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ORIGINAL RESEARCH

Human behaviour in multimodal interaction: main effects of civic action and interpersonal and problem-solving skills

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Abstract
Metacognitive skill training may rest within any kind of social interaction that requires awareness of what an individual and others think, in social, educational and organizational settings alike. This work is an extensive study of multimodal application interaction (virtual agent, spoken dialogue, visual communication of progress) for metacognitive skill training via negotiation skill training scenarios. Human behaviour, as effected by civic action and interpersonal and problem-solving skill training, is investigated through interaction sessions with a virtual agent on multimodal multiparty negotiation. This work reports on the results of the user-system evaluation sessions involving 41 participants before and after interaction with the system, integrating macro- (dialogue system performance) and micro- (metacognitive-related and individual- and community-level-related attitudes and skills) factors. Findings indicate significant and positive relationships between user and system evaluation questions after interaction with the dialogue system and between self-efficacy, self-regulation, individual readiness to change, mastery goal orientation, interpersonal and problem-solving skills and civic action before and after the interaction experience. Implications, limitations and further research issues are discussed in light of context of the multimodal interaction and its effects on the human behaviour during metacognitive skill training.

Keywords Multimodal interaction · Human behaviour · Skill training · Metacognitive · Individual- and community-level related attitudes and skills

1 Introduction

Metacognition is commonly considered as the knowledge about what an individual knows and how he or she performs, is able to articulate, reflect and regulate during social interaction involving any context of learning and training activities (King 1999). "Thinking about one's own thinking" (Schoenfeld 1987), refers to what an individual acknowledges as his or her own potential in processing information, knowing the features of a given task at hand and following prospective strategies to accomplish it (Flavell 1987; Hollingworth and McLoughlin 2001). Having the ability to reflect upon, understand and control their own learning, or else, knowledge-regulation, metacognitively-aware learners tend to be more strategically oriented and perform better than unaware ones. This is because they are more capable of setting objectives, order them and monitor their learning and execution in a way that directly improves performance (Pressley and Ghatala 1990; Theodosiou and Papaioannou 2006). For this matter, individuals are able to better manage, control, regulate and differentiate their cognitive skills directly, in order to adjust and achieve a successful task performance (Schraw and Dennison 1994). Once they perform well, they are more likely to exhibit greater self-efficacy, that is the motivational belief of achieving challenging tasks and therefore, alter and self-regulate their learning strategies for next activity and vice versa (Pintrich 2003). In other words, the individuals exercise a self-evaluation process though which they mobilize, control, sustain and adapt their thoughts, attention and behaviour

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towards accomplishing any particular action or task at hand (Maes and Karoly 2005). In that sense, they exercise their ability to think logically and analytically to solve problems, communicate effectively with others to assess prospective situations (i.e. interpersonal and problem-solving skills), as well as being oriented towards endorsing mastery as a goal (i.e. mastery goal motivational belief) in their tasks and prefer activities that are challenging and involve further learning (Ames 1992; Moely et al. 2002).

In the case of social interaction, in particular, where individuals perceive others as social actors (e.g. social presence theory; Short et al. 1976), they are likely to experience socially intelligent human-to-human attitudes and behaviours such as preference and liking of teammates, friendliness, perceived social connectedness (i.e. momentary experience of belongingness and relatedness with others; Kaptein et al. 2011) in terms of sharing interests, ideas, being engaged in the interaction per se, establish rapport and develop bonds with their counterparts. In taking this active social role, in essence, they are more likely to support and benefit from opportunities to engage with the society and their community by actively helping others, that is civic action (Moely et al. 2002) and demonstrating favourable responses towards the implementation of change initiatives, that is readiness to change (Armenakis et al. 1993).

Similar human-to-human social intelligence and presence essentials and attributes have been replicated in human-to-digital (virtual) agent interactions (Reeves and Nass 1996). Kurzweil (1999) defines the stream of artificial intelligence as "the art of creating machines capable of performing actions that are considered intelligent when performed by a human" (Goya-Martinez 2016). Since the early development of the field of artificial intelligence and the appearance of Bolt's (1980) "Put That There" demonstration system which processed speech in parallel with manual pointing (Oviatt 1999), a variety of recent multimodal systems has emerged attempting to replicate human-like attitudes and behaviour. The human attitudes and behaviour are manifested in forms such as interpersonal and problem-solving skills, decision making processes, language, gestures and even, lately, emotions, given "anthropomorphic conversational agents" as an end result (Goya-Martinez 2016) or even support mental health problems in young adults, such as social withdrawal (Sumi 2016).

A novel research example of such an Embodied Conversational Agent (ECA) technology application (e.g. Cassell 2001; Pelachaud 2009; Pickard et al. 2014) is the metacognitive skill training through multimodal interaction approach. It utilised artificial intelligence technology for training metacognitive knowledge and skills of both system and users in social, educational and work settings (Alexandersson et al. 2014). The common goal of scientists from multimodal human–computer interaction, cognitive modelling, psychology and technology-enhanced learning involved in that project was to implement and test a multimodal, multiparty and multi-perspective dialogue system with virtual agent engaging in natural interaction with the user through combinations of spoken language, gestures, mimics and body language-going beyond traditional forms of learning experiences (Koryzis et al. 2016).

More specifically, user-feedback evaluation sessions took place in Parliamentary settings and involved exploring:

- Self-evaluations of attitudes and skills corresponding to motivational beliefs in performing challenging tasks more effectively (self-efficacy),
- The ability to mobilize, control and adopt a proactive attitude towards a course of action (self-regulation),
- Endorsing mastery as a goal in course work (mastery goal orientation),
- Skills to adapt, adopt and support change initiatives (individual readiness to change),
- The intention to actively engage in aiding others by getting involved in community programmes and related activities (civic action) and
- The ability to listen and adopt a logical and analytical strategy for solving problems (interpersonal and problem-solving skills), which constitute a significant contribution regarding the connection between artificial intelligence (technology agent-based environments) and such attitudes and skills.

In the case of social orientation and humanitarian attitudes and skills, as civic action and interpersonal and problem-solving skills represent in particular, exploring such aspects of community-related attitudes and skills within intelligent systems applications, constitutes a critical challenge, since strengthening the motivational beliefs, attitudes, skills and knowledge people need in order to signal important contribution in their societies, communities and nations, stands as an ongoing target for long-term civic life responsibility and participation (Anglin et al. 2012). Civics education surveys have long indicated a civic engagement gap existed among youths and prospective differences in civic knowledge among students and adults of various social, economic and cultural status (Kahne and Middaugh 2008), stressing the need to explore current and future civics education acquisition and development differences further, in order to aid potential interventions (Levinson 2010).

Moreover, the existence of individuals' abilities to make a difference both personally and within collaboration with others (self-efficacy), to control (regulate) their beliefs, emotions and attention to guide their actions (or activities) over time, the intentions of endorsing mastery as a goal (prefer courses of actions or tasks that are stimulating, encompass and trigger further learning) and finally, the orientation

(readiness) towards accepting, supporting and sustaining change initiatives wherever needed or instigated, contribute to psychological health and well-being, achievement and positive attitude towards adapting change (Carver and Scheier 1999; Moely et al. 2002; Vakola 2014).

Based on the above rationale and reasoning, the current paper presents an extensive exploration of the associations found between user-system evaluation questions post-interaction with a metacognitive skill training system in terms of application performance and the relationships indicated before-and-after the interaction experience between the aforementioned metacognitive-related and individual-and-community level-based attitudes and skills measured such as self-efficacy, self-regulation, mastery goal orientation, individual readiness to change, interpersonal and problem-solving skills and civic action (feelings of connectedness to community; Moely et al. 2002). The developed approach integrates macro- (dialogue system performance indicators) and micro- (metacognitive-related and individual-and-community level-associated attitudes and skills) factors in intelligent virtual environments domain. Thus, to increase compliance to multimodal systems and investigate the utility of metacognitive-motivational and behavioural proactive indicators as an integral feature of elaborate actions in human-to-virtual social (intelligence-presence) interaction, where social conventions, user affective states, attitudes and motives exercise a significant role (Markopoulos et al. 2005) within an intelligent virtual negotiation context.

The aim of this work is to explore human behaviour in multimodal interaction with the following viewpoints:

a. The measurement of the effect of civic action and interpersonal and problem-solving skill training on human participants using a fully interactional multimodal virtual trainer.
b. The successful administration of seven tests from the literature as an extensive study on civic action and interpersonal and problem-solving skill training measurements on the same participants, before and after interaction.
c. The informed feedback and reflection of participants that provided a detailed account on the effects of the skill training to the participants, such as acknowledging the wishes and needs of the others and the society, as well as the path to achieving positive gain for thyself and the fellow humans through non-aggressive or assertive negotiation.

The rest of the paper is structured as follows: Sect. 2 presents the related work with focus on metacognitive skill metrics. Section 3 introduces the system setup for virtual agents employed in learning and training settings. Section 4 discusses the method and measures, while Sect. 5 presents the results. Section 6 discusses the findings and Sect. 7 concludes the paper and outlines future work.

2 Related work

The need to explore the development and acquisition of successful metacognitive, individual and community-related attitudes and skills to advance effective learning, training and associated interventions, has been strongly indicated in both human face-to-face and intelligent virtual learning interactions over the years (Caridakis et al. 2007; Chae et al. 2016). In this sense, therefore, the integration of intelligent virtual environments (IVEs) in diverse learning and training contexts worldwide remains a challenging issue for learner engagement, motivation, knowledge and skills assessment (Wang 2011). This concern has triggered the long-standing and ongoing target for advanced software engineering (Gratch et al. 2002) to produce sophisticated virtual agents that can support a long-term, consistent and immersive relationship with the learners in a believable (credible), trustworthy and intelligent (cognitive capabilities) manner (Liu et al. 2016).

When virtual agents become a powerful self-motivated tool for applying computer science to education or business, they rely on their virtual environment "architecture" to support or advance the learner knowledge, attitudes and skills in terms of critical thinking, body posture and movement coordination, logical reasoning, interpersonal and problem-solving, decision-making, natural language and affective regulation in bilateral or multi-agent systems context (Kraus 2001; Liew et al. 2013). In the claimed context, virtual learning environments have been reported to assist learners in synthesising thinking skills and critical consideration (Schwienhorst 2002 cited in Henderson et al. 2009), mature students' perceived ability of fulfilling tasks post-interaction (i.e. self-efficacy; Henderson et al. 2009) and favourable attitudes towards their intention to participate in the learning activities (Chae et al. 2016). They have also been indicated to advance higher education learner motivation, ease and confidence during learning experience, assist them to sustain an improved attitude towards their learning activities during interaction and engagement with the learning course objective (i.e. immersion; Grivokostopoulou et al. 2018). Additionally, they are shown to offer relevant tools for advancing learner engagement, participant inspiration through instruction and guided direction to finish the learning tasks and proper feedback (Soliman and Guetl 2014). Intelligent virtual agents have been further demonstrated to motivate, assist and improve learning (Lester et al. 1997) and advance knowledge retention and transfer performance (Holmes 2007; Yung and Paas 2015) in comparison to non-virtual environments (Domagk 2010). In other studies,

virtual agents have been indicated to significantly affect learner perceptions of social presence, improving their confidence in themselves and their eagerness to adopt the agent as a decision tool (Qiu and Benbasat 2009). In such cases, virtual agents are claimed to appear as more convincing to differentiate learner perceptions in task-focused learning environments (like negotiation) when they are appealing than when they are unattractive (Khan and Satcliffe 2014).

Guo and Goh (2015), in their meta-analytic review, report greater learning performance for participants interacting with embodied agents in relation to Heidig and Clarebout (2011) and Yee et al. (2007) who indicated no significant positive impact on learning achievement. In most research cases, as briefly reported above, the exploration of motivation and learning performance for users interacting with virtual agents as well as their attitudinal and behavioural outcomes (user experience), tend to bear equivocal findings. In that respect, the use of virtual agents in real negotiation learning context involving mature participants requires further investigation to verify and measure its effects on users' metacognitive, individual- and community-related attitudes and skills factors.

2.1 Self-efficacy

Individuals with high self-efficacy are more likely to be intrinsically motivated to do challenging tasks and less likely to be anxious about performing them, while those with decreased self-efficacy may be more easily become restrained and abandon courses of action (Bandura 1997). In academic but not limited only to those settings, in particular, Klassen et al. (2010) have indicated, for example, self-efficacy as a motivational factor of learning in that participants exhibiting higher self-efficacy levels tend to perceive challenging tasks as something to be directed and controlled (i.e. mastered), so they can concentrate more on how they will approach their coursework or allocated tasks. Also, increased self-efficacy levels may mediate motivation and achievement, in that young adults who indicate decreased scores on self-efficacy would be more likely to avoid or being less prone to be willing to follow the tasks assigned to them (Prat-Sala and Redford 2010; Komlao 2015).

2.2 Self-regulation

Self-regulation emphasizes the exercise of control in thinking, attention, concentration and flexibility over satisfying daily tasks and demands (Siegel 2007) and is considered to be a motivational factor (variable) in educational (learning), social and organizational settings (Klassen et al. 2010). Self-regulation can be described as the ability of an individual to become a metacognitively, motivationally, and behaviourally proactive participant in any kind of learning and activity process (Zimmerman 2006). Effectively self-regulation is a self-evaluation process of whether individuals possess the ability to mobilize, control, sustain and adapt their thoughts, attention, concentration and behaviour towards achieving a particular action or task at hand (Maes and Karoly 2005). Without self-regulation, the individual may not be able to adjust to changes and respond to daily demands in a flexible manner (Siegel 2007). Previous research in educational context, in particular, has indicated that students exhibiting self-regulation tend to be more academically motivated and better achievers in relation to others, likely to experience increased levels of college attainment, achievement, good health and general well-being (Pintrich 2003; Aspinwall 2004). In effect, complementing self-regulation with self-efficacy, awareness of how to organize and screen a task or course of action at hand, may further be accomplished (Howell and Watson 2007).

2.3 Civic action and interpersonal and problem-solving skills

Civic action and interpersonal and problem-solving skills include aspects of skills and personal attributes regarding civic and social issues, as the intentions to become involved in the future in some community service or action and ability to communicate, think logically and analytically and solve problems (Moely et al. 2002). By actively participating in the future in some community programme by helping others, an individual signals connectedness to community and society, in general. That connectedness to issues of the community and society tends to reflect "an element of an orientation towards others considered to form a basis of citizenship, going beyond self-fulfilment to values about civic involvement and social obligation" (Giles and Eyler 1994), mirroring the attitude that one should adopt to make a difference, a part of what Pascarella et al. (1988) have called "humanitarian and civic values" (Giles and Eyler 1994).

2.4 Individual readiness to change

Armenakis et al. (1993) define readiness as the "cognitive precursor to the behaviour of either resistance to, or support for a change effort". The construct of readiness comprises individuals' positive reactions and responses in supporting and confidence in succeeding to implement change initiatives beneficial in any given social (organizational) context.

2.5 Mastery goal orientation

Individuals who tend to endorse mastery as a goal in their courses of action and work, or attain a goal orientation in performing their tasks based on intrinsic and not extrinsic rewards, are most likely to look for tasks and activities that

are stimulating, encompass and trigger further learning and feel more assertive in their community involvement, taking on and benefiting from prospects to engage with the community and society (e.g. civic engagement; Moely et al. 2002).

3 System setup

For this work, we utilised the Metalogue metacognitive skill training virtual agent interactive dialogue system (Alexandersson et al. 2014). The system itself includes several models (i.e. cognitive, learning, interaction and management ones) as exemplified in many modalities such as spoken natural language, facial expressions, body posture and biosensor data, through face and eye gaze tracking and facial expression encoding, body tracking and body expression encoding, temporal segmentation and recognition of static and dynamic face and body expressions, natural language processing, gesture and facial interpretation with fusion responsible for combining the modality-specific analyses into the dialogue actions. Figure 1 depicts the interaction setup.

When interacting with digital (social intelligent) agents who display human mimicry-matching behaviours, individuals are inclined to treat them like they treat real people (Reeves and Nass 1996). They perceive conversational agents as more engaging (Walker et al. 1994) and react more favourably to them (Sproull et al. 2004). Virtual agents are further perceived as equally influential (persuasive) with other humans in modifying attitudes (Zanbaka et al. 2006) and as good-looking (attractive) and enjoyable females as an indication of more desirable and effective personalities (Khan and De Angeli 2009). In regards to the virtual agent, per se, reciprocal positivity and developed rapport was exhibited by non-verbal behaviours, such as leaning forward, heaving eye contact, smiling and other gesturing, showing friendly interaction style, politeness and thus, expected to provide users (participants) with natural means to foster affinity and trust (Cassell and Bickmore 2000) and influence their perceptions of its social (intelligence) presence (Qiu and Benbasat 2009), connectedness (i.e. developing a bond during conversation, sharing interests and ideas, being involved in the interaction) and trustworthiness by the avatar's attractiveness within the collaborative natural negotiation environment (Khan and Satcliffe 2014).

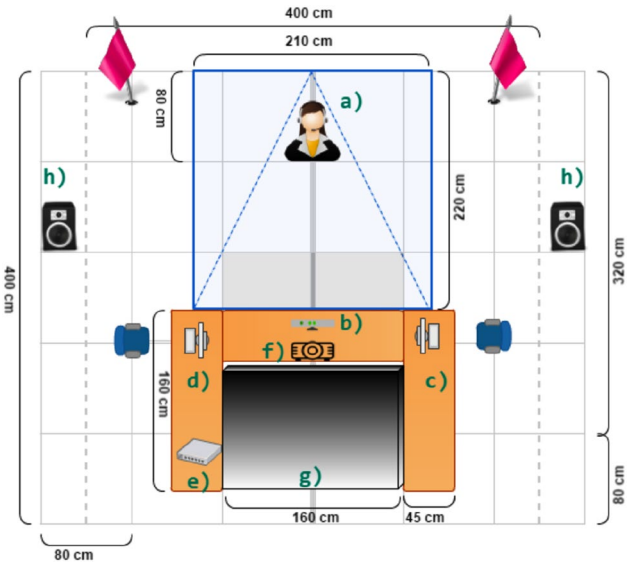

Fig. 1 The interaction experiment setup layout: **a** the user with hands-free headphones, **b** Kinect device for motion recognition, **c** and **d** the processing units, **e** internet connection for connecting to the video and speech analysis servers, **f** projector for user feedback, **g** screen for system feedback to the user (shown in Fig. 2), and **h** audio devices

The system was setup in a quiet room with unobtrusive recording devices. The main screen is depicted in Fig. 2. The user may see the multi-issue negotiation on "smoking banning at the workplace" topic, where the human participant and the virtual agent negotiate on the issues of scope, taxation, campaign and enforcement for the main topic. Blue are positive negotiation results for the human participant, while the red and orange are negative (unwanted) outcomes, orange being less unwanted than red. While are neutral. Each turn, the participant or the agent may decide and communicate their suggestions and receive the response from the other party.

Each user/learner experienced the training system interaction on the same setup. The user could see real-time feedback on the screen, the virtual agent, movements, the system automatic speech recognition from the user voice input and instructions to the users on correcting their posture (Fig. 3).

Multi-party negotiation was initiated by the system virtual agent while the participants were presented with the negotiation space, that is the goals and costs associated with the negotiation aspects they had to involve themselves into and achieve.

4 Methodology and measurements

Prior to the user-system evaluation sessions that took place in the Hellenic Parliament settings, a pilot study was conducted with 5 pilot participants interacting in pairs with the application in order to test consecutive and overlapping visual signals and appraise the load of information presented to the users in order to accomplish completeness and informativeness in the real time application context. Consecutively, 41 participants took part in the user-feedback sessions followed. The average age of participants was 20 years (SD = 5.6) (61% female, 39% male). All participants indicated to be fluent in English-the language

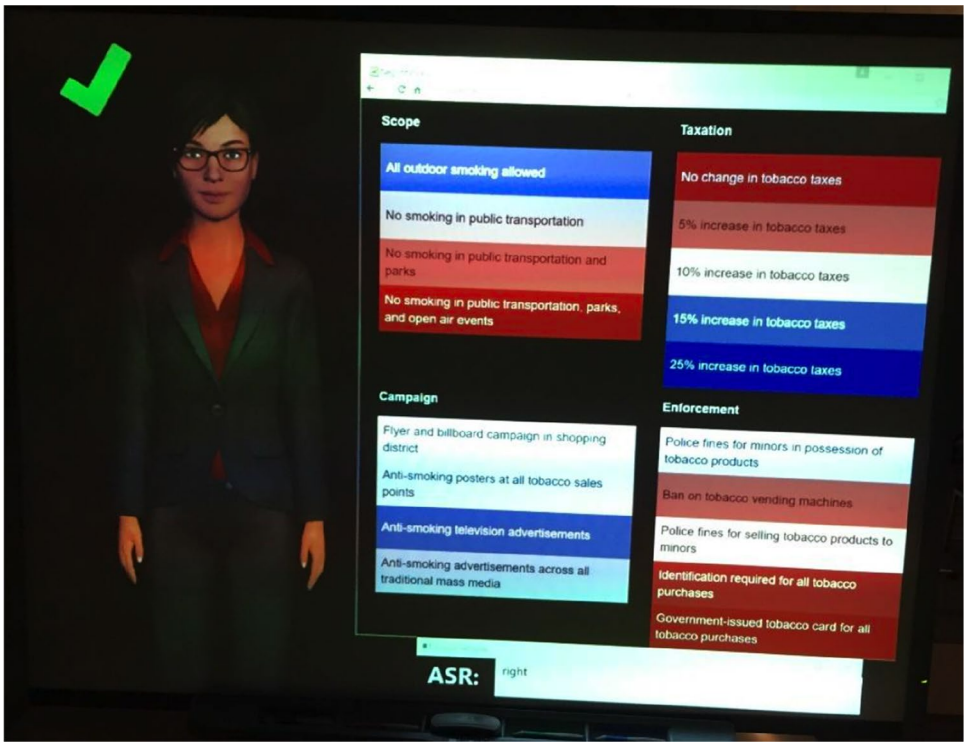

Fig. 2 The Metalogue system interaction display depicting the virtual agent (negotiator) and the multi-issue negotiation space

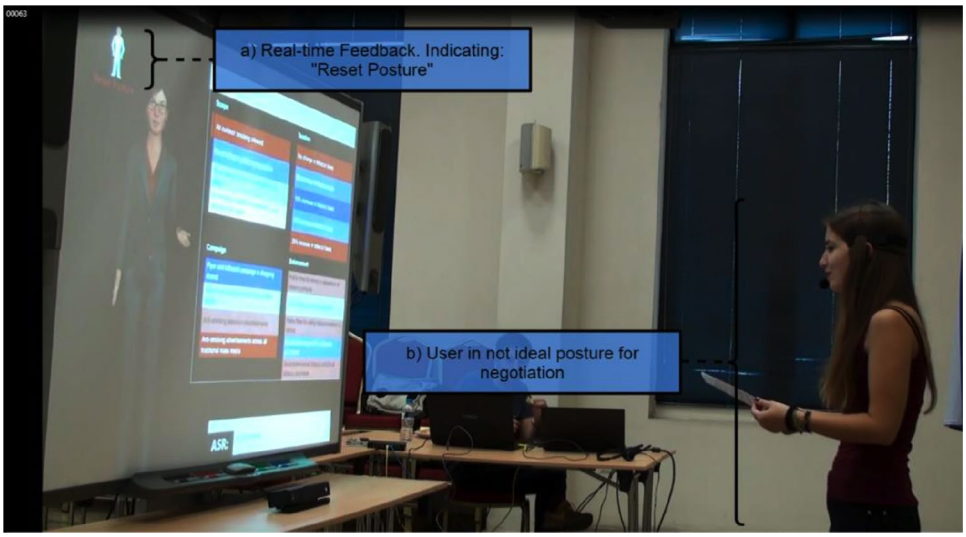

Fig. 3 The system provides multiple types of feedback during the interaction: contextual feedback about the status of negotiation, real-time feedback on the posture of the participant (part of the training), and interaction feedback on what the system understands from the user voice dialog

used by the virtual agent (negotiator)-as used in similar studies (e.g. Kaptein et al. 2011). First, the participants were introduced to the system functionalities, witnessed two demo interactions with the application from the facilitators and were given time to ask for clarifications and sign the participation forms. Then, each participant negotiated three different multi-issue scenarios with the system for an average time of 15 min for all three sessions. The selected time allocation was suggested by invited human trainers and is on par with similar approaches, such as Cama et al. (2011), where the interaction time between human participants and artificial agents was ten minutes. Finally, they answered a pre- and post-interaction experience questionnaire in English. The administered measurement tool comprised of demographic information, user-system experience 5-Likert scale type questions accompanied by the assessment of General Self-Efficacy (Pascarella et al. 1988), Self-Regulation (Komlao 2015), Interpersonal and Problem-Solving Skills (adapted from CASQ (Moely et al. 2002), Civic Action (also adapted from CASQ as above), Individual Readiness to Change (modified version of the

Individual Readiness to Change scale (Vakola 2014) and Mastery Goal Orientation scales (Moely et al. 2002)).

The Civic Attitudes and Skills Questionnaire (CASQ) constitutes a validated instrument of civic attitudes and skills being constructed by incorporating aspects (or implications) of experiential learning, attribution and social learning theories, namely the Experiential Learning Theory (ELT) (Kolb 1984; Kolb and Kolb 2006); Attribution Theory (AT) (Bringle and Velo 1998); Situational Leadership Theory (SLT) (Aspinwall 2004), as follows: individuals may perceive and assimilate concepts as personally meaningful through reflection and active involvement by experience (ELT) (Kolb and Kolb 2006) might adopt either explanations (i.e. why something happens) or inferences (attributes) of their own and others' behaviours within society (AT), that is, inferring characteristics from behaviour, assigning, for example, liability to someone (Lin and Kraus 2010) and the significance of the development of self-efficacy, that is the belief of having the ability to engage in performing certain tasks successfully either individually and (or) in collaboration with others (SLT) (Aspinwall 2004) in various educational and social (organizational) conditions (Low and Ang 2011; Maes and Karoly 2005).

In order to explore the significance of certain aspects of civic attitudes and skills corresponding to those including the intentions to become involved in the future in some community service or action and self-evaluations of ability to communicate, think logically and analytically and solve problems, we used the two CASQ scales pertaining to Civic Action (8 items) and Interpersonal and Problem-Solving Skills (12 items), respectively. As regards Civic Action, participants indicated their agreement or disagreement with each item by marking a five-type Likert scale from strongly disagree (1) to strongly agree (5). Sample item is as follows: "I plan to become an active member of my community". The reliability coefficient in the current study for Civic Action were $a = .93$ and $a = .94$ (before-and-after interaction, accordingly).

In relation to Interpersonal and Problem-Solving Skills scale, participants used the same response five-type Likert format ranging from strongly disagree (1) to strongly agree (5). Example of sample item includes the following: "I try to find effective ways of solving problems". Higher scores on Civic Action scale reflect greater intentions towards actively helping others, being more aware of and feeling more connected to community issues. Higher scores of Interpersonal and Problem-Solving Skills scales indicate respondents feeling as of having higher levels of skills necessary to plan and take an active role in community service, reflecting civic engagement and participation. Internal consistency coefficients in the present study for Interpersonal and Problem-Solving skills were $a = .77$ and $a = .83$ (before-and-after interaction, correspondingly).

The Generalized Self-Efficacy Scale required respondents to indicate the extent to which each statement applied to them by filling in 10 items on a four-point scale ranging from not at all true (1) to exactly true (4). Higher scores reflect greater self-efficacy ability. Sample item comprises the following: "When I am confronted with a problem, I can usually find several solutions". The *a* reliabilities in the current study were Self-efficacy before $a = .78$ and Self-efficacy after $a = .84$, respectively.

The Self-Regulation Scale (Bandura 1991) includes 10 items and participants indicate the extent to which each statement applies to them using a four-point Likert scale ranging from not at all true (1) to exactly true (4), with higher scores indicating greater ability to control and maintain one's attention (including three reverse score items—5, 7, 9). Sample item includes the following: "I stay focused on my goal and don't allow anything to distract me from my plan of action". The reliability coefficients for the above scale in the current study were $a = .65$ and $a = .76$ (before- and after-interaction, respectively). The scale refers to post-intentional self-regulation when individuals are in the phase of goal-pursuit and face difficulties in maintaining their action. In such a maintenance situation it is required to focus attention on the task at hand and to keep a favourable emotional balance. Thus, attention-regulation and emotion-regulation are reflected in the scale items (Schwarzer et al. 1999).

The Individual Readiness to Change Scale is a modified version of Vakola's Individual Readiness to Change, 6-item self-developed scale (Vakola 2014), with respondents self-evaluating their agreement or disagreement with each item, on a five-point Likert scale response format ranging from strongly disagree (1) to strongly agree (5). Sample item is as follows: "When changes occur, I believe that I am ready to cope with them". Higher scores of the scale reflect a greater intention to accept and support changes (item 3 was reverse scored). The reliability coefficients for the aforementioned scale in the present study were $a = .70$ and $a = .74$ (before- and after-interaction, respectively).

The Mastery Goal Orientation Scale (Moely et al. 1995; Beaumont 2010), where participants rated the extent to which they endorsed mastery as a goal (mastery goal motivational belief) in their work or courses, i.e. indicated their preference (or their level of disagreement or agreement) for work that is challenging, involving and stimulates further learning (Moely et al. 2002), includes 8 items on a five-point Likert response format ranging from strongly disagree (1) to strongly agree (5). Example of sample item includes the following: "I want to learn as much as possible". Higher scores of the scale reflect greater orientation towards challenging learning experiences and more self-interested and active approaches to academic life and learning context in general (Moely et al. 2002). The *a* reliabilities in the current study

were Mastery Goal Orientation before $a = .83$ and Mastery Goal Orientation after $a = .87$.

5 Results

The results of the study were objective, collected using the logging capacities of the system, and subjective, through user questionnaires administered by the facilitators.

5.1 Correlations

Table 1 presents the means, standard deviations, α consistency reliabilities and correlations for the study variables.

At the bivariate level, most of the variables correlated significantly and positively before and after interaction with the application, the strongest correlation being that between self-efficacy before-and-after ($r = .82$, $P < .01$) and the weakest between civic action before and self-efficacy after ($r = -.04$, $P =$ ns).

Table 2 presents the Spearman's Rho correlations between users' system experience evaluation questions after interaction with the dialogue system.

In brief, the results indicated that there were statistically significant and positive relationships between users' responses to the questions regarding their beliefs whether the actions of the dialogue system were correct, the interaction with the system made sense to them, the system communicated enough or too much information to them, whether the information given was useful, the communication timely and was easy to complete tasks during the interaction. In addition, whether the pace of interaction was slow or fast enough to feel right and the users knew what they could say at each point of the dialogue, the interaction with the system was natural and easy, whether they believe the concept of metacognitive skill training through negotiation is an interesting idea, the setup of the system is easy to understand and use. Finally, on questions whether they would use the system again if it was an integral part of their training routine, they believe the system has the potential to become a great skill training application, whether they would use a simplified version of the system with the content or functionality they find it interesting, whether the feedback provided to them "during" and "after" interaction was valuable and helped them become more aware of their performance.

5.2 Paired samples t-tests

In order to explore potential differences in the experience of the study variables, *paired samples t-tests* were executed. Their results presented in Table 3 indicate that there seems to be a marginally significant difference between *civic action before-and-after interaction* with the dialogue system,

Table 1 Means, standard deviations (SD), intercorrelations and coefficient alphas of the study variables

	Mean	SD	1	2	3	4	5	6	7	8	9	10	11	12
1. Self-regulation before	2.85	.347	(.65)											
2. Self-regulation after	2.89	.403	.74*	(.76)										
3. Self-efficacy before	3.09	.40	.11	.36*	(.78)									
4. Self-efficacy after	3.27	.43	.19	.47*	.82**	(.84)								
5. Individual Readiness to Change before	4.15	.47	.66**	.62**	.17	.34*	(.70)							
6. Individual Readiness to Change after	4.95	.83	.54*	.63**	.10	.37*	.80**	(.74)						
7. Mastery Goal Orientation before	4.35	.53	.18	.24	.26	.47**	.34*	.32*	(.83)					
8. Mastery Goal Orientation after	4.35	.60	.16	.36*	.35*	.56**	.32*	.36*	.81**	(.87)				
9. Interpersonal and Problem-Solving Skills before	4.15	.471	.37*	.34*	.38*	.44**	.35*	.33*	.52**	.57**	(.77)			
10. Interpersonal and Problem-Solving Skills after	4.13	.511	.27	.41**	.58**	.69**	.42**	.52**	.61**	.63**	.78**	(.83)		
11. Civic Action before	3.58	.979	.39*	.27	−.10	−.04	.34*	.14	.31*	.10	.38*	.14	(.93)	
12. Civic Action after	3.70	1.05	.38*	.37*	−.06	.09	.35*	.20	.37*	.21	.35*	.20	.82**	(.94)

*$P < .05$, **$P < .01$, alpha coefficients are presented on the diagonal (before-after interaction with the dialogue system, i.e. before and after skill training)

Table 2 Spearman's rho correlations between users' system experience evaluation questions after interaction (see "Appendix")

Q	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1																							
2	.45**																						
3	.51**	.41**																					
4	.26	.24	.48**																				
5	.71**	.55**	.57**	.30																			
6	.62**	.32*	.56**	.38*	.59**																		
7	.45**	.56**	.31	.29	.59**	.24																	
8	.28	.23	.41**	.25	.37*	.43**	.28																
9	.17	.42**	.28	.35*	.30	.14	.32*	.13															
10	.37*	.47**	.53**	.40*	.63**	.42**	.52**	.07	.35*														
11	.45**	.43**	.33*	.31*	.47**	.36*	.40**	.12	.41**	.64**													
12	.47**	.27	.27	.34*	.45**	.30	.30	.09	.24	.58**	.58**												
13	.13	.62**	.17	.20	.27	−.01	.33*	.18	.34*	.19	.10	−.10											
14	.17	.53**	.27	.21	.19	−.00	.18	.17	.27	.43**	.42**	.37*	.44**										
15	.26	.52**	.38*	.23	.41**	.41**	.38*	.25	.52**	.56**	.38*	.13	.47**	.37*									
16	.40*	.42**	.56**	.13	.38*	.41**	.16	.32*	.40**	.37*	.27	.19	.36*	.34*	.60**								
17	−.08	.05	.30	.28	.04	.06	.02	−.04	.26	.38*	.34*	.07	.01	.15	.25	.16							
18	.63**	.44**	.40**	.40*	.53**	.35*	.39*	.19	.33*	.37*	.52**	.36*	.21	.45**	.34*	.26	.09						
19	.51**	.48**	.39*	.32*	.48**	.34*	.50**	.13	.17	.31*	.39*	.21	.22	.23	.43**	.25	−.03	.60**					
20	.44**	.21	.35*	.16	.40**	.38*	.24	−.03	.30	.44**	.49**	.24	−.08	.18	.34*	.12	.10	.55**	.63**				
21	.30	.04	.23	.10	.29	.35*	.17	−.10	.04	.34*	.31*	.27	−.36	−.01	.09	.00	−.15	.35*	.53**	.78**			
22	.30	.44**	.51**	.63**	−.08	.40*	.26	.17	.13	.47**	.45**	−.16	.37*	.17	.45**	.56**	.62**	.71**	.26	.51**	.45**		
23	−.10	−.03	.13	.19	−.04	.32*	.25	.17	.18	.09	.12	−.26	.07	.13	.28	.12	.43	.37	.25	.41**	.23	.28	

**Correlation is significant at the .01 level (2-tailed)

*Correlation is significant at the .05 level (2-tailed)

Table 3 Paired samples t-tests

	Sig. (2-tailed)
1. Civic Action before–Civic Action after	$t(39) = -1.98$, $P = .054$ marginally accepted
2. Self-Efficacy before–Self-Efficacy after	$t(39) = -4.42$, $P < .01$**

Before-after interaction with the dialogue system, **$P < .01$

marginally lending support to users' likely to engage in future involvement in civic and community issues, reflecting their attitudes towards helping others in order to make a positive difference, after experiencing the dialogue system interaction.

The significant difference found between *self-efficacy before-and-after interaction* with the system indicates a higher sense of personal competence and mastery *after interacting with the dialogue system*, corroborating to users having stronger belief in their abilities to perform tasks successfully post-dialogue system application.

5.3 Assessment scales and interaction feedback

The assessment scales discussed in Sect. 4 were administered to the participants before and after their interaction with the system. Figure 4 shows how the scale averages for *self-efficacy* and *self-regulation* (Likert 1–4) are computed before and after interaction.

It is evident that for both scales there is a marginal positive difference, hinting that there may be a correlation between the measurements of the two assessment methods.

The same computations were performed for the remaining assessment methods. The scale averages for *interpersonal and problem solving*, *civic action*, *individual readiness to change* and *mastery goal orientation*, before and after interaction are visualized in Fig. 5.

Civic action and individual readiness to change have a positive difference, while master goal orientation is unchanged and interpersonal and problem solving has a marginal negative difference. From this analysis it is shown that the negotiation training sessions user feedback results

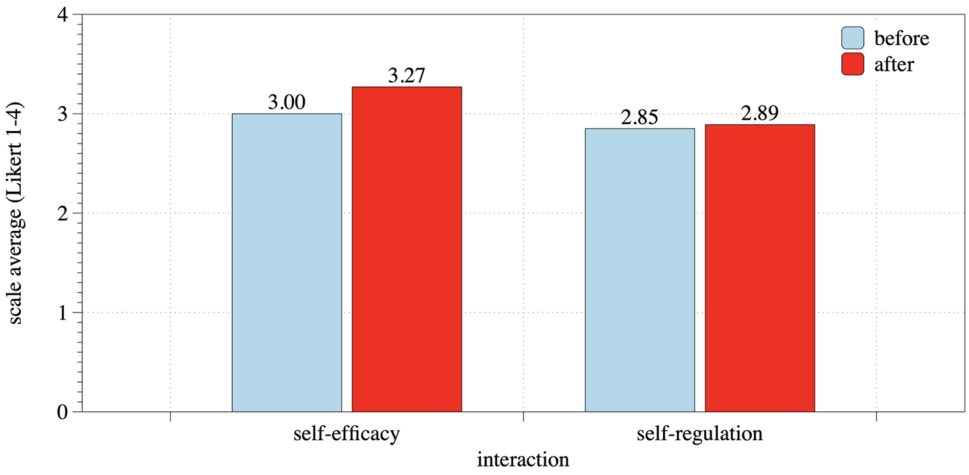

Fig. 4 The self-efficacy and self-regulation scale average, before and after the user interaction with the trainer (system)

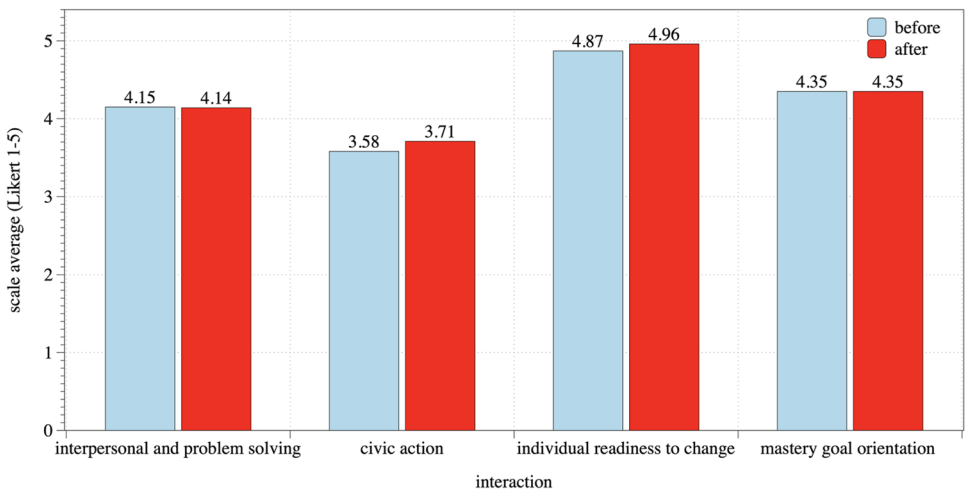

Fig. 5 The interpersonal and problem solving, civic action, individual readiness to change and mastery goal orientation scale average, before and after the user interaction with the trainer (system)

Table 4 Hierarchical regression analyses predicting civic action before interaction

	Civic Action before		
	β	R^2	ΔR^2
Step 1: Main effects Self-efficacy before	−.28		
Step 2: Main effects Self-regulation before	.28		
Interpersonal and Problem-solving Skills before	.39*	.29*	.11*

*$P < .05$ (one-tailed)

Table 5 Hierarchical regression analyses predicting civic action after interaction

	Civic action after		
	β	R^2	ΔR^2
Step 1: Main effects Self-efficacy after	−.10		
Step 2: Main effects Self-regulation after	.42*	.14*	.13*

*$P < .05$ (one-tailed)

in positive difference of a similar magnitude for four out of the six methods.

The above results are indicators that there may be correlation between effects measured by the selected method metrics. Thus, hierarchical regressions were computed to search for model predictors for such possible correlated variables.

5.4 Hierarchical regressions

Hierarchical regression analyses were conducted to test for the prediction of *civic action* and *interpersonal and problem-solving skills before-and-after* users' interaction with the dialogue system. Before proceeding with hierarchical regressions, we assured that all prerequisite conditions related with this analysis (e.g. lack of multicollinearity, deviations from normality, and influential cases) were met. The results from these analyses are presented in Tables 4, 5, 6, 7.

In all analyses corresponding each time to the prediction before and after, respectively, at the first step we entered self-efficacy before-after and then the rest of the independent variables again before-after (self-regulation, interpersonal and problem-solving skills, individual readiness to change and mastery goal orientation), accordingly. The results presented in Tables 4, 5, 6, 7 indicate the outcomes of the final relationships occurred between the prospective variables. A significant relationship was indicated *between interpersonal and problem-solving skills before* and *civic action before* (β = .39, $P < .05$), explaining an additional 11.4% ($F(3, 37) = 5.09$, $P < .01$) of the variance in *civic action pre-interaction* (Table 4). *Self-regulation after* was associated with *civic action after* (β = .42, $P < .05$), explaining an additional 13.8% ($F(2,37) = 3.20$, $P < .05$) of the variance in *civic action post-interaction* (Table 5). The relationships between *self-efficacy before*, *civic action before* and *mastery goal orientation before* with *interpersonal and problem-solving skills before* were significant, indicating *mastery goal orientation before as the best predictor* (β = .30, $P < .05$, β = .28, $P < .05$ and β = .37, $P < .01$, respectively). *Self-efficacy before* accounted for 14% of the variation in *interpersonal and problem-solving skills before* when used as the first predictor, while the final model including all the rest of the independent variables accounted for an additional 11.7% ($F(5,35) = 6.44$, $P < .01$) of the variance in *interpersonal and problem-solving skills before* interaction scores (Table 6). Finally, the associations between *self-efficacy after*, *individual readiness to change after* and *mastery goal orientation after* with *interpersonal and problem-solving skills after* were significant, signifying *self-efficacy after as*

Table 6 Hierarchical regression analyses predicting interpersonal and problem-solving skills before interaction

	Interpersonal and problem-solving skills before		
	β	R^2	ΔR^2
Step 1: Main effects Self-Efficacy before	.30*	.14*	.14*
Step 2: Main effects Self-regulation before	.19		
Civic Action before	.28*		
Individual Readiness to Change before	−.05		
Mastery Goal Orientation before	.37**	.47**	.11**

*$P < .05$ (one-tailed), **$P < .01$ (one-tailed)

Table 7 Hierarchical regression analyses predicting interpersonal and problem-solving skills after interaction

	Interpersonal and problem-solving skills after		
	β	R^2	ΔR^2
Step 1: Main effects Self-Efficacy after	.45**	.48**	.48**
Step 2: Main effects Self-regulation after	−.12		
Civic Action after	.01		
Individual Readiness to Change after	.31*		
Mastery Goal Orientation after	.30*	.63*	.06*

*$P < .05$ (one-tailed), **$P < .01$ (one-tailed)

the best predictor (β = .45, $P < .01$, β = .31, $P < .05$ and.30, $P < .05$, respectively). *Self-efficacy after* accounted for 48% of the variation in *interpersonal and problem-solving skills after* when used as the first predictor, while the final model comprising all the rest of the independent variables accounted for an additional 6% ($F(5,34) = 11.76$, $P < .01$) of the variance in *interpersonal and problem-solving skills after* scores (Table 7).

6 Discussion

The implementation and evaluation of the multi-modal, multi-party and multi-perspective dialogue system employing a virtual agent engaging in natural interaction with the user through combinations of spoken language, gestures, mimics and body language to capture interactive learning behaviour and training metacognitive awareness, knowledge and skills for both system and users in social, educational and work settings alike, indicated significant positive findings as regards the favourable attitudes and skills users experienced after interacting with the dialogue system during our evaluation sessions.

As our results showed, the more users believed the actions of the system were correct, the more the interaction with the avatar made sense and communicated enough and useful information to them, the communication was timely and easy to complete tasks during the interaction, the more the pace of interaction made them feel right and the users knew what they could say at each point of the dialogue, the easier and more natural the interaction was. The participants also provided feedback on the Metalogue system concept, agreeing that it was an interesting approach, with the setup of the system as easy to understand and use. Furthermore, the participants indicated that they would use the system again if it was an integral part of their training routine. They believed the system had great potential for a standalone skill training application and they would also use a simplified version of the system with the content or functionality they found interesting. The feedback they got both during and after interaction was valuable and helped them to become more aware of their performance. In that event, therefore, in terms of dialogue system end-user success in mastering metacognitive knowledge and skills for interactive learning behaviour, overall, the approach was proven to be successful.

The additional exploration of certain attitudes and skills important for beneficial human functioning in any kind of social and community context within our usability testing survey employed, corroborates further to the unique competitive advantage of the proposed approach in achieving to link agent-based environments with valuable human attitudes and skills as self-efficacy, self-regulation, individual readiness to change, mastery goal orientation and aspects of civic attitudes and skills like civic action and interpersonal and problem-solving skills do represent and reflect. Users controlled their beliefs, emotions and attention to guide their actions, made a difference both personally and within collaboration with others *before-and-after interacting* with the system, were positively (or favourably) oriented towards accepting, supporting and sustaining change initiatives wherever needed or instigated, endorsed mastery as a goal (i.e. preferred courses of actions or tasks that are challenging, stimulating and trigger further learning), intended to listen and take the role of others in thinking logically and analytically for solving problems and finally, were positively oriented towards becoming involved in certain community action programmes in the future by helping those in need and motivating others. Participants perceiving of being able to perform tasks with success *before interacting* with the system, were also able to control (regulate) their beliefs, actions and attention to guide their designated actions *after experiencing* the system, preferred challenging tasks which encompass further learning and were helped to take the role of other in thinking logically and analytically in solving problems. Also, users being positively oriented towards adopting and supporting changes wherever initiated, opting for stimulating tasks and actions and taking the role of others in thinking logically and analytically for solving problems *before interacting* with the system, made a difference both individually and in collaboration with others *after experiencing* the negotiation dialogue, extending earlier findings which indicate that self-efficacy is integral to self-regulation, self-regulated learning, taking up on challenges, effort and responses to setbacks (Wilson and Narayan 2016; Bandura 1997; Zimmerman 1989) in diverse educational and actual artificial intelligence settings.

Participants involved in encompassing instigated changes and finding effective ways of solving problems *before interacting* with the system, they were able to control their beliefs, emotions and attention to guide their courses of action *after experiencing* the dialogue system application, extending both the individual-difference perspective of readiness to change favourable effects on change initiatives indicated within work settings (Holt et al. 2007) and the logical and analytical thinking in solving problems with individuals' greater ability to modulate their thought, affect, behaviour or attention via specific mechanisms and supportive meta-skills (Diehl et al. 2006) across changing conditions within flexible and adaptive intelligence systems application.

Users preferring being oriented towards developing new skills trying to understand their courses of actions relied on intrinsic and not extrinsic learning rewards (Moely et al. 2002) and developing their ability to listen to others in attempting to resolve challenging situations through logic and analytical thinking *before interacting* with the system, demonstrate positive responses and reactions in supporting

and confidence in succeeding to implement change initiatives *post-interaction* experience, expanding and relating the favourable effects of such motivational beliefs and civic skills indicated in educational settings for promoting civic engagement (Ames 1992; Moely et al. 2002) to individuals' willingness to accept and support changes in advanced intelligence systems application domain.

Participants who believed in their ability to respond to obstacles or setbacks effectively, exercised control over their intentions, thoughts, actions and attention to perform their courses of action effectively and supported changes, achieved a sense of competence and mastery based on self-referenced standards (Beaumont 2010) *after interacting* with the system, extending earlier favourable influences of such proactive personality attitudes and behaviour constructs in educational and work context obtained (Tims and Bakker 2010; Vakola 2014; Wilson and Narayan 2016) to ones adhering within innovative dialogue systems application context. Users possessing the ability to respond to novel situations effectively, mobilize, control, sustain and adapt their thoughts, attention and behaviour towards achieving their tasks at hand (Maes and Karoly 2005) and confident in change efforts relying on intrinsic learning rewards in achieving a sense of mastery, were able to listen and work cooperatively with others, use logical and analytical thinking and deal with difficult tasks *after experiencing* interaction with the avatar. Those exhibited the ability to become metacognitively, motivationally and behaviourally proactive participants in learning and activity processes (Zimmerman 1989), being confident in and adapting to change efforts, oriented towards developing new skills achieving a sense of mastery as a goal in their actions or tasks and work cooperatively with others to diffuse conflicts and resolve problems by using logical and analytical thinking *before interaction* with the system, were favourably oriented towards becoming active members of their communities signalling their connectedness to their society *post-interaction* experience. These results expand and relate such positive and proactive knowledge, skills, abilities and attitudes (KSAs; Grosssman et al. 2015) inherent in critical social thinking (CST) with aspects of civic attitudes and skills (e.g. civic action and interpersonal and problem-solving skills), elaborating for the first time on a real coordination between the civic attitudes and intelligence systems applications lines of research.

Our findings also indicate a marginally oriented positive attitude of users towards being connected to civic engagement, i.e., helping other people, achieving public goals and mobilizing others (Moely et al. 2002) *after interacting* with the dialogue system (i.e. civic action-post) and contributing to greater ability to make a difference individually and in collaboration with others to carry out a particular course of action successfully (i.e. self-efficacy after). Such significant findings expand earlier ones from education, health, sports and business alike (Cohen and Chaffee 2013) to robust and malleable intelligent systems application embedded for the first time. In that way, they designate a contribution for great potential for both an understanding of the development of civic attitudes and skills for future efforts to help individuals explore and build such attitudes within artificial intelligence domain, even further.

In addition, individuals who evaluated themselves as of intended to be more involved in community action programmes to help those in need *before-interaction* experience, described themselves as high in their ability to listen, to take the role of others, to work cooperatively, make friends and solve problems effectively through logical and analytical thinking. *Post-interaction* with the system, those we were high in modulating their thoughts, feelings, behaviour or attention towards their goal-directed activities within and across the user experience, were more positive in becoming proactively involved in civic and community programmes being oriented towards helping those in need. *Pre-interaction* experience, individuals who described themselves as high in making friends, listening to and taking the position of others seriously in thinking logically and analytically to resolve problems, had stronger beliefs in their own ability to deal effectively with novel or less known situations (as presented during the interaction), were more appreciative and acknowledged their learning experience for its own worth and described themselves as high in being committed to making a positive difference by planning to become involved in the future in their community. *After interacting* with the dialogue system application, users who evaluated themselves as high in communicating well with others and looking for efficient ways to solve problems, they felt more self-efficacious in taking charge and personal initiative (acting proactively) (Morrison and Phelps 1999; Speier and Frese 1997), were more positive in supporting and having more confidence in succeeding to implement change initiatives and high towards developing new skills, trying to understand their tasks, improve their level of competence and achieve a sense of mastery preferring challenging activities, interested in learning for its own worth.

7 Conclusion

The interaction with an adaptive and flexible dialogue system application proved to be very successful in achieving natural multimodal and multi-party user requirements communication between the humans and the virtual agent. The results proved very promising in bringing out the utility of proactive behaviour indicators as an integral part of most complex actions with a high likelihood of success and connect innovative, robust and malleable dialogue systems application with the elements of an orientation towards

others containing personal values about civic involvement and social obligation which mirror the attitude that one should make a difference, a part of what Pascarella et al. (1998) have called "humanitarian and civic values" (Giles and Eyler 1994).

In a nutshell, the development, exploration and integration of contextualized knowledge essentials reflecting macro- (dialogue system performance) and micro- (metacognitive-related and individual-and-community level-related attitudes, skills and behavioural intentions) factors evaluated within virtual agent-based technology domain potentially applicable within multifaceted social conditions involving negotiation, leadership, interviewing and cultural training (Lin and Kraus 2010) in diverse settings, for example, conflict resolution either in educational, diplomatic and personal relationships conditions or even business transactions (Gal et al. 2011), stand themselves as critical contributions, whatsoever.

A longitudinal research design pertaining greater sample size from different sources would allow greater generalizability of our results, however, the practical issues and inherent difficulties associated with the extremely demanding intelligence systems applications research designs to implement, need to be taken into consideration. In addition, a longitudinal replication of this study would clarify that the observed effects on long-term connectedness and persistence over time.

Future research may concentrate on addressing the challenge of approaching such dialogue system applications as fully fledged negotiation tools based on the critical cooperation and coordination such adaptive and flexible systems require for being programmed to negotiate on behalf of and with their human principals (Low and Ang 2011), the process of the negotiation per se followed in terms of the contracting procedure during negotiating, e.g. integration-oriented approach (Agarwal et al. 2012) and the various conditions and defined results regarding the strategy a negotiator could take (Kraus 2001).

Appendix

The Table 2 questions are presented below:

Q1: Do you think the actions of the system were correct?
Q2: Did the interaction with the system made sense to you?
Q3: Did the system communicate enough information to you?
Q4: Did the system communicate too much information to you?
Q5: Was the information provided by the system to you useful?
Q6: Was the system communication to you timely?
Q7: Was it easy to complete tasks in your interaction?
Q8: Was the pace of interaction fast enough to feel right?
Q9: Would you say that the interaction with the system was natural?
Q10: Did you know what you could say at each point of the dialogue?
Q11: Would you say that your interaction with the system was natural?
Q12: Are you confident you know enough about the functionalities and the information found in Metalogue so you would be able to use it on your own?
Q13: How easy was to interact with the system?
Q14: How natural was to interact with system?
Q15: Do you think that the concept is an interesting idea?
Q16: Do you find the setup of the setup of the system intimidating?
Q17: Would you use the system again if it was an integral part of your training routine?
Q18: Do you think that the system has the potential to become a great skills training application?
Q19: Would you use a simplified version of the system with only the content or functionality you find it interesting?
Q20: Was the feedback provided "during" the interaction valuable to you?
Q21: Was the feedback provided "after" the interaction valuable to you?
Q22: Did the feedback that was provided "during" the interaction help you to become more aware of your performance?
Q23: Did the feedback that was provided "after" the interaction help you to become more aware of your performance?

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