question

The objective of the experimental study is to determine whether visualisations and infographics provide useful guidance for migrants who fill out a Dutch tax return form. It was examined to what extent visual help is able to overcome the lack of foreign language skills by making the content of a form understandable for non-native speakers. Moreover, the study investigates the possibility that non-textual modalities of communication without the support of text can be successful in carrying the correct meaning. Finally, this project aims to indicate which visualisations or information design techniques are more effective for non-Dutch users of official forms.

3. Methods and detailed project description

Polish migrants are chosen for the test subject participation for two reasons. First, they constitute a substantial population in the Netherlands (estimated between 250,000 and 300,000 [8]). Second, the author speaks Polish and therefore is able to communicate with members of the target population who do not speak any foreign languages, such as English. The visual tool is not translated to any other language, which potentially allows immigrants from different countries to use it, due to being language-independent.

In order to choose an official form that should be redesigned by adding visualisations, a questionnaire was prepared. Polish migrants living in the Netherlands were asked a series of demographic questions and whether they have ever encountered any difficulties in filling out official forms. If the answer was positive, they indicated which Dutch government forms were the most problematic for them. The results showed that the Dutch tax return form (*aangifte inkomstenbelasting*) was the most difficult document to fill out. Additionally, the problems were experienced not only by low-educated migrants and by people with low language skills, but also by highly educated people or respondents with upper-intermediate Dutch level. Language difficulties were one of the main impediments for forms users. Furthermore, the inquiry showed that guidelines provided by tax authorities are perceived as unclear and people do not feel informed enough about procedures. Finally, according to the survey results, the layout of the original tax return form was not the main source of problems for its users.

These preliminary results pointed out the direction for the following phase of the study. First, it showed that tax return form was the document to be improved. Second, according to survey's results, the layout of the original tax return form was not the source of problems for its users, so instead of redesigning or simplifying it, it was decided that an additional guide should be constructed. Moreover, it became evident the sample should include migrants with different backgrounds and levels of language skills.

The project started with a simple prototype that was tested in the first, cooperative user evaluation. The results of this evaluation were analysed in order to develop the final procedure of the experiment and to test an initial interface of both the tool and the recreated tax form. However, the amount of mistakes made by test subjects was not counted, because the evaluator guided participants during the evaluation procedure. The next, improved prototype was tested in the second user evaluation, followed by an analysis of results and adjustments applied to the visual tool. After that, the process repeated once again in the third user evaluation.

The procedure of the second and the third evaluation was identical. Each of test subjects had to fill out a reproduced tax return application based on a fictional scenario, with the help of a provided visual tool and without evaluator's guidance. After that, a semi-structured interview was conducted and a number of correct answers given in the tax form was counted.

The study was based on both qualitative and quantitative data. Due to the individual differences between Polish migrants living in the Netherlands [8], it was assumed that purely qualitative study will not provide the description of the differences in personal experiences with tax forms. For example, it is not uncommon that a migrant with a master degree works as a warehouseman or housekeeper in a country of destination, even though his profession in a country of origin was more prestigious. This kind of migrant story caused problems in categorising test subjects. Therefore, the semi-structured interviews were conducted, because they are able to provide a rich description of problems encountered by forms users and capture a subject's perspective [40, 41].

Figure 7. *Study process.*

3.1 The visual tool

On the base of the survey, the tax return for resident taxpayers was chosen. This form can be filled out on paper or using a web interface. Web interface (henceforth called the tax return form) is commonly used in the Netherlands, therefore the study was focused on building a guide (henceforth called the visual tool) that can be open in a browser next to the online tax return form when filling it out. Most citizens want to fill out the form as quickly as they can, with a minimum effort and look up guidance notes only if they encounter problems [3]. A user guide that can be kept right next to the web form seemed to be the most suitable form of help to lead people through essential information in a document and facilitates moving back and forth between sections. Moreover, simple icons and diagrams allowed users to skim quickly for information [4]. This way, users did not have to read through many more questions in order to find the ones relevant to them [3]. To give an example: the original tax return form is interactive, in a way that selecting particular check boxes makes more detailed questions appear. The visual tool was meant to help with making decisions which boxes should be selected and which ones should be discarded, thus quickening the procedure.

Given that people could not use their real tax return forms for the purpose of testing the visual tool (see considerations in 3.2 below), the mock-version of the online form was built. It was recreated in HTML and JavaScript, based on an original interface. It was not the perfect copy of the source form, for instance a user navigated the page through the menu on the left, instead of selecting buttons on the bottom of the interface. Moreover, the help under a yellow icon with a question mark was accessed after hovering a cursor over it, instead of appearing on click. However, the textual help available in a tax form remained the same as was originally provided by tax authorities, so no information was lost.

The first prototype of the tool was designed based on an existing research mentioned in 1.1 and on personal graphic design expertise. The visual techniques used in the tool were taken from the information design and knowledge visualisations domains. Moreover, previously mentioned related works from legal and health fields inspired some of visual aids. The simplification techniques applied to the tool were mainly abstraction and visualisation [28]. In an abstraction, an essential information is repackaged into an easily accessible form, for instance, illustrations that are skimmed in order to find relevant content. In terms of visualisations, flowcharts guiding the user (see Fig. 8) were used, as well as iconic illustrations (see Fig. 9-10).

In order to reduce the cognitive load, the layout was kept the same as in the form, with the same look and feel [3]. Information designers point out the importance of using plain language [4, 42], however, in this project, the amount of text (in Dutch) was reduced to a minimum: there were titles of sections helping users to navigate and captions under/next to some of the infographics.

The colour coding [4, 25] was meant to help with structuring the information provided by the tool. In the illustrations showing different individuals, the blue figure was always a user: for a person using it, this figure was an equivalent of "I/me". Black figures meant other people, such as family, employers and so on. Furthermore, a green check sign meant that a user should select "yes" in the original form or that this particular situation concerned him; the red "x" sign meant the opposite (see Fig. 8-10). Colour coding is one of the patterns supporting strategic reading in an intuitive way. Other patterns used in the visual tool included: repeating symbols such as open hands meaning financial help from the government, for example unemployment benefits or social assistance; a piggy bank meaning savings; arrows pointed towards a person meaning income and away from a person meaning expenses. These symbols were not explained explicitly, but referred to a personal intuition, based on prior experiences (in the same way a triangle drawn on a door is associated with a men toilet).

Edward Tufte, an expert in information design and data visualisation, recommends using node-link graphics [14, 29], therefore, several flowcharts were developed next to pictograms. Series of questions accompanied by explanatory graphics and mostly "yes/no" answers guided users to the final answer that should be applied in a tax form (see Fig. 8). In terms of other types of visualisations, a comic inspired by de Robert de Rooy's comic contracts [16] was added (see Fig. 10): its role was to explain a process over time regarding the specific type of income.

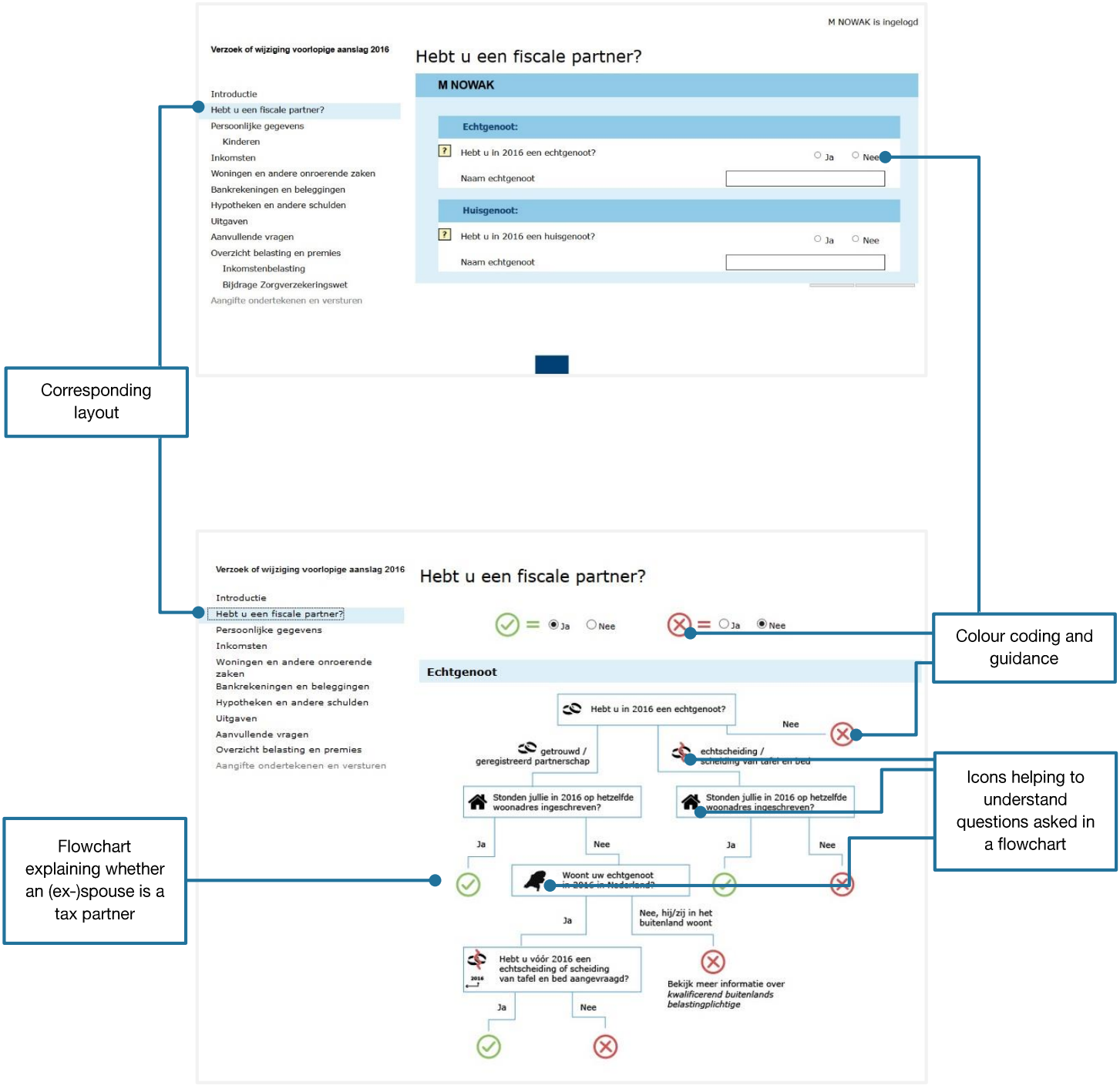

Figure 8. *The same section of the recreated tax form (top) and fragment of the complementary visual tool, section about tax partners (bottom).*

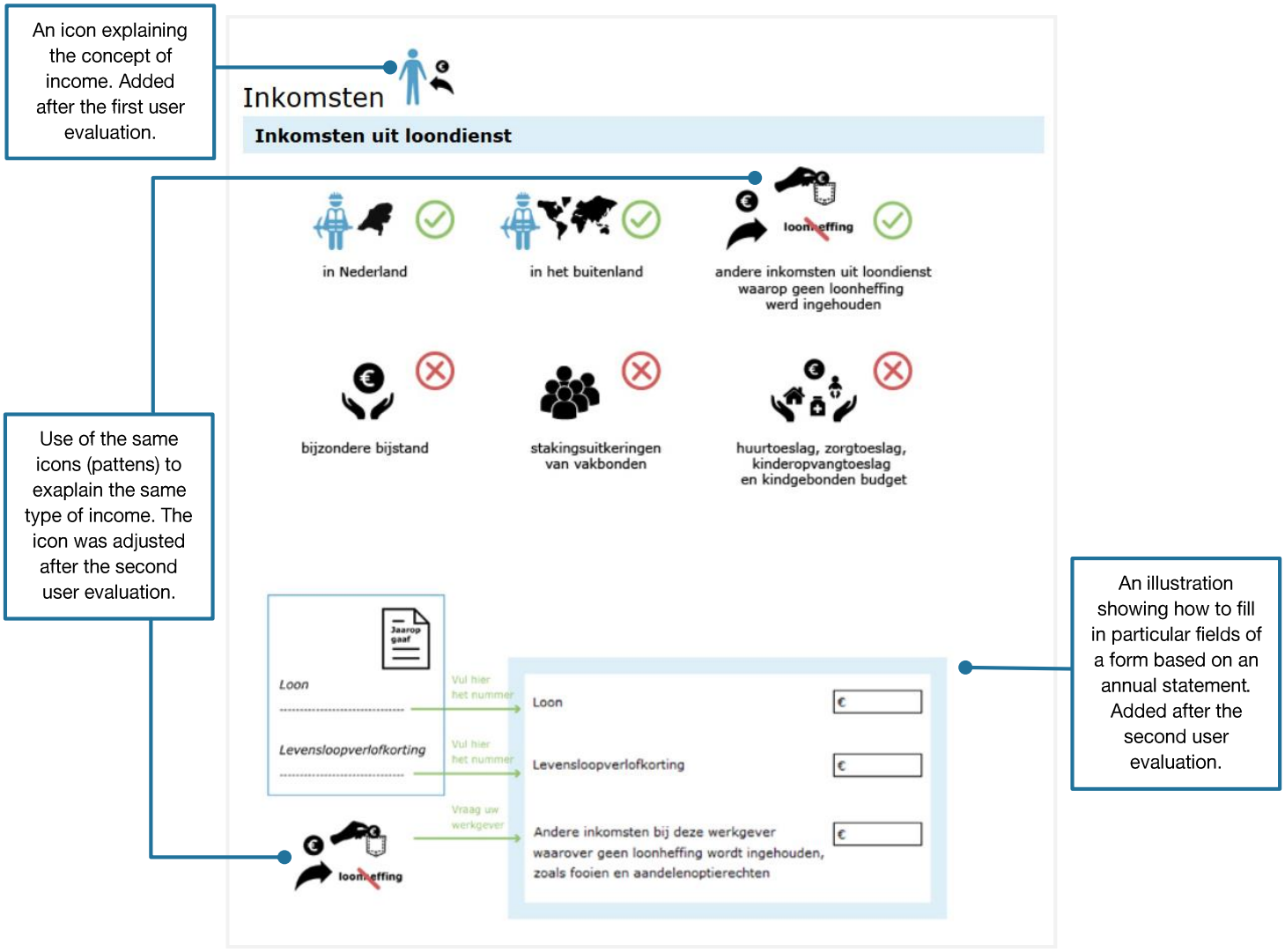

Figure 9. *Fragment of the visual tool, section about the income from paid employment.*

Figure 10. *Fragment of the visual tool, a simple comic in a section about the income from recovered expenses and allowances.*

3.2 Fictional scenario

Every participant of the experiment filled out a tax form with information provided by a fictional scenario. An alternative solution would be to ask test subjects to fill out the form with their real data. However, this approach has several downsides. First, evaluation of the outcome would be more difficult, because every case varies in complexity. For example, one person has only one source of income, no deductible expenses, and no tax partner. But someone else has two sources of income from work plus alimony, many expenses and a family living in the same apartment. These two cases would be incomparable in the experiment design. Secondly, filling out a form with real data reveals sensitive information about participants. Finally, the experiment procedure would be more complicated for users, because it would require gathering relevant documentation before participating in the experiment.

The fictional scenario was chosen because of these reasons. It was constructed based on a personal experience and on the variety of real stories found on Polish online groups, for instance on a popular forum called Niedziela.nl [43]. To illustrate: it is not common for this group of migrants to have a mortgage in the Netherlands, so such condition was not included in the scenario. On the other hand, being divorced, receiving alimony and unemployment benefits happen more often in the population, therefore these circumstances were added to the story.

Some elements of the scenario were not to be included when filling in a tax return form. Their purpose was to test the extent to which participants understood the provided help.

The scenario was described in words on one page and included the short story of a persona. The story was identical for male and female participants, apart from one detail: the name of a persona. In case of men, the fictitious user is called Maciej Nowak, in case of women: Maria Nowak. It was assumed that a test subject could identify with a persona to a bigger extent because of a corresponding gender. Apart from the story, two fictional, annual statements (*jaaropgaven*) containing the relevant income figures and details were provided. The scenario was prepared in a hard copy because it allowed users to quickly go back and forth between the computer screen and a story on paper.

3.3 First, preliminary user evaluation

First prototypes of the visual tool and recreated tax return form were functional websites, however the tax form was not fully interactive. Overall, it looked like an original form, but all detailed questions were visible at once, instead of appearing when selected by a user. For example, all sub-categories of income were visible in the menu on the left side of the interface, instead of becoming visible when these particular types of income were chosen.

After preparing the first prototypes of the visual tool, recreated tax form and fictional scenario, all of these were tested on 3 users in a cooperative evaluation [44]. The users varied in their language skills and education levels. During the test, a user was performing a task while thinking aloud - filling out a reproduced tax with the help of a provided tool - with the researcher present. Because the tax form was not fully interactive yet, each participant was helped along while testing the project.

The first user was a warehouseman without any knowledge of Dutch. He treated the visual help as a user guide to look up when he was not sure about the answer. His general feedback was: "I have to click a lot, copy and paste into translator… If I had an application meant to help me, it should be in the Polish language from the start". He noticed buttons that were not working on the tax form, therefore they were fixed before the second user evaluation.

The second test subject was a housekeeper with basic Dutch skills. He went through all visual guidance and his feedback focused more on specific visualisations. For instance, he said pointing at a diagram explaining having a tax partner: "Here, even without knowing Dutch I know that *getrouwd* means *to be married*, then you have a flowchart, so you know what is going on". According to his feedback, icons from the flowchart were clear to understand without any textual support. However, he indicated a lack of adequate distinction between an income and deductible expenses in the whole visual tool. As a consequence, more distinctive visualisations for income and expenses were added in the next prototype (see an example in Fig. 9). Moreover, the icon explaining the concept of other income from employment was redesigned in a way suggested by the second test subject.

The third test subject was a teacher in a language school and Polish-Dutch translator with advanced Dutch skills. She used the visual tool only when the help (in Dutch) provided under icons with a question mark was not sufficient. "Well, you have all this information explained in bubbles under question marks. But in my opinion, visualisations are more transparent than what tax authorities write because drawings explain the most important information, you have everything here". Her feedback focused on a subjective feeling whether the visual tool can help Poles in the Netherlands: "They would like it, it is short and in a visual form… Usually, they are afraid because they do not understand what is written somewhere". She commented on a flowchart about tax partners: "I have seen on various other websites different aids for people, but in my opinion, they were even more complex than the explanation of tax authorities. And here it is simple, because you follow *yes* and *no*, *yes* and *no*".

This evaluation helped to develop the final procedure of the experiment. It showed that every participant needed clear instructions before starting and they required an access to the Internet in order to use an online translator during the process. Furthermore, it became evident that fictional scenarios were not detailed enough. Therefore, clearer explanations were added, for instance how a fictional persona travelled to work. Finally, the evaluation showed points for improvement in terms of visualisations and interactivity of the form. If at least two test subjects indicated an error in one of these areas, it was fixed in the final project, for example an aforementioned icon explaining the concept of income. The menu on the left was corrected in such a way that it displayed optional tabs after particular check boxes were selected.

The prototype developed after this evaluation led to the final experiment design.

3.4 Sample and experimental design

Following the first, preliminary evaluation with three test users, a full experimental study was conducted involving 17 Polish participants living in the Netherlands. They had different backgrounds, professions, and language skills. Their ages ranged from 22 to 55, education varied from secondary level to a master degree and Dutch skills ranged from none to advanced level [45].

In the second evaluation, 10 participants were divided into two groups, each consisting of 5 participants. Test subjects from the experimental group filled out a tax form individually with help of the visual tool; the control group performed the same task, but with a textual tool. The textual tool was constructed from information provided by Dutch authorities under "help" icons or on the official website, without the addition of visual aids. Apart from this difference in the guiding tool, both conditions followed the same procedure.

The following procedure was applied: first, each test subject was asked to answer several demographic questions. Then, the recreated tax form and the tool were open next to each other in a browser. The participant was provided with printed scenario and annual statements (*jaaropgaven*) from two fictional employers. In order to make the conditions of the experiment comparable to the usual experience of filling in an online tax form, a subject was allowed to use an online translator. However, it was forbidden to browse for any additional help on the Internet or ask anybody else for help.

When a participant finished all steps of the form, he or she was asked to answer a series of questions in a semi-structured interview which was recorded. A person was assessing the difficulty of a task, comparing it with their personal, previous experience of filling out a tax form, specifying to what extent the guiding tool was helpful and whether it caused any additional problems, which would not happen otherwise. Moreover, it was noted whether a participant used any form of translation (online or dictionary) while filling out a form.

In the third evaluation, 7 participants tested the prototype that was improved as a result of the previous evaluation. This time there was only one condition: only the visual tool was investigated. Participants of the third evaluation followed the same procedure as subjects from the second procedure: they filled out a tax return form based on a fictional scenario and with the help of the visual tool.

3.5 Analysis of results

They were two types of results taken into consideration: quantitative and qualitative results. In the case of quantitative results, the number of correct answers made by participants was counted. For instance,

a fictional scenario provided information about alimony received from an ex-spouse. If it was not filled out correctly in the tax form, then a number of points for that question equalled 0.

In the case of qualitative results, recorded interviews were analysed, together with notes made by the author during the experiment. Themes recurring in the interviews created a framework for categories of issues. Based on these categories, the qualitative data was coded and organised in a way that the most persistent problems were clearly visible.

4. Results

4.1 Second user evaluation

4.1.1 Quantitative results

In total, each participant could receive 11 points for the correctly filled out tax return form. One point was awarded for a correctly filled page of one category, half point was awarded when it was partially correct. None of the subjects performed the task in a perfect way. On average, a number of points for the first group were 6,9 and 8 for the control group. The difference in the number of errors between test and control groups was not significant (according to the two-sample t-Test assuming unequal variances, $p = 0.351$).

	Visual group	Control group
Mean	6.9	8
SD	1.746	1.768

Figure 11. *Comparison of correct answers in both groups: mean and standard deviation*

4.1.2 Qualitative results

Visual group

The participants using the visual tool stated that it helped them to fill out a tax form to some extent. All of the subjects commented flowcharts (see Fig. 3) in a positive manner, for example: “The tool helped me at the beginning, this charts about tax partners showing who is who” (student, basic Dutch), “It is nicely drawn, it is quite clear and you know what is happening there” (production worker, does not know Dutch). Some of the pictograms were considered helpful: “These houses, they are very transparent to me” (student, basic Dutch), “In expenses, [the pictures] helped me, there was something about alimony, I can also give money to different organisations, it was clear, it helped me” (warehouseman, basic Dutch). General feedback included several positive comments about the visual guidance: “I would use [the tool] while filling in a tax form. I would translate what is in the original form, at the same time look up this crib sheet and would try a little bit to figure out what I have to fill in. As if it were a tool for real, I would probably use it” (student, does not know Dutch), “This [tool] is nice and clear, I think it can be useful for somebody in the future” (warehouseman, basic Dutch).

However, other graphics were not that transparent and easy to understand. A respondent said: “Sometimes, in the income section, I got the impression some of these pictures are not clear. When someone does not know the language, the caption below will not say much. This is why people try to use pictures, but in some cases, they are not clear, for instance, this piggy bank” (student, does not know Dutch). At the same time, after asking the probing question how he understands this particular pictogram, he correctly recognized it as a pension. Another person said: “some of the symbols are helpful, some not, some of them do not explain anything to me” (student, basic Dutch). Additionally, the same respondent expressed a regret that “there was not enough explanation in the income part, in order to handle sub-points”. For this reason, new visualisations were developed in this section: a detailed illustration showing how to fill in particular fields of a form based on an annual statement (see Fig. 9)

and traveling expenses were explained with the help of icons. Furthermore, an icon of an employer giving unregistered money to a person (see Fig. 9) was changed. Another test subject commented: "The help was not developed sufficiently and these pictures were not fully clear" (coordinator in a supermarket, basic Dutch). Furthermore, none of the participants could correctly assess what the meaning of a comic was (see Fig. 10). Therefore, an employer's icon was adjusted in the comic in order to make it clearer before the next evaluation. Besides, some users made a mistake by considering a rented apartment as their immovable property. For this reason an additional icon was added to that category and other icons were adjusted in a way to highlight the difference between a rented apartment and an immovable property.

Control group

In the control group where participants used only textual help, the interviews were much shorter and held less extensive feedback, both positive and negative. Three participants out of five said that they did not use additional help at all: "I did not use the additional tool at all, everything could be done based on this data" (tailor, does not know Dutch), a respondent said, pointing at question mark icons. Another person specified: "I used it twice when wanted to check the information about a flatmate and to read about expenses. Otherwise, I just clicked on a question mark icon, it was almost the same to me" (student, advanced Dutch). The negative feedback included a comment that "in medical expenses, I was hoping for longer explanation" (student, advanced Dutch). Moreover, one person expected more straightforward instructions on how to fill in an income from work: "I thought that since I have this help, it will tell me *add this box to that box and write it down in a form there*. And this help just informed me *if you have incomes from blah blah blah…* and it did not help me at all" (unemployed, does not know Dutch).

Both groups

The type of comments that occurred in both groups were remarks about the language barrier when filling in the form, Dutch tax authorities in general and problems with the experiment itself.

It is worth noting that nine out of ten participants used Google translate while doing the experiment (the only person that did not use a translator was a woman with advanced Dutch skills). The language barrier was a theme that appeared in every interview. Some participants assessed the task as difficult because of the language: "it would be easy if not for the language" (electrical technician, does not know Dutch, control group), "it [the translator] did not translate everything correctly, some translations of these things sounded funny in Polish" (production worker, does not know Dutch, visual group). Moreover, the majority of participants recalled problems from the past concerning official documents provided by Dutch authorities and poor translations.

Additionally, other general remarks concerned the tax authorities and participants' experience with tax return forms. A respondent recalled: "Filling in my form was so easy I just turned on Google translate, did copy-paste and it was all" (student, does not know Dutch, visual group). Another person said: "Honestly, I tried to fill it in by myself, but I gave up, because after downloading the application I just looked [and thought] *oho, okay*… My Dutch was not good enough to give it a try, so I gave up" (coordinator in a supermarket, basic Dutch, visual group). One respondent who speaks the language proficiently said: "Since I fill out these forms on the Internet, I have not had any problems, but every time I give it to my [Dutch] boyfriend for double-checking. It is about language and about the general culture" (student, advanced Dutch, control group). One person was very emotional about tax authorities: "I have bad experiences with tax authorities, I do not want to have anything to do with them, we contact each other only through my accountant" (warehouseman, basic Dutch, visual group). Moreover, another respondent said he tried to contact tax authorities in the past, but without any results (unemployed, does not know Dutch, control group).

Furthermore, many participants complained that their own tax return form was easier to fill out, because of the unfamiliar scenario that was given to them: "When a person gets alimony, she know this stuff better, right? And she would not overlook this point. And for me, it is the first time I got to know it in the virtual form – the form that I read an hour ago." (student, does not know Dutch, the visual group); "I have a simpler situation, it was easier then" (coordinator in a supermarket, basic Dutch, visual group); "The difficulty resulted from the scenario" (tailor, does not know Dutch, control group). Many of them stated that in reality, they have just one employer and no special expenses that should be included in a tax application.

Finally, two participants were honest by admitting that they would take the task experiment more seriously if it was their own tax return form.

After analysing the interviews from the previous evaluation and developing the next prototype, the third evaluation took place. The next version of the tool included previously mentioned changes and additions in visualisations.

4.2 Third user evaluation

4.2.1 Quantitative results

Points were awarded the same way as in the first user evaluation (see 4.1.1). The mean of results equalled 7.

4.2.2 Qualitative results

The feedback from the participants of the second evaluation had a similar structure to the first evaluation. Test subjects made more detailed remarks on particular visualisations, as well as provided general feedback about the usability of the tool. Moreover, the majority of them also had reflections on the condition of Poles in the Netherlands in relation to tax authorities.

Some of the visualisation were clear to participants: "I saw crossed wedding bands and knew it is about a divorce" (pharmacist, does not know Dutch), "An infographic helped me because I realised children do not count as tax partners" (florist, basic Dutch), "It was clear that there is a question whether I own a property, it is obvious from the pictures" (production worker, advanced Dutch), "I used the visual tool all the time. Pictures explain everything and they are clear" (line leader, intermediate Dutch).

Moreover, the participants made more general remarks about usefulness of the visual tool: "These infographics helped me because I understood things that otherwise I would look up on the Internet" (translator, advanced Dutch), one test subject said visual guidance is helpful, because "when someone comes to the Netherlands, he does not know what basic words mean" (line leader, intermediate Dutch). Some of the participants did not use the tool all the time, but only when having doubts: "I looked up these visualisations when something was not clear" (production worker, advanced Dutch), moreover, a florist with basic Dutch mainly relied on an online translator and consulted with the visual tool only twice.

For many participants, some level of expertise in Dutch was crucial to fill out a tax form: "I would have to spend a lot of time just to translate a vocabulary that is later confirmed by pictures, because I cannot rely on pictures alone, I am not 100% sure about the meaning" (pharmacist, does not know Dutch), "Generally, the tool seems to be simple to use, but there must be some level of Dutch to fill this out. It is a little discouraging, if a person does not know Dutch, she would not fill it alone because she is afraid to make an error and then having problems with tax authorities. If you are not quite sure how to fill it out well, then you would go to an accountant, pay 50 euros and have a surety that everything is fine" (production worker, advanced Dutch). He also gave an example that if someone needs a mortgage, he asks an expert for help with arranging it, instead of doing it all by himself. Moreover, a florist with basic Dutch said that every person who lives in the Netherlands for a while will learn the language sooner or later, so the visual help should stay in Dutch. And she added: "Everybody uses accountant services anyway", which implied that visual help may not be needed at all.

Some infographics were not clear for test subjects: new visualisation of a rented apartment was not clear for one participant, for two test subjects school expenses were not explained sufficiently, tax consultant was not clear according to two participants and two other persons did not understand infographics explaining traveling expenses. A symbol of hands representing a different kind of benefits caused a confusion too: "I did not guess that these hands mean help from the government. I would probably never guess that this is something you get from someone. I associate it with the logo of an organisation like the UN" (translator, advanced Dutch), whereas a student without Dutch skills interpreted a symbol of hands as an insurance. That student added: "These pictures helped me when I had to discard something, for example, I realised a laptop is not a deductible expense. But these visualisations do not explain well because it is a matter of interpretation what they mean". Furthermore, a florist said that the visualisation did not help her with understanding where to fill in unemployment benefits. Moreover, one person did not notice that he can open sub-categories under the income category, which is an issue related to the interface design rather than visualisations.

In the scenario, a fictional persona received both partner alimony (a taxable income) and children alimony (non-taxable). It caused difficulties for two participants because of their prior knowledge: "I did not notice that, because I was thinking like a man: I am the one paying alimony, instead of receiving it [from a woman]" (pharmacist, does not know Dutch), whereas a production worker with advanced Dutch skills was not sure what to do with a partner alimony, because according to his knowledge, only children can receive an alimony.

General comments included: "There were some tricky things, but it these cases it does not matter if I have visual help or not. Some things are just tricky and you have to think about them deeply… anyway, it is not possible to visualise them" (translator, advanced Dutch). The same participant complained that the tax rules in the Netherlands are not clear, because the authorities change them all the time, and even their call centre does not know the answer: "When you call tax authorities, one person explains a thing in one way. But if you call again to another person, she will tell you exactly the opposite thing". Another person concluded that he would need the help of another person to fill out the form with the guidance of the visual tool for the first time. However, because visualisations helped him to remember instructions, therefore the next time he would perform the task by himself, because "A human has a visual memory" (pharmacist, does not know Dutch). Another person also thought that a prior experience is helpful: "I already know Dutch tax return form and this fact speeds up things" (translator, advanced Dutch).

5. Discussion

The results of the second evaluation showed that there was no significant difference in the amount of errors made by participants using the visual tool and the control group. The slightly better average result in the second group could be the consequence of focusing more on a tax form itself and on the textual help available under question mark icons. Moreover, there can be individual differences involved, for instance, one participant admitted that he studied tax law in the past (even though his profession is different). Given the limited number of participants (5 per condition) such individual factors can influence the averages relatively easily. Respondents from the visual group talked more extensively about encountered problems and gave more positive feedback. Especially flowcharts were highly praised, but not all pictograms were clear and one comic proved to be hard to understand. The overall user experience was evaluated better among participants from the visual group. In comparison, the subjects from the control group mainly focused on complaining about the language barrier and experiences with tax forms in general.

When comparing scores and comments of participants with different language skills, the results show that people without any knowledge of Dutch struggled with the task more than people who assessed their Dutch as basic. However, the level of language skills was not always directly correlated with a number of points received; for instance, one participant with basic Dutch scored as high as participants with advanced Dutch. Moreover, the average results of the test group and the control group in the first evaluation were similar; therefore it is worth analysing the overall user experience, instead of just a number of correct answers. Individual differences can cause different outcomes in language acquisition [12, 13] and in comparison, other types of personal traits may be the reason for different results and user experiences while filling out a tax form. The results showed several factors that should be taken into account: firstly, a prior exposure to Dutch tax return form, secondly, prior experience with taxes in general, even in the country of origin, which subsequently can depend on the age of a person. Furthermore, in the case of using a fictional scenario, a familiarity with particular life circumstances makes the task easier to perform. In some cases, general knowledge and assumptions made by user change the outcome, for instance, some male participants associated alimony with an income that only children or women receive. To prevent that, in this case, the evaluation should be done with a fictional female persona, even if a test subject is male. However, like the theory of DIK continuum states, the knowledge based on a visualisation is formed in the mind of a recipient and therefore it is not always predictable [39].

The fictional scenario proved to be an additional obstacle for participants. People who did not share the same experiences as their fictional persona felt confused. They assessed their own tax return form as easier to fill out, because of less complicated life circumstances. Moreover, participants had to become acquainted with an unknown story during the experiment, which seems to be more difficult than reflecting on their own life situation. It is also important to note that people with low literacy skills and those who cannot understand what they read could struggle with the written scenario.

The evaluation of specific types of visualisations showed that flowcharts and diagrams were effective for the majority of participants. In Tufte's opinion, these kinds of diagrams can carry more information and explain relations adequately [29]. Moreover, according to the knowledge visualisation model described by Burkhard [25], a medium has to catch the recipient's attention in order to provide new insight. Flowcharts force a user to follow a path of nodes, therefore giving him/her an active role in constructing the knowledge. In comparison, the illustrations in form of icons proved to be less effective for recipients. In the DIK continuum, they can be classified as communicative visualisations [39]. The authors point out: "In this group, a pictogrammatic language and the use of metaphors and illustrations are usually employed in the visualization, since an accurate data retrieval is not its main aim: chances are that a data-ink ratio approach to visualization may prove non-effective or even counter-productive in this context." [39, p. 448]. In addition, Burkhard admits that visualisations may cause misunderstandings and in that case, a recipient needs further explanation. The experiment highlighted that participants performed better if they could understand Dutch captions under pictograms and read additional help available under icons with a question mark. Furthermore, the colour and shape patterns used in the visual tool did not fulfill the role of guiding a user sufficiently by making the recall easier. However, in general, the interface was easy to use as a guide to move back and forth, like a manual to browse when needed [3].

6. Conclusions and future research

According to the study findings, applying knowledge visualisation and information design techniques to the guidance tool can help Polish users to fill out a Dutch tax return form efficiently and make the experience more pleasant. However, it does not completely reduce errors made by people. Moreover, not all types of pictures are helpful to the same extent, but a simple flowchart proves to be a good guidance for people. Additionally, complex information provided by the government is hard to understand when reduced only to visualisations. It is advised to use both visual aids and textual guidance, preferably in language adjusted to non-native speakers.

Because of the small sample, it was not possible to draw any definite conclusions regarding the influence of individual factors on the performed task. There was a prevalence of more positive evaluations of the tool among users who speaks Dutch on the basic level at least.

In the future, it would be interesting to compare how native speakers evaluate the same tool, in comparison to migrants who speak Dutch on a basic level. Moreover, the visual guidance could be tested on a bigger population of foreigners from different countries, not only on Poles. The tool was not translated from Dutch in order to be potentially useful for other non-native speakers. However, cultural factors should be tested, for example, some illustrations may not be able to provide an understanding for non-Europeans. There is a possibility that the visual tool could support not only migrants but also Dutch citizens who struggle with official forms. Additionally, in terms of experiment design, a fictional scenario could be provided to participants in different, non-textual forms.

Finally, other modalities than textual and visuals could be used in the guiding tool. Animation, videos, sound or even a haptic feedback can have the potential to add more interactivity to people's experience. The next step could be testing to what extent different media can provide help to the users.

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