Teaching User Centered Conceptual Design Using Cross-Cultural Personas and Peer Reviews for a Large Cohort of Students

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***Abstract*—It is important that Software Engineering and Information Technology students learn techniques to conceive solutions that are centered on the users. Users are often from many different cultures; hence an awareness of cultural differences is an important concept for students to grasp. Particularly when class sizes are large, access to users that would allow the students to practice User-Centered design principles is not feasible. Different methodologies must be pursued to teach students the principles of design. This paper presents peer review and personas, archetypical users of an application, as techniques for teaching User-Centered conceptual design to a large cohort of students. We provided a persona from a set of six personas, each authored to represent two different cultures (Australian or Vietnamese), to 153 undergraduate students at an Australian university to conceive design solutions for the persona. Later, the students were exposed to all of the personas and then they peer reviewed each other's design artifacts. From the comments left by the students we conclude that the technique has met its learning objectives.**

Keywords- persona, peer review, Holistic Persona, teaching User-Centered Design, conceptual design

I. INTRODUCTION

In professional careers, Software Engineers and Information System technologists conceive applications that are to be used by a diverse range of people. Hence, it is essential that students studying Software Engineering and Information Systems be exposed to principles of User Centered Design (UCD) and learn about one of the most important phases of design, conceptual design. However, teaching conceptual design that follows UCD methodology to a large cohort of students without an end user is difficult. A persona, an archetypical user, is a tool within UCD methodology, developed to keep designers focused on the end users among many other benefits [1].

Many researchers and practitioners have developed methods to author personas and investigated their use [2]. Numerous researchers have also critiqued the use of personas or the methods used to author them e.g. [3-5]. To address the criticism of personas as too general and lacking realism or depth Anvari and Tran [6] proposed Holistic Personas which are structured to more closely resemble the end users than other types of personas.

Researchers have investigated the usefulness of both personas and of peer review for teaching design in educational establishments. Long [7] conducted research on the use of personas for teaching design. His experiment was conducted for five weeks with 3rd year Industrial Design students. There were three groups and each group consisted of three teams, without giving indication of team sizes or number of tutors involved. Jones, et al. [8] anecdotally reports students' positive experiences in using personas for design purposes but without providing any empirical evidence. Cleland-Huang, et al. [9] reported on 22 Masters students and 31 Graduate students who used Architecturally Savvy Personas to design the architecture of a system. Valentim, et al. [10] used personas in teaching design thinking to 17 postgraduate students. The students performed advanced design activities in groups and with the instructor. Tran, et al. [11] used personas to design a teaching module for professionals to learn Accounting Information Systems. Iacob and Faily [12] reports the benefit of students reviewing their peers during practical sessions in a software engineering course. In all of the studies reported above, the review conducted relied heavily on teaching staff supervision. To the best of our knowledge, we have not seen any empirical investigations that report the use of personas, conceptual design and peer review which completes the learning cycle, in a large cohort of undergraduate students with limited resources.

We have conducted numerous studies with the broader objectives of developing tools for authoring personas, promulgating their usage for teaching conceptual design, and for the use of peer review for critical thinking for undergraduate Software Engineering and Information Systems students to use in their future professional collaborative environments. In this paper we report on the opportunity we provided to the students to become exposed to real-life software engineering methods and use tools which address the lack of end users in a classroom context. We discuss the benefits of using Holistic Personas to aid students in the conceptual design process to discover issues beyond coding and software programming concepts; teaching students about UCD methodology; and by peer review according to a rubric, to further consolidate students' design skills and feel rewarded in their learning experience.

The Holistic Personas were varied (1) along two dimensions, knowledge and cognitive process by having

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deep or surface attitude to learning, and (2) varied to represent two different cultures, Australian and Vietnamese. The Holistic Personas were authored based on the results of a survey answered by the students in two countries: Australia and Vietnam. Though the requirement was to conceive a software application, we were primarily interested in researching students' conceptual design abilities. The requirement for conceptual design was to develop an application to help the Holistic Persona with linguistic difficulties.

This paper addresses the following research questions:

- Is the use of personas affected by students' approach to learning?
- Would the cultural background of the personas affect their design?
- Do students perceive peer review as a useful tool?

This paper is organized as follows, next is the review of the literature in the area (Section II), which leads to our research objectives (Section III) followed by a description of our methodology (Section IV), threats to our studies (Section V) and procedure (Section VI). Next, we present the results of our research and its discussions (Section VII). We close the paper with the conclusion and future research (Section VIII).

II. BACKGROUND AND RELATED WORK

A. User Centered Design and involvement of users

Human interaction with computers has become ubiquitous. UCD has its origin in the laboratory of Donald Norman at the University of California, San Diego: "user-centered design emphasizes that the purpose of the system is to serve the user" [13, p. 61]. For successfully implementing UCD for software applications, it is essential to gather requirement specifications from diverse stakeholders such as users of the application, the operators and managers [14, 15]. However, the involvement, if possible, of both end users together with the personnel with expertise to manage the users during the design and development, will add to the project cost and increase development time [16-18].

B. Conceptual design and personas

Researchers generally agree that the most influential phase of the design is the conceptual design phase, in which, the behavior of the new system is formed [13, 19]. In work environments, designs are often conceived by brain storming workshops with users and stakeholders to generate ideas. In educational establishments where class sizes are large, students' interaction with the end users is impractical. Teaching conceptual design and UCD is difficult due to budget and time limitations and the lack of suitable users willing to participate [20].

The use of personas, archetypical users, is a tool within UCD methodology to keep focused on the end users during design and for communication with stakeholders [1]. Personas are normally authored using photos and text [1, 21]. Personas that represent the end users closely, such as personas with a personality, are likely to facilitate a conceptual design that is in accordance with user requirements [22]. Students can feel more empathy with personas that are represented with a photo of a person rather than with an illustration [7]. Salminen, et al. [21] recommends that the use of photos with some background could improve the persona profile rather than a photo that shows the person's face only. Head shot and including extra people in the photo could create confusion. In educational establishments, end users are often unavailable for students' design purposes. To address the issues of not having users to interact with students, personas have been used for design purposes [8-11, 22, 23]. Bourgeois-Bougrine, et al. [24] found that the students who use personas and other design tools conceive richer conceptual designs. Haag and Marsden [25] found that students empathize with personas that are similar to themselves and this would influence their design.

Techniques used to author and promote personas vary across industry practitioners and researchers. Vestergaard, et al. [26] used observational techniques and ethnography to gather data and author personas. Goodwin [1] recommended market research and clustering techniques for information to author personas. To build an Online Customer Care portal for the City of Austin, Switzky [27] developed personas after identifying the use cases. Personas are promoted among designers using different techniques, such as Guðjónsdóttir and Lindquist [28] who used posters and cardboard cut outs to promote personas. In our work, we profile the students early in the semester and use this data in authoring personas. Profiling also allows us to compare how well students can design for people different from them.

C. Deep approach and Surface approach to learning-knowledge and cognitive process

The concepts of deep learning, learning for understanding, and surface learning, rote learning, learning for passing the examinations have been around for a few decades [29]. Qualitative and quantitative methods are used in researching the approach to learning [30]. Based on pedagogical theories of constructivism and systems theory, Biggs, et al. [31] developed an instrument to measure the deep approach and surface approach to learning to capture data for factor analysis. The method is widely used in educational establishments, even though the instrument has had a number of critics [32].

Anderson and Krathwohl [33] revised Bloom's Taxonomy of educational objectives into four categories of knowledge (an agreement between the scholars in the field): factual, conceptual, procedural and metacognitive and six categories of cognitive process (action for the knowledge): remembering, understanding, applying, analyzing, evaluating and creating. Students use different techniques and approaches to learning depending on the assessment techniques and purpose of learning [33]. From the literature we can conclude that the surface approach to learning is similar to rote learning or the first cognitive process of Remembering in the revised Bloom's Taxonomy while the remaining five cognitive processes of Understanding, Applying, Analyzing, Evaluating, and Creating refer to the deep approach to learning [31, 33, 34].

D. Peer review and educational benefit

Peer review and collaborative learning have been found to enhance learning [12, 35]. In peer review, the reviewer clarifies the reviewed material and forms a summary of it before commenting on the knowledge content which can be corrective, suggestive or confirmatory; these activities are at the higher rungs of cognitive process [36-38]. Feedback is provided via peer comments so that the receiver can improve performance [39]. A number of researchers have found peer review to be a valid and unbiased form of assessment and students find peer review to be a good form of learning as they are exposed to their peers' work which is a rare opportunity [35, 36]. Iacob and Faily [12] redesigned a Software Engineering course and made peer review a part of the assessment. This helped the students to look beyond coding, to cooperate in teams and to develop critical thinking. The students responded positively to the changes. van Zundert, et al. [40] in reviewing the publications on peer assessment noted that initially students felt a lack of confidence in assessing their peers as a negative aspect of the task but they reported a perceived benefit in carrying out the task. Peterson and Peterson [41] found that when the peer reviewer was not anonymous, the marks allocated were higher.

E. Engagement, self-regulation and motivation

Engagement is active as well as cognitive and behavioral participation in learning [42]. In self-regulated learning, the learner sets a goal and actively controls and regulates her or his cognition, motivation and behavior in order to achieve the goal [42]. Engagement consists of four interdependent phases: planning, monitoring, management and reflection [42]. Based on the literature, Fredricks, et al. [43] lists the facets of engagement as behavioral, emotional and cognitive. Skinner and Pitzer [44] consider engagement as an outward manifestation of motivation. Motivation refers to goals a person tries to achieve and the intensity he pursues to achieve the goals. Motivational design, the design which improves motivation, is influenced by learning environmental design and instructional design and it makes the instruction appealing without it being entertaining [45].

F. Rubric and peer review

Rubric, as an assessment tool, provides for a consistent, objective, valid, reliable, comparable and fair assessment of a written work [46, 47]. A rubric can be holistic or analytic, However an objective assessment is carried out with an analytic rubric [48, 49]. Moskal and Leydens [48] refer to a rubric being reliable when two assessors evaluate the work and give same or similar score to the work. Rubrics have been used by numerous researchers to assess design artifacts e.g. [50-52]. McKenna [52] devised a rubric for assessing design work and found that with little training, the level of agreement between assessors was high. McMartin, et al. [51] devised a rubric that had numerous categories for evaluating design and for each category marks were assigned depending on degree to which the work was innovative and met the criteria. Bailey and Szabo [50] devised a rubric to assess design artifacts based on the revised Bloom's Taxonomy.

III. Research Objectives

Researchers have investigated the introduction of personas for teaching purposes [8-11, 22, 23]. Students have difficulty in learning design [53] and specifically UCD. In this paper our research objective is to investigate the educational benefits of using Holistic Personas with knowledge and cognitive process, and to teach user-centered conceptual design and peer review using a rubric. We also wish to investigate the differences in students' perception of learning and their behavior due to differences in their approaches to learning [31, 33].

As the major users of technology are forecasted to be in developing countries [54], we also investigate the use of personas for cross-cultural contexts by introducing personas from developing countries [26]. We evaluated the response of Western students to these personas in terms of design and development of the applications.

In order to answer our research objective we refine our earlier questions and examine the specific questions:

1) Is the use of personas suitable for students with a deep approach to learning?

2) Is the use of personas suitable for students with a surface approach to learning?

3) Are students able to employ, in their design tasks, personas from a cultural background that differs from their own?

4) Do students perceive peer review as a useful tool in conjunction with the use of personas?

IV. Methodology

A. Outline of the study

We devised a study using survey and experiment methods to investigate the authoring and use of personas for a design activity within educational establishments. The research objectives in this paper were posed as part of our overall goal. We used part of our study as outlined below to answer the research objectives. The study was conducted in 2018 and consisted of number of parts, in three of which the students were active (Fig. 1).

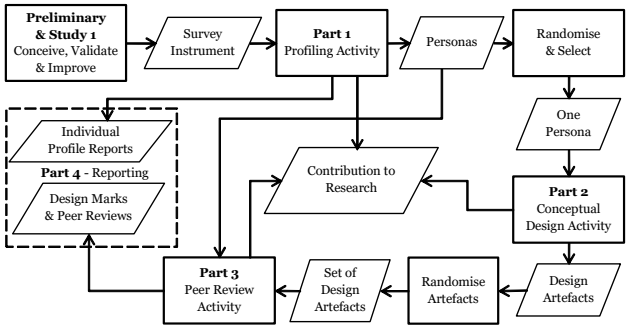

Figure 1. Research Model

1) Part 1 – Profiling Activity: The students provided their profiles by answering a survey instrument.

2) Part 2 – Conceptual Design Activity: The students rated one of the personas, performed a design activity using the same persona and answered a survey.

3) Part 3 - Peer Review Activity: The students rated all six personas, peer reviewed a set of six design artifacts created by fellow students and answered a survey.

4) Part 4 - Reporting: We provided to each student a full report of their personalities, their design activities and the peer evaluation.

B. Profiling Activity - Persona characteristics

We conducted a survey in part one of our study to collect data from students. As we could not find a suitable survey, we initially constructed a preliminary questionnaire and validated it by interviews and cognitive walk-throughs in 2015. We gained further experience by using our instrument which we developed during 2016 and implemented in a previous study in 2017 [11, 55]. The experiences we gained from these two earlier studies provided us with information to modify and enhance our instruments for the current study in 2018. We authored three personas based on the profiles of the student participants in Australia.

As the number of users of technology from developing countries is increasing [54], we conducted the first part of our study by recruiting 39 second-year and third-year students in Vietnam in 2018. We authored three of our personas based on the profiles of the students in Vietnam. This is to fulfil one of the goals of this paper.

Table I presents the personas and their characteristics. We have provided one persona: 'Minh' in the appendix. The other personas can be obtained from the first author.

C. Conceptual Design Activity

During the design activity, the students were randomly but evenly presented with one of the six personas (Table I). The students read and rated the persona and then performed a design activity that involved writing a conceptual design for an application and a scenario in which the persona interacted with the application. The students were given opportunity to expand their design and explain the architecture of the application, any unique features that the application possessed, how would the application meet the persona's requirements and a more detailed scenario in which the persona interacted with the application. The students answered questions regarding their thinking during the design activity.

TABLE I. PERSONA TRAITS

No	*Persona*	*Knowledge*	*Cognitive Process*	*Learning Approach*
1	Paul	meta-cognitive	create	deep
2	Peter	factual	remember	surface
3	William	not specified	not specified	not specified
4	Minh	meta-cognitive	create	deep
5	Thuy	factual	remember	surface
6	Chi	not specified	not specified	not specified

D. Peer Review Activity

During the peer review activity, the students were randomly but evenly presented with all six personas (Table I). In order to ensure that the students understood the personas, they answered a short survey about the personas. The students received six sets of design artifacts in a random order, one for each persona, for evaluation. All students' identifications were removed and replaced with Participant IDs. The students evaluated each design artifact and provided comments and reasoning for their assessment.

The students answered a post peer review survey in which their views were sought about the personas and finally they were provided a text box to write any comment they wished.

E. Reporting

The students received a report by email providing them with their profiles, design artifacts and the details of the peer reviews, the marks allocated and the comments given, without any indication of the identity of the reviewers.

V. THREATS TO VALIDITY OF THE STUDY AND MEASURES TO OVERCOME THESE

Two types of threats, internal and external, to the validity of the study were identified during the design of the study and measures to mitigate these are as follows.

A. Internal threats

One of the threats to validity of the study was whether the designers have the same perception of the personas as they were intended. We included in the study instruments to evaluate the students' perception of the persona that was given to them for design purposes. Fig. 2 shows the perception of the students in answer to questions about the traits of the persona they designed with (data from all students who completed part 3 is used – Table II). As evident from the Fig. 2 and Table I, the persona's traits as assessed by students matched the intended traits.

The second threat was the students' bias or favoritism towards their fellow students [35, 41]. To overcome this threat we made known to the reviewers that the process was double blind. The student's identification was removed and replaced with Participant ID. The students were not given

TABLE II. PARTICIPANTS IN STUDY

No	*Part Completed*	*Participants*
1	Completed Part 1 – Profiling - week 3	272
2	Completed Part 2 – Conceptual Design - week 7	265
3	Completed Part 3 – Peer Review - week 10 - 11	216
4	Completed Parts 1, 2 and 3 – Profiling, Conceptual Design and Peer Review	153 [a]
5	Total Number of students enrolled during part 3	313

[a.] Completed all parts of the study and provided consent for their data to be used for research.

their own Participant ID and hence they could not attempt to find out who were reviewing their design artifacts.

The third threat was the concern that there was no ground truth assessment for design quality. To overcome this threat, the first author marked and then checked all the design artifacts. The fourth author independently checked a random sample of the marks given by the first author and the students. Both authors noted that the majority of the students were fair and thorough in marking their fellow students' design artifacts. The methodology used and the results obtained will be presented in a future publication.

The fourth threat was lack of students' experience in peer reviewing [40]. To overcome this threat, we provided the students with a comprehensive rubric which we have developed over a number of years [55-58].

The fifth threat was that some students from Vietnam could not follow enough English to satisfactorily answer the questions. This threat was mitigated by conducting a short purpose built online course where the students learnt enough English to understand the questions in the survey. Two of the authors validated the results of the study by having visited the students personally, observed their behaviors and discussed their conduct and traits with their teachers [26]. The experiences gained in teaching Vietnamese students were presented at the International Conference on Language, Society and Culture in Asian Contexts [59].

The sixth threat was that the students could take too long to complete the peer review as they may be interrupted and this would bias some of the results. We carefully monitored the time students took. We found 10 students took in excess of 127 minutes (mean + 2 x standard deviation) to complete the peer review activity and hence their data were excluded from peer review timing evaluation. However their peer reviews and assessments were otherwise valid and hence they were not removed from other statistics.

The seventh threat was that the photos selected could convey a different perception of personas than was intended [21]. We carefully selected pictures that showed a single persona with background, that is, without having anyone else in the view. We also chose the same two pictures for the two sets of three personas that represented females in Vietnam and males in Australia. These measures mitigated this threat.

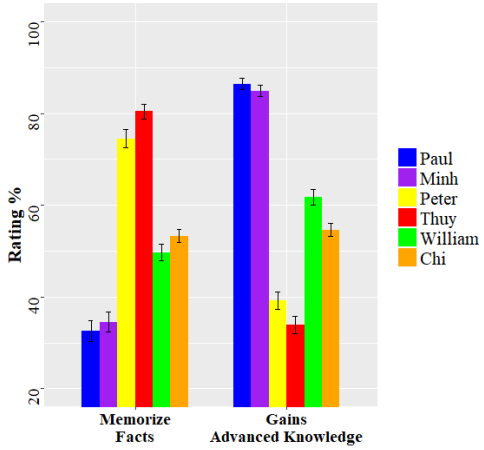

Figure 2. How the Holistic Persona learns new knowledge

Other threats such as boredom are mitigated by carefully dividing the survey instrument into sections with appropriate headings, providing a consent page for students to opt out of the research and ensuring they obtain pedagogical benefit by participation in the survey. Part one (survey activity) and part two (conceptual design activity) of the study was completed during the students' normal laboratory sessions. Students completed part three in their own time.

B. *External threats*

The external threats relate to: (1) the inability to generalize the conclusions of this study due to limited sample size and (2) cultural differences which affect the perception of designers. To mitigate the first threat we plan to repeat this study in a number of different settings with different classes and students of different backgrounds. To mitigate the second threat, we introduced a set of personas from a different culture, Vietnam, in our study. We plan to repeat this for our future studies with personas introduced from different countries.

VI. Procedure

The activities were a requirement for the course in Information Technology and carried 5% of the course assessment. The students had the option not to participate in the research activity. The study was approved by the Macquarie University Human Research Ethics Committee. To facilitate the conduct of the online study, we used Qualtrics, a tool to author web-based surveys. The students did the profiling survey and conceptual design activity during their practical sessions and the peer review activity during their own time. They spent different amounts of time for each of the activities. Fig. 3 and Fig. 4 show the box plot of the variation in time students spent for conceptual design and peer review, respectively. Fig. 5 shows peer review marks.

Table II presents the statistics of the students who participated in this study. Due to students changing courses, there were changes in participation. In this paper we present statistical analysis of data from students who participated in all three parts of the study and gave consent to include their data for research purposes. Table III shows the demographics for the participants.

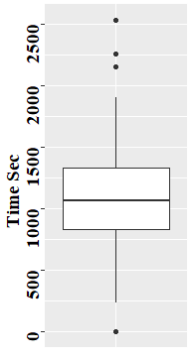

Figure 3. Conceptual design duration

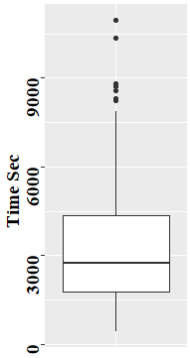

Figure 4. Peer review duration

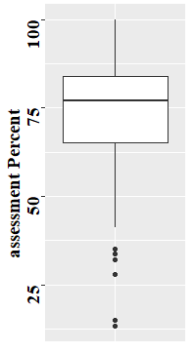

Figure 5. Peer review marks

Table III shows that the majority of the participants were native English speakers or have spoken English for more

than three years (98%). There were two students who had spoken or written in English for less than three years. Their results showed that they have adequate understanding to participate in the study.

Table III also shows known fields of study. The majority of students studied, or were studying, Information System (86%), Finance and Accounting (47%), and Software Engineering (24%). The percentages of the known fields of study are not additive. This subject would provide intermediate knowledge of software practices; hence, students studied multiple fields of studies.

VII. Results and Discussion

In this section, we provide an outline of how we dichotomized students that have a deep approach and a surface approach to learning and then continue our discussion under separate headings in answering our research questions. Under the last heading in this section we cover other findings resulting from our studies.

We used Biggs' survey instrument to measure the students' approach to learning [31]. Our data was quantitative. We had a short time interval between part one where the students responded to the profiling survey and part two when the students did the design activity, for us to prepare the personas. We dichotomized the sample population into those who have deep approach to learning and surface approach to learning by comparing their self-rating for items in the survey about approaches to learning [31]. We deemed a student to have a deep approach to learning if their score for the items in the survey about a deep approach to learning was greater than their scores for items in the survey about a surface approach to learning (Fig. 6). Fig. 6 was prepared using data from all students who completed Part 1 (Table II - Profiling Activity - week 3).

TABLE III. Demographics

No	Participants (all three parts of the study)			
	Item	*Category*	*Count*	*%*
1	Total		153	100
2	Gender	Male	105	69
3		Female	48	31
4	Known fields of Study - students did multiple fields of studies hence the counts are not additive.	Information Systems	132	86
5		Finance and Accounting	72	47
6		Software Engineering	37	24
7		Science	24	16
8		Engineering	17	11
9		Game Design	10	7
10		Human Science	12	8
11		Arts and Literature	8	5
12		Fine Arts	4	3
13	Fluency in English language	Native speaker	92	60
14		3 years or more	59	38
15		1-3 years	1	1
16		less than 1 year	1	1

A. Research Questions 1 and 2: Is the use of personas suitable for students with a deep or a surface approach to learning?

We analyzed the time spent in part 2 for conceptual design activity and in part 3 for the peer review activity for both categories of approaches to learning and presented the results in Table IV. We also present the statistics for their mark for conceptual design by peer review. Table IV indicates that the average time the students spent on the design activity was 1099 seconds (about 18 minutes) and that the average time spent on peer review activity was 2978 seconds (about 50 minutes). These times exclude the time students spent answering the surveys. Though on average the students who have a deeper approach to learning spent more time on both the conceptual design activity and the peer review, the difference is not significant. The peers gave similar average marks for both categories of students. The t-test shows that the difference is not significant. These results indicate that students of both categories performed similarly. Answering our research questions numbered 1 and 2, the students regardless of their approaches to learning used personas suitably to conceive their design of applications. Hence the students were equally motivated to learn. This is in line with other researchers findings that the design of the course can motivate the students to make an effort in learning [45, 49].

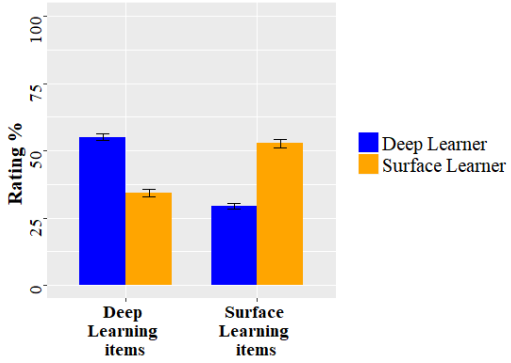

Figure 6. Students' Learning Approach

TABLE IV. Design and Review by Participants having different Approaches to Learning

No	Participants (all three parts of the study)		Deep Approach		Surface Approach		t-test
	Item	*Unit*	*Mean*	*SE*	*Mean*	*SE*	p-value
1	Conceptual design duration	sec	1123	40	1059	49	0.31 (t = 1.02, df=123)
2	Peer Review duration	sec	3009	183	2928	214	0.77 (t = 0.29, df=120)
3	Conceptual design marks by Peer Review	%	73.4	1.7	73.5	2.1	0.96 (t=-0.04, df=124)

B. *Research Question 3: Are students able to employ, in their design tasks, personas from a cultural background that differ from their own?*

Table V shows that 88% of students stated that they added features to their design to meet the needs of the personas. They were also given a text box to provide details of the features. Some of the design added features are listed in Table VI which demonstrate that students conscientiously added features to address the needs of the persona according to the persona's traits and culture. From Table V, there is no significant difference between the students in the two categories of deep learning approach and surface learning approach (89% and 86%). Hence, the majority of the students thought that they have added extra features to the design to meet the needs of the persona. Further, Table V shows that 95% of the students referred to personas by their names in their design artifacts. This is evident in quotes from students presented in Table VI and Table VII that most students in their design artifacts and peer review referred to personas by their names and some treated them as their clients. Fig. 7 shows the rating of the resemblance of personas to human persons by the students (data from all students who completed part 2 is used – Table II). As can be seen, the students thought of personas as real persons and this did not vary significantly across the personas, even though they were presented as coming from different cultural backgrounds. Answering our research question 3, the students were able to employ in their design tasks, personas from a different cultural background than their own culture. As Fig. 8 shows, participants perceived a relatively low degree of resemblance between themselves and the personas. This, together with the success of the design task shown by row 3 of Table IV and Fig. 5, demonstrates that personas can be used to guide design tasks for end users who differ from the designers themselves. We can deduce that the personas make the students think of users during their design activities

TABLE V. FEEDBACK AND FEATURE ADDED SPECIFIC TO PERSONA

No	Item	Both approaches	Deep Approach	Surface Approach
1	Number of participants all three parts of the study	153 (100%)	96 (100%)	57 (100%)
2	Feature added specific to persona's traits	134 (88%)	85 (89%)	49 (86%)
3	Positive feedback [b]	92 (60%)	60 (63%)	32 (56%)
4	No feedback	56 (37%)	33 (34%)	23 (40%)
5	Negative feedback	5 (3%)	3 (3%)	2 (4%)
6	Addressed the persona by name in design artifact	146 (95%)	90 (94%)	56 (98%)

[b.] Positive learning feedback, constructive criticism or recall their experiences.

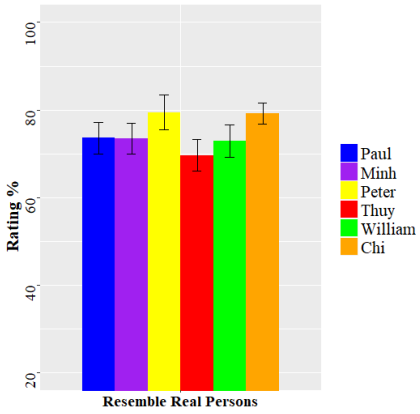

Figure 7. Personas resemble real persons

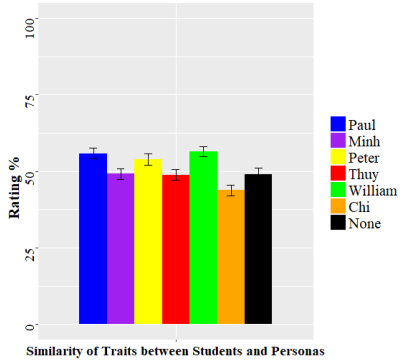

Figure 8. Students traits similar to personas

thus meeting the UCD design criteria. Hence personas helped students to carry out design activities according to practices that are exercised by professional software engineers.

C. *Research Questions 4: Do students perceive peer review as a useful tool in conjunction with the use of personas?*

Table V also shows an analysis of students' feedback at the end of the study. The feedback is considered an indication of positive learning, if it is a constructive criticism, or a positive feedback about the personas' traits or relating persona's traits to their own traits. An example of positive feedback is the suggestion to improve the survey provided by Participant ID 1810025: 'Good task, very thorough. Felt the rubric descriptors could be improved. For example, the scenario writing the interaction between the app and persona can be given for a full mark, however, it doesn't state whether the scenario will be helpful for the persona'. This kind of feedback requires reading, understanding, analyzing and critiquing which are at higher rung of cognitive processes [33, 36]. Table V shows that 60% of the students gave feedback that was considered to indicate that the learning activity was positive. Only 3% gave negative feedback and 37% did not provide any feedback. Our results are in line with other researchers who used peer review as a teaching mechanism especially in a large cohort of students [12]. For example Participant ID 1810282 commented: 'After doing this, I understand steps in designing an application (at initial stage)' and Participant ID 1810036

commented: 'I learned more about what was expected here than from the previous information given in class'. These findings are similar to other researchers findings such as [20]. Our studies demonstrate that with a small amount of time and budget, undergraduate students in a large class can benefit from learning UCD principles using personas. Thus, answering our research question 4, students perceived peer review in conjunction with the use of personas a useful tool.

D. Other findings resulting from our studies

In our study, none of the students commented about lacking confidence in peer reviewing [40]. We attribute this to design of our instruments: students were asked to explain separately the details of the initially conceived design. The divisions and exploration of the initial conception made the task of reviewing the conceptual design easier. This activity also allowed the students to further explore their conception. A number of participants provided positive comments, some of which are listed in Table VII - Participant ID 1810271 commented: 'This experiment has been quite interesting' and Participant ID 1810097 commented: 'overall good' (not listed in the Table VII).

TABLE VI. QUOTE FROM STUDENTS – POST THOUGHT - END OF THE DESIGN ACTIVITY

Participant ID	Persona Country	artifact	Quote from students' design – solution thoughts
1810105	Paul Australia	Feature added	Because of Paul's hectic lifestyle, I decided to add a mobile app across numerous platforms so that he can access it anywhere. Furthermore as Paul is a deep approach student, I added access to a large library of literary tools so that he can really dive in the English world.
		Solution Thoughts	1. How will Paul be attracted to this design. 2. How can Paul access the work when he is busy. 3. What type of student is Paul so that the app works for him.
1810236	Paul Australia	Feature added	The features such as voice capturing system and provide definitions and real life examples can mostly helped at people like Paul who struggle with linguistic, and help them to builds up their vocabulary in different job areas in life.
		Solution Thoughts	The foremost thought on my minds is to help Paul developing understanding on the linguistic, and makes him get used to a particular type of language, thus this language can also be used by Paul himself in his own life
1810036	Minh Vietnam	Feature added	Her busy schedule and disciplined attitude, combined with physical limitations (internet, personal computer limitation, etc) drove me to design something that would function quickly and without an internet connection.
		Solution Thoughts	What would Minh find convenient and easy to use? Would this application actually help Minh's problem?
1810212	Minh Vietnam	Solution Thoughts	What would make it accessible for people who don't have access to any computers at home or anywhere. People who want to test themselves after reading a chapter, which even i would love to do. People who want to gain extra knowledge apart from just uni stuff People who want to write notes along with reading chapters.
1810089	Minh Vietnam	Feature added	I have added Reading part in my system considering Minh's traits. She will read those reading materials and the system will take her voice and say that her pronunciation is correct or not. It will help her to increase her reading ability.
1810169	Peter Australia	Feature added	memorize he can remember a lot of information so is easy to present a large amount of information for him because he doesn't analyze it by himself just memorize
		Solution Thoughts	Peter capacity to memorize information
1810244	Peter Australia	Feature added	The addition of the activity games that enhance user engagement was added as Peter tends to get distracted from study via browsing photos on social media. As the game will be fun and engaging for Peter he is less likely to get distracted on social media while doing the activities. Furthermore, the activities are short and concise and daily reminders are sent to complete certain tasks which will help Peter as he prefers learning via brief format and tends to forget what is involved in his schedules.
		Solution Thoughts	What would make sure that Peter engages with the application that would overall improve his linguistic capabilities.
1810107	Thuy Vietnam	Feature added	Thuy is shy, I added a platform where she can interacts with close people.
		Solution Thoughts	It is important to make the system interactive, as Thuy can easily lose interest in it if she does not find the app fun to use
1810121	Thuy Vietnam	Solution Thoughts	How could it serve Thuy best regarding her preferences and learning style.
1810282	William Australia	Feature added	reference papers and videos as a method of learning this method often applied by William
1810043	Chi Vietnam	Feature added	The app is free since learning English can be found online. However, in Chi does not own a computer and does not use the internet often. Voice translation and pronunciation was also added do to chi's traits
		Solution Thoughts	About the user perspective, and how the app would benefit the user. What functions would be useful to add for the user.

TABLE VII. QUOTE FROM STUDENTS – POST THOUGHT - END OF THE PEER REVIEW

Participant ID	Quote from students – Post thought – end of the peer review activity
1810105	The designs where well thought out and answered to each and every requirement for the students. Whilst all issues where mostly outlined, they could have been explained in greater detail in order to achieve full marks
1810107	My personal traits are a combination of all the holistic personas above.
1810121	Using the holistic personas to create an application is a good way of showing us just how important users are at the center of software design.
1810158	I can relate to Minh and Paul as they are students who are diligent and can work without a fuss. Also the learning tool, If I was to use it I would have no preferences on what kind of platform but would use whatever was given to me.
1810043	Thinking of a design of one of the persona was interesting and made me think outside the box.
1810025	Good task, very thorough. Felt the rubric descriptors could be improved. For example, the scenario writing the interaction between the app and persona can be given for a full mark, however, it doesn't state whether the scenario will be helpful for the persona.
1810034	Interesting assessment, allows you to think outside the box.
1810036	I learned more about what was expected here than from the previous information given in class
1810211	Requirements meeting is hard for Chi as specific personality requirements were not explained, only external needs were listed (no internet etc.) no traits about how they study and there attitude towards learning.
1810212	It would love to design a software for Minh specifically because she is very hard working but only because of lack of resources she is not able to excel in speaking and learning English
1810089	I think university should emphasize on learning English as they all want to do good job near in future.
1810139	All holistic persona can represent real life scenarios within university.
1810242	i'm easily distracted by social media and prefer to have information given to me as most times researching for a specific topic is difficult, although I enjoy reading information that I can understand or try to understand information i find interesting. I use applications reading the basics and learning from there. I appeal more to making an application for Minh as she is studious and it would be enjoyable making an application to suit her needs.
1810251	Fun activity
1810271	This experiment has been quite interesting.
1810282	After doing this, I understand steps in designing an application (at initial stage)
1810169	The reason why I prefer design a program for Peter is because the way he learns is different to my so try to make a program that will suit his needs will be challenging.
1810236	Some interesting aspects of design had surprised me
1810244	All the students had great understanding of their given personas and were able to generate applications that would be helpful for their designated user.

We provided a comprehensive rubric for marking the design during peer review. Some students made specific comments about the rubric and provided suggestions for its improvement (e.g. comment by Participant ID 1810025, Table VII). We believe the rubric provided the undergraduate students those deemed inexperienced in reviewing their peers' design clear guidelines and confidence.

The majority of the students who started the peer review completed it. From Fig. 4, it can be seen that some students took in excess of 127 minutes (mean plus two standard deviation after eliminating one extreme value) to complete the peer review. They may have been interrupted during the peer review tasks however the indications are that the students were keen to complete them. The motivation to complete the peer review and dedication to learning in our study are in line with findings of other researchers, e.g. [42]. It is conjectured that because there was strong personal interaction in the design and peer review tasks the students were motivated to continue the activity until completion.

The strategy provides for students to think 'outside the box' and conceive unconventional solutions such as the remark left by Participant ID 1810236 'The features such as voice capturing system and provide definitions and real life examples can mostly helped at [sic] people like Paul who struggle with linguistic, and help them to builds up their vocabulary in different job areas in life' and participant ID 1810043: 'Thinking of a design of one of the persona was interesting and made me think outside the box'. Thus the students can approach conceptual design in an innovative and creative manner. This is essential to learning but is often difficult to teach. Our findings are in line with other researchers, [12, 19, 35], that peer reviewing allows students to be exposed to their fellow students' designs and to complete their learning.

VIII. CONCLUSION AND FUTURE RESEARCH

In our study we used cross-cultural personas with specific knowledge and cognitive process that had different approaches to learning to teach User-Centered conceptual design to a large cohort of undergraduate students in the

Computing Department. We used peer review for students to assess and critique their peers' conceptual designs according to a rubric. Our results indicate that we have fulfilled our objectives and students learnt the principles of UCD and nuances of design from their peers' different perspectives on design regardless of their own individual approaches to learning.

In this paper, we presented the results of 153 second-year undergraduate Australian students who took part in this study. We initially conducted a profiling survey of the students, and authored a set of six personas, three personas based on Australian students' profiles and three personas based on Vietnamese students' profiles. Each of the Australian undergraduate students conceived a design for an application for one persona followed by peer review. Hence from a pedagogical perspective, they had two opportunities to learn design. Since the marking was done by peer review, it neutralized the supervisor expectation or researcher bias. The results of our empirical study indicate that students, regardless of their approaches to learning, concentrated on design and were motivated to persevere with the peer review activities. It is conjectured that using a cross-cultural persona with specific knowledge and cognitive process creates a sense of working with a real person during design and hence the students persevere with the design and peer review activities.

We found that when both the reviewers and the reviewed students are anonymous, students do objectively review each other's design, critique their fellow students frankly and assign design marks appropriately. The majority of the students co-operated well and performed the peer review actively. They left either positive comments about the study or did not directly express an opinion. Our results are similar to other researchers' findings e.g. [35, 36].

We plan to further this research by varying the persona representation and to study its effectiveness on the conceptual design. We also plan to extend the design session to more detailed design sections.

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APPENDIX

The following Holistic Persona, Minh, represents an archetypical user of the software application which you are designing for her.

Minh is a third-year Arts student at a small university in central Vietnam. Her parents live in a village so she stays in the university dormitory. She has a part time job as a tutor.

Minh tutors for two hours and studies for at least 3 hours every day. She visits the university library. The library has limited modern equipment such as computers. Minh does not have her own computer. Sometimes she uses the computer at the university to do her studies. However she finds that the Wi-Fi bandwidth is limited and the connection is unreliable.

Minh uses mobile phone for communication, like most people in her region. She uses applications such as Facebook and YouTube on her mobile phone. Minh plans her time and uses her resources thoughtfully. She often downloads documents, videos and other materials to study them later.

Minh excels in her studies as she prepares well and reads widely. She attends all her classes regularly, pays attention to lecturers and tutors and occasionally participates in the class discussions. She makes her own notes. She recalls and reflects on the material which she has been taught trying to understand the terminologies as well as the subject matter. She often reviews the lessons given and learns how to rewrite them. She is interested in gaining advanced knowledge. Whenever there are new lessons, Minh searches for information, reads the documents and forums, and watches short videos. She makes herself familiar with the subject matter before the class. She often reads blogs and long posts, asks questions and participates in online discussions. She rarely gets distracted by the online social activities.

Minh often volunteers for a number of activities in her class as well as in her university. She enjoys conversing with her friends and making new acquaintances. Minh accepts requests for help from her friends but makes new appointments only if her schedule permits.

Minh is fluent in her native language and has learnt the basics of the English language. In speaking her native language, Minh has to detect subtle tones. Hence her ears are attuned to recognise sounds in words. However she has difficulty speaking English as she cannot pronounce English words.

Every day Minh watches YouTube and listens to English songs for half an hour to improve her pronunciation. On weekends she travels to the nearby historic town, Hoi An, in order to practice her English by speaking with the tourists. She finds that this option is expensive, time consuming and has limited success.

Minh wishes to learn English so that she can work in a foreign company that pays well.

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