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Personas with knowledge and cognitive process: tools for teaching conceptual design

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Abstract

Persona is a tool within User Centered Design principles to assist students to be mindful of the users of the system during the conceptual phase of the design. We conducted a series of empirical studies, involving over 200 information systems students who performed design activities, four groups of students were provided with four Personas authored to be different in knowledge and cognitive processes and a control group who received a list of requirements. We found that students' performance, while designing to a Persona are as good as, or better than using the list of requirements. The students who were given one of the Personas thought of a user which had traits similar to the Personas' traits but the students who received the list of requirements thought of themselves as users of the product. Our results indicate that Persona assists students to think of the target users during their design activity.

Keywords: persona, User-Centered Design, conceptual design, education, teaching

Introduction

Information Systems (IS) students are educated for roles such as business analyst and software solutions architect. Such roles require understanding of the organization and the intended users of the software, to deliver the requirements and conceptual designs of the software. To identify what software features will be useful to target users, the business analyst needs to know how users are likely to engage with the software product and which features will be of relevance and interest to which users. This requires recognition that the users of applications often possess varying degrees of intelligence and knowledge, and abilities to process knowledge intelligently – cognitive processes (Anvari and Tran 2013).

Knowledge, which has meaning in a given context, is the information that the person has gathered and can put into practice (Lejeune 2011). According to Novak and Canas, the concept of knowledge is formed by observing regularity in an event or object (Novak and Cañas 2008). Vimarlund et al. (2001) in a theoretical analysis of participatory design lists increase in knowledge capital and decrease in information asymmetry as some of the benefits of participatory design hence the new technology would absorb the knowledge possessed by the members of the organisation and making it common. Thus the users of the new system can gain access to the knowledge (Holmlid 2009). Cognitive processes are the activities that are used for learning and decision making which include thinking and reasoning (Anderson et al. 2001; Patel and Kannampallil 2015). Chen et al. (2016) in a review of literature on user-interface design in the areas of emergency management, driving, piloting, education

and training, and recruitment found that many studies highlighted the importance of users' cognitive load and how it effects the usability of the applications. Many of these studies aim to improve user interaction with the applications and hence improve the efficiency of the users in performing their tasks. In educational contexts, Anderson and Krathwohl (2001) classified knowledge as nouns and cognitive processes as verbs that act on nouns, knowledge. Cognitive process is related to retaining and transferring knowledge. Cognitive process consists of remembering, understanding, applying, analysing, evaluating and creating (Anderson and Krathwohl 2001).

Gaining access to sufficient users, to cover the range of possible users of a product is costly and often not possible. Particularly in educational settings for design projects, students are rarely given access to users for requirements gathering but are presented with a general problem statement and/or list of requirements from which they are expected to create a design solution. However, this approach does not sensitize students to the varied needs and abilities of users or make them aware of human factors in product design. One approach to provide surrogate users, that has emerged from the User Centered Design (Norman and Draper 1986) methodology and has been used in the ICT workplace, is the use of personas. Researchers have studied the effect and influence of personas, an archetypical user of the application, on design activities within educational settings e.g. (Anvari et al. 2017; Cleland-Huang et al. 2014; Dayton 2003; Jones et al. 2008; Tran et al. 2018; Valentim et al. 2017).

Despite the important roles that knowledge and cognitive processes play in the way users use software products, e.g. in the areas of self-directed learning applications such as e-health (Laverman et al. 2014) and e-learning (Hong et al. 2017), to-date researchers have not evaluated persona with Knowledge and Cognitive Process dimensions and how students can analyze and design, and model software products. We seek to address this gap in this paper. We investigate whether Personas with varying knowledge and cognitive processes that represent different cohorts of users can be used for design activities in a similar manner as providing the students with a list of system requirements. By exploring this question this study aims to contribute to the development of software design tools for educational purposes and better prepare students for industry.

In this paper, we first review the literature in the area, leading to our research questions. We then describe our methodology, followed by the results of our research, threats to our studies and discussion. We close the paper with the conclusion and future research.

Literature Review

Design thinking is an important skill and students should be trained to practice it (Razzouk and Shute 2012). The researchers indicate that there are various overlapping non-linear phases in design thinking (Razzouk and Shute 2012). As designers 'tend to stick to their principal solution concept as long as possible through the design process' (Razzouk and Shute 2012, p. 341), hence the conceptual phase of design is important. Most researchers agree that during the conceptual phase of a design, the behavior of the application is formalized (Anvari and Tran 2014; Razzouk and Shute 2012). Cognitive engineering, which is an interdisciplinary approach based on the principles of cognitive science and engineering principles, is used for design of applications and equipment that interacts with humans (Hettinger et al. 2017). Practitioners who interact with the applications need 'knowledge, skills and strategies' (Hettinger et al. 2017, p. 22) to carry out their tasks. Cognitive engineering gave rise to an important methodology in software design: User Centered Design (UCD) (Norman and Draper 1986).

The role of users within UCD has been subject of numerous research papers. UCD professionals can use intelligence, knowledge and cognitive process to design applications that cater for users' profiles. Persona is a tool within UCD methodology. Persona, is widely used in the software industry (Nielsen et al. 2015) to improve the usability and accessibility of the software application, and hence to reduce cognitive load (Chen et al. 2016) on the users of the application and for better communication with stakeholders (Adlin and Pruitt 2010). Persona minimizes self-referential during design stage (Cooper 2004). The persona consists of textual description of salient features and a picture or a drawing depicting the end users of an application or product (Anvari et al. 2015; Salminen et al. 2018). In a design thinking project Valentim et al. (2017) used personas to motivate the design team into thinking about the users for their design activity. Valentim et al. (2017) also found that the personas were used

for communication purposes and restricted the designers from generalizing their design activity. Researchers have shown that the use of personas can result in more empathic designs that are focused on the users' emotions (Chen et al. 2011; Haag and Marsden 2018). Dayton (2003) in reviewing persona and scenario based design concluded that use of persona helps creativity. Panke et al. (2007) used persona for communication and development of an e-learning website, and concluded that persona 'has potential for creative development of a new product or service' (Panke et al. 2007, p. 188). Personas have been used for understanding system requirements and design specification. Aoyama (2005) notes that: ' the name of persona … indicate specific category of users. It provides a concrete and comprehensive archetype of users.' (Aoyama 2005, p. 93).

In educational institutions, students seldom have access to users. Researchers have studied the effect and influence of personas on design activities within educational settings. For teaching purposes, to address architectural requirements of the system from the perspective of users, Cleland-Huang et al. (2014) developed Architecturally Savvy persona for balancing architectural decisions to optimize stakeholders' goals during agile development. Anvari et al. (2017) in a study of design among students found that persona with personality traits influence conceptual design. Jones et al. (2008) described various types of personas and challenges in using persona in classrooms for design purposes. Long in an empirical study of design activity in a 5 week course, found that 'through using personas, designs with superior usability characteristics were produced' (Long 2009, p. 1). Though the concept of persona has been advocated for a long time and it has been demonstrated that its use within educational institutions is viable, it has not, as yet, been widely used in classroom teachings for undergraduates. In this paper we demonstrate the pedagogical value of using persona in teaching design concepts as well as comparing persona with traditional method of teaching design concepts, using a list of requirements. Furthermore, to provide multi-dimensional persona, we novelty investigate the use of personas with varying levels of Knowledge and Cognitive Process.

Research Questions

Past researchers investigated the viability of using personas for design activity within classroom situations. In this paper we explore the use and benefit of Persona with knowledge and cognitive process in educational settings, compare it with a list of requirements, the Spec, and demonstrate the pedagogical value of the methodology we use. Hence the research questions we ask in this paper are:

> **RQ1**: Can Personas with varying knowledge and cognitive processes that represent different cohorts of users be used for design activities in lieu of a list of system requirements, the Spec.

As a relevant investigation, this paper also addresses the question:

> **RQ2:** Do students think of users during the conception phase of design?

This second question was important because we believe that due to students' lack of access to users and industry experience, they do not think about the user when dealing with a software requirements specification (SRS) or creating a design. Instead they tend to focus on the features of the software. This focus is not consistent with UCD and likely to result in products that don't meet the needs of actual users. Students need to learn to be mindful of users and the impact of user features on design and product usefulness and usability.

Methodology

To answer the research questions we used survey research to capture self-reported data about the students and their experience with the design activity and experimentation to evaluate the influence of different personas on conceptual design (Easterbrook et al. 2008). We devised a study that consisted of three separate parts; each part was built on the results of the previous parts. Fig. 1 shows the research model used in this study. In these study parts the software application that the students designed had the objective of allowing a student to manage her/his finances. Our research was not about design of a financial application but we used the context of a financial application to investigate designers' behavior and assess personas' usability. The material presented in this paper to answer the

research questions is part of a larger study directed towards authoring personas as a tool for design activities within educational establishments.

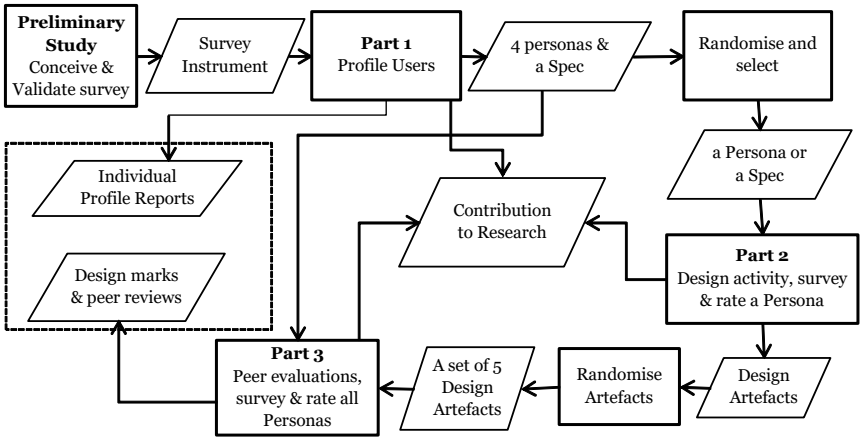

Figure 1. Research Model

Data collection was primarily survey based. Our literature search revealed no single existing suitable survey. Hence we formulated a questionnaire, drawing on questions and constructs from other studies where possible, and performed a preliminary study to validate the questionnaire by interviews and cognitive walk-throughs. We used the survey instrument in part 1 of our studies to gather information from second year undergraduate students enrolled in a unit on requirements analysis, software design and development. These students were the target audience of the studies. The answers to the survey were used to author four personas with varying knowledge levels and cognitive process abilities as shown in Table 1. Drawing on the work of Anderson and Krathwohl (2001), the knowledge levels included: factual, procedural and meta-cognitive, and the cognitive process abilities included: understand, analyze and create. From the results of the part 1 of our study, we found that there were four different personas as summarized in table 1. They were varied by memory, imagination and cognitive process abilities. Processes used to author personas are out of the scope of this paper and will be made available in future publications. Common to what is provided to students in a classroom situation, we authored a list of requirements or specification (the Spec) to be used by a control group.

Table 1. Persona for Knowledge and Cognitive process

No	Persona	Knowledge	Cognitive Process	Imagination	Memory
1	Henry	Meta-cognitive	Create	High	Good
2	Henrik	Factual	Remember / Understand	Low	Average
3	Hank	Procedural	Analyze	Average	very good
4	Harry	Factual	Understand	Average	poor

In Part 2 of the study, the design part, we used the same set of second year undergraduate students, with the exception of a few who had changed course, as the designers of the application. At the beginning of the Part 2, the students received a tutorial on UCD principles, conceptual design and introduction to basic financial terms.

A between subjects experimental design was used with five experimental conditions, 4 Personas and 1 Spec, the control condition. Students were randomly assigned to one of the experimental conditions. Students assigned to a Persona created a design artefact to meet the needs of the Persona. Students who received the Spec prepared a design based on the list of the requirements provided. All treatment groups answered questions regarding the Persona or the Spec. During the design activity students were exposed only to one item, either one of the personas or the Spec. As part of the design activity, students answered survey questions about their experiences during the design. In the case of Persona

conditions, the questionnaire addressed the Persona by name, and asked the students' opinions about their experiences with the Persona. In the case of the Spec, the survey questions asked about the students' experiences with an imaginary user of the application; they were also asked whether that imaginary user resembled them. After the design activity, the students who received the Persona rated the same Persona and the students who received the Spec were given one of the four personas at random to read and rate. Finally all students answered questions about their overall experiences during the design activity and their solution thoughts.

In Part 3 of the study, the students received all four Personas and the Spec and they answered questions regarding each of the Personas, and in case of the Spec, an imaginary user of the application which was designed according to the Spec. Participants peer reviewed five design artefacts (four artefacts were designed for each of the Personas and an artefact was designed to the Spec) according to a rubric. The students answered questions about their level of liking each of the four Personas and how closely their personal traits matched with the Personas' traits. The marks allocated to each design is a combination of the average of the peer reviewed marks plus the mark allocated by the researcher (first author) who assessed each design according to the rubric.

For almost all parts of the study, we used survey instruments to capture the students' views quantitatively using Likert scale and qualitatively by providing text boxes for students to answer questions. We re-coded the Likert scales, with zero representing the lowest scale (Norman 2010) and converted the results to percentages. We analyzed the quantitative results using R statistical packages (Field et al. 2012; Norman 2010).

The University Human Research Ethics permissions were obtained for conduct of all parts of the study. None of the participants received any financial benefit. Participation in the preliminary part of the study was voluntary. Parts 1, 2 and 3 of the study were integrated with the course that the students were studying and hence participation was compulsory. However only the data from students who voluntarily agreed were used for research purposes. One of the Personas, Henrik, and the Spec are reproduced in the Appendix. Other Personas can be obtained from the authors.

Results

The results from the preliminary part and part 1 of the study which relates to the design of the survey instrument, profiling the students and authoring the personas are out of scope of this paper and hence are not presented or discussed here. In this section we present students' responses to the survey instrument and the statistical evaluation of the results of the Part 2 (design activity) and the Part 3 (peer review). In the next section we will present the analysis of the results.

Demographics

The student demographics for Parts 2 and 3 are summarized in Table 2. The total number of participants in the Parts 2 and 3 were 245 and 217 respectively. The percentages of students who did not provide demographics were 11.4 % and 14.7 % in the Parts 2 and 3 of the study respectively. A number of students studied numerous subjects and hence the numbers for the item 'known field of study' are not additive. Items 5 - 13 of Table 2 show that the students are from diverse backgrounds. The students were studying an IT subject that required fluency in the English language. Table 2 shows most students were native speakers or had spoken English for more than 3 years. Hence, it was assumed that the students' knowledge of English is sufficient for our studies.

Table 2. Demographics

No	Item	Category	Part 2	Part 3
1	Total		245	217
2	Gender	Male	172	147
3		Female	45	38
4		Unknown	28	32
5	Known fields of Study - students did multiple fields of studies	Information Systems	188	159
6		Software Engineering	30	27
7		Science	26	25
8		Engineering	19	17
9		Game Design	13	11
10		Finance and Accounting	70	58
11		Human Sciences	26	25
12		Arts	5	5
13		Other	52	46
14		Unknown	28	32
15	Fluency in English language	Native Speaker	145	128
16		3 years or more	62	47
17		1-3 years	8	8
18		less than 1 year	2	2
19		Unknown	28	32

Design experience with Personas and the Spec

Table 3 presents the statistical analysis of the students' responses to survey questions for evaluation of Personas and specification after the design activity in Part 2. Analysis of the responses did not indicate significant differences between the experiences of the students who designed for Personas and the students who designed to the Spec.

After the design activity, the students who were designing with one of the Personas were asked: 'I was thinking of a real person when I was designing for [Persona]' and the students who were designing according to the Spec were asked: 'I was thinking of a real person when I was designing'. If they answered yes to the above statement, the next question for those who had designed with a Persona was 'The person I was thinking of, was similar to [Persona] when I was designing for him' and for the students who had designed according to the Spec, the question was: 'The person I was thinking of, was similar to myself'. The answers to the second questions were given on a Likert scale. Table 4 presents the results. The results are not significantly different.

Preferences for future design

During peer review, Part 3, the students, after reading all 4 Personas and the Spec, rated their preferences for each of the Personas and the Spec for future design activities. Table 5 presents a summary of the results. The results show that participants' preferences for Personas Henry and Henrik are significantly higher than the Spec. Item 5 of Table 5 show that overall the participants did not show significant preference for either a Persona or the Spec.

Table 3: Design experience with Persona and specification

No	Survey question about design experiences	Persona / Spec	Mean %	SE %
1	Engaged: I was totally engaged with [Persona]'s traits while I was designing for him. (a user in case of Spec)	Henry	66.8	3.5
2		Henrik	68.6	3.9
3		Hank	72.0	3.7
4		Harry	69.7	4.4
5		Spec	70.0	3.9
6	Influenced: [Persona] positively influenced my design for him. (a user in case of Spec)	Henry	66.8	3.9
7		Henrik	77.0	3.3
8		Hank	72.5	3.8
9		Harry	71.8	4.7
10		Spec	77.2	3.4
11	Like Another: In future, I would like to design another application for the [persona] (or the spec)	Henry	64.4	3.7
12		Henrik	61.3	3.5
13		Hank	66.5	3.4
14		Harry	63.3	4.1
15		Spec	56.1	4.1
16	Easy: I found that the design activities/ scenario writings were easy.	Henry	50.0	3.5
17		Henrik	56.9	3.0
18		Hank	53.5	2.9
19		Harry	60.6	3.2
20		Spec	53.9	2.5
Note: SE - Standard Error				

Table 4: Thinking of a real person while designing

G	P/S	Thought of a real person	Person similar to	Mean %	SE %
1	Henry	82.7	Henry	73.3	3.8
2	Henrik	90.2	Henrik	70.1	3.8
3	Hank	80.0	Hank	75.0	3.7
4	Harry	85.1	Harry	72.5	4.2
5	Spec	82.2	Myself (Designer)	65.5	5.2
Notes: G=Group, P/S= Persona/Spec, SE - Standard Error					

Perception of oneself in comparison with the Personas

In Part 3, the students rated similarity between themselves and each of the Personas in addition to not having any similarity with any of the Personas 'None' (5 questions). Table 6 is the summary of the results. On the Likert scale, students significantly rated themselves to be like one of the Personas. The students in our sample population thought themselves to be more like Henry (mean = 60.3, SE=1.7) and less like Harry (mean=53.6, SE=1.7). They rated a lower scale for their traits as being someone other than one of the four Personas - None (mean=46.9, SE= 2.1).

Table 5: Preferred for future design - post preview

No	Persona / Spec	Mean %	SE %	p-value (t-test) ~ (Compared with Spec)
1	Henry	68.4	1.5	0.021 * (t=2.3, df=400)
2	Henrik	69.2	1.5	0.008 ** (t=2.7, df=392)
3	Hank	63.9	1.5	0.547 (t=0.6, df=393)
4	Harry	64.4	1.8	0.453 (t=0.8, df=426)
5	Average of all Personas	66.4	2.0	0.065 (t=1.9, df=284)
6	Spec	62.4	1.8	-

Notes: SE - Standard Error ~ Welch two sample t-test
* p <0.05 - The sample populations are different at a probability of 5% or less
** p <0.01 - The sample populations are different at a probability of 1% or less

Table 6: Perception of personal traits similar to Personas

No	Persona / Spec	Mean %	SE %	p-value (t-test)
1	Henry	60.3	1.7	0.000 ** (t=5.0, df=409)
2	Henrik	55.8	1.7	0.001 ** (t=3.3, df=413)
3	Hank	54.9	1.7	0.003 ** (t=3.0, df=408)
4	Harry	53.6	1.7	0.014 ** (t=2.5, df=411)
5	Average of all Personas	48.1	1.4	0.000 ** (t=4.0, df=288)
6	None	46.9	2.1	-

Notes: SE - Standard Error ~ p-value Welch two sample t-test (Persona/s compared with None)
** p <0.01 - The sample populations are different at a probability of 1% or less

Resemblance of Personas to a real person

In Part 2, the students rated the resemblance of the Personas to a real person. Table 7 shows the students' ratings for the statement: 'I think [Persona] represents a real person'. The mean of their rating is about 76.7% with small standard error. Hence the students confirmed that the Personas resemble real persons.

Table 7: Persona resembles a real person

No	Persona	Mean %	Standard Error %
1	Henry	76.6	2.7
2	Henrik	76.6	2.5
3	Hank	75.5	2.7
4	Harry	77.9	2.7

Peer review of design artefacts

In Part 3, each student peer reviewed five design artefacts that were randomly assigned to them, (four design artifacts from each of the four Personas and one from the Spec). The researcher also assessed the design independently and allocated marks to each design using the rubric. The means and standard errors of the marks for each Persona are presented in Table 8. From this result, on average, the designs

for the Spec are marked lowest and the designs for Henrik are marked highest. Only the difference between the marks for Henrik compared with the Spec is significant for our sample of population. Henry, Hank and Harry although scored higher than the Spec, the differences are not significant.

Solution thoughts

In Part 3, the students were asked to provide comments about their solution thoughts: 'While I was conceiving solutions, foremost thoughts on my mind were'. A sample of their entries is reproduced in Table 9.

Table 8: Assessment of Design by Peer Review

No	Persona / Spec	Mean %	SE %	p-value (t-test) ~ Persona vs Spec
1	Henry	74.7	1.3	0.09 (t=1.7, df=405)
2	Henrik	75.9	1.3	0.02 * (t=2.3, df=398)
3	Hank	71.6	1.3	0.79 (t=0.3, df=410)
4	Harry	71.7	1.5	0.77 (t=0.2, df=427)
5	Spec	71.0	1.7	-
Notes: SE - Standard Error ~ p-value Welch two sample t-test (Compared with Spec) * p <0.05 - The sample populations are different at a probability of 5% or less				

Threats to the studies

The study was designed as a classic controlled experiment with random treatment, a sufficient number of subjects, and appropriate statistical analysis, the threats to validity are discussed below.

Internal threats

Boredom and fatigue are considered as a low threat, as the students' efforts were graded. The data from students who did not complete the survey were excluded. The students conducted Parts 1 and 2 during normal class sessions. The students completed the Part 3 of the study in their own time. The design activities were conducted in the classroom and the students did not have any prior knowledge of the Personas or the Spec. Every student completed the activities on their own initiative and as the Personas or the Spec were allocated at random, hence all students produced original work.

As students who were designing were given only one item to design hence the students would not know if there was any other option available. Marks were allocated to students' performance in design activity according to a rubric. All identities were removed and the design artifacts were randomly allocated for peer review. Use of the same marking rubric by all markers and taking the average of the design marks allocated by multiple blinded peer reviewers and the researcher aimed to reduce bias. The peers were asked to provide reasoning for the marks allocated. To remove the threat that the portion of marks allocated by the researcher was biased, the marks for a random sample of the design artifacts were cross checked independently by another researcher. Further the marks allocated by the researcher were statistically cross-checked with the peer reviewed marks to ascertain their consistency. The students received the breakdown of the marks allocated to their design and their peers' reviews anonymously. The University Human Research Ethics was satisfied that all students would be treated fairly. They would have known and would have taken measures if any students felt they were unfairly treated and hence made a complaint. It was known to the researchers that the students in the class compared their marks and their work with each other. As no student made any complaint about their results is an indication that the marks were allocated fairly.

The knowledge of only one item during design activity and the peer review also removed any threat due to Hawthorne effect as the students were not aware that using personas may be the innovative approach favored by the researchers and using the Spec is the old standard approach to such projects.

Table 9: Sample of students' solution thoughts

Participant ID	Persona / Spec	Solution thoughts
1710039	Henry	My foremost thoughts were on the similarities between Henry and I, this allowed me to tailor an application that I think would be most beneficial for me and therefore more beneficial for the user.
1710071	Henrik	to meet the needs of Henrik as well as designing something that had real-world implications and could be ideal for a large number of people.
1710087	Henrik	Henrik was my client and i will get paid to make an application designed and running for him.
1710170	Henrik	how to get this guy to take care of his finances.
1710091	Hank	Making sure that the solution fit the specifics of the problems Hank was having.
1710183	Hank	Convenience and easy of access. It should not be something that takes much time or difficult. It should also be easily set up and require minimal input so that it is efficient. Additional details may be added in order to aid Hank in making wiser future decisions, but should not be mandatory.
1710036	Harry	How to relate to the scenario. / Make sure the guidelines are simple and easy to follow. / Break down Harry`s requirements. / Imagine Harry is a real client.
1710258	Harry	What Harry will need to use to suit his characteristics.
1710187	Spec	how to achieve the simplest solution for the user.
1710188	Spec	How I would develop a solution myself…
1710037	Spec	Providing a practical solution, that i could see userable [sic] by myself.

External threats

The main threats to the studies are single cohort and homogenous cultural groups for Parts 1, 2 and 3. The parts 1, 2 and 3 were conducted using students from one offering (i.e. same semester, unit and institution) and most students were enrolled in a Bachelor of Information Technology. The studies were conducted in a Western country and most students were native English speakers or spoken English for more than 3 years. Hence it cannot be generalized to other cultural groups and students with different backgrounds. We plan to conduct these studies in multiple cultural settings with different student cohorts.

In our study, the design duration was 15 minutes. The persona information provided was sufficient for the purposes. For longer design durations, the details of the personas' traits such as intelligence, knowledge and cognitive process will need to be authored appropriately.

Discussion

The results (see Table 3) show that students were able to produce designs with similar ease and experience to being provided with a specification. This suggests that use of Personas by students for design is a viable alternative to providing them with a requirements specification and in answer to the first research question, we see that Persona with knowledge and cognitive process can be used as a tool to teach students conceptual design. The downside of providing students with a specification is that the interpretation from the user's needs, to the requirements, has already been done for the student. In the work place it is likely they will need to identify the problem and user needs first, as part of requirements elicitation and then do requirements validation and specification. Persona allows them to do requirements elicitation, analysis, specification and design as the persona provides a means to access users' needs.

Related to research question 2, the participants' evaluation that all 4 Personas represent real persons is greater than average (Table 7). This is emphasized further by participants' highly rating the similarity

between their own traits and the Personas (Table 6). Without the sense that one is designing for actual people, it is difficult to follow UCD principles and appreciate the importance of building systems that real people can use (Adlin and Pruitt 2010; Norman and Draper 1986).

Table 3 shows that the students reported high levels of engagement with the Spec (No 1-5; higher than Henry, Henrik and Harry) and found design to the Spec similar to design for Personas (No 16-20). Table 4 shows that participants when designing with the Spec thought about themselves which may explain the high observed values in Table 3. However in Part 3 the peer reviewed marks given to design artefacts are significantly higher for Personas Henry and Henrik compared with the marks given to the Spec (Table 8). For Personas Hank and Harry even though the results are higher than the Spec, they are not significant. Hence their reported level of engagement did not reflect in higher marks. This indicates that it will be easier to design for some users than for others and suggests future research to identify why designers resonate better with some Personas than others and how training might be able to address this issue that otherwise could lead to poor designs for some users.

In the Part 3, when the students had full knowledge of all Personas and the Spec, (Table 5) they expressed that in the future they would prefer to design a product for the Persona Henrik (mean=69.2, SE=1.5) rather than create a design using the Spec (mean=62.4, SE=1.8). This confirms the result from Part 2: Table 3 shows that in Part 2, the students for their future design activity indicated their preference to design for a Persona than design to the Spec. The statistics in Table 3, even though it is not significant, is independent as the students, when answering the questions, only had knowledge about one artefact: either one of the Personas or the Spec. Our results are in line with other researchers' findings that the designers feel more empathy with the Personas (Chen et al. 2011; Dayton 2003; Long 2009).

A review of the students' thoughts, Table 9, whilst conducting the design revealed that the students addressed the Persona by name and concentrated on his characteristics. This is in contrast with the students who were presented with the Spec and had to address 'the user' (ID 1710187) or 'myself' (ID 1710037). The students' comments are in line with the findings of previous researchers (Anvari et al. 2015; Aoyama 2005; Dayton 2003; Valentim et al. 2017). In answer to the second research question, the majority of the students in our studies thought about themselves or a user similar to themselves when they were designing with the Spec but the majority of the students thought of a user similar to the Persona when they were designing for a Persona.

As an observation, Table 6 shows that more students thought themselves to be like Henry (mean 60.3%, SE 1.7%) than Harry (mean 53.6% SE 1.7%) or none (mean 46.9% SE 2.1%). Thus the students' perceptions were that they sought knowledge at the procedural and metacognitive levels and were on the creative rung of cognitive process.

In our studies we fulfilled pedagogical goals by having students review and practice UCD concepts, gain experience with surveys to capture user profiles, and participate in creating and evaluating designs. They learnt from each other by peer reviewing each other's work and they received a tutorial in finance. At the end of Part 3, we provided an opportunity for students to make comments about the studies. We did not receive any negative comments. All comments received were positive. For example, comment from Participant ID 1710204: *'Almost each of students provided some interesting points. I found some interesting ideas for myself, which could be useful in future app developing brainstorms*'; and Participant ID 1710081: *'i think those suggestion are really good, compared with my assignment. in this review, i truly understand how to do a design and compare other design. wish i can do again of my assigement[sic]*'; and Participant ID 1710086: *'A holistic persona seems to just give the developer a good direction in which to start brainstorming potential features to solve specific problems. Character traits mentioned within these are too narrow to properly capture a single person perfectly I feel. Everyone is a mix and match of all different things and it is important to keep that in mind too*'. One student commented that the study time was limited and another student comment was related to not remembering the details.

Conclusion

In this paper we have empirically demonstrated that the sample population of students, who conducted a design activity using the Personas with knowledge and cognitive process were able to undertake the design activity with the same effort and level of ease as those using a list of requirements. We have also demonstrated that the students who were given a Persona for their design activity thought of a person who was similar to the Persona whereas the students who received the Spec thought of themselves during their design activity.

The findings of this study have important implications for the education of future software engineers and IS professionals. Learning conceptual design is not an easy task and learning to do UCD without access to users is difficult. This study demonstrates that Personas can aid students to perform design with actual users in mind, in contrast to having students create designs from a specification. Furthermore, our study provides a strategy for potentially increasing students' engagement and interest in practicing design activities.

Appendices

Persona Henrik

Henrik is a student studying towards his degree at a research intensive university. Henrik's parents who live in a suburb of Sydney, far-away from the University, are busy with their lives. They migrated to Sydney when Henrik was still a child and are now settled in their home. At the insistence of his parents, Henrik moved out and lives closer to the University.

During his schooling, Henrik had difficulty understanding his subjects but he made enough effort and passed. Henrik is doing IT studies as he found out through his friends that it would provide him with good employment opportunities. Henrik makes reasonable effort for his studies. He attends lab and classroom regularly. He does not often take notes but collects all the material that the lecturers and tutors provide. He reads them later. In the lab, whenever Henrik is required to use a new software application, he looks for affordances and learns about the software application. He reads documents and visits local forums to learn new knowledge but he does not participate in the forum activities. Henrik rarely accepts requests for help from his friends or appointments for new activities as he does not like changes.Henrik has living expenses, pays university fees and buys books and other necessities. He also engages in entertaining activities that require him to buy equipment, and make payment for accommodation, transport and insurance. Henrik has a goal of buying his own flat and hence he wants to have a saving plan to achieve his goal.

Henrik receives scholarship, tertiary assistance and some allowance from his parents. He also works casually whenever he needs extra monies. When Henrik is in need, he borrows money from a bank for a fixed period. Later when he works, he saves money and pays the loan and the interest payment when they are due. He does not pay attention to the due date; he is often late to pay off the loan, hence he is penalised. He thinks this option is expensive and tries to avoid it. He finds that working casually is getting harder as his study-load is getting heavier. He thought that if he plans his finances properly he does not have to work at the time that he needs to concentrate on his studies. He feels that he needs assistance with his finances.

The Spec

The user is a tertiary student studying away from home. The user has to pay fees and meet other irregular expenses which happen during the year. The user also receives regular bills such as food and accommodation that he has to pay. The user receives payment from scholarship. His parents provide him a monthly allowance. The user works casually whenever he has a bill to pay. The user also borrows money from a bank for a fixed period whenever he is in need. He works and saves money and pays the loan and the interest payment by the due date. The user has a goal of buying his own flat

and hence he wants to have saving plans to achieve his goal. The user wishes to know in advance when he has to work to meet his expenses so that he can plan for his studies. In your design allow for documentation and assistance so that the user can use your application without a need for training by other users.

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